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Protecting sticky consumers in essential markets

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Protecting Sticky Consumers in Essential Markets*

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Abstract

This paper studies regulatory policy interventions aimed at protecting sticky consumers who are exposed to exploitation. We model heterogeneous consumer switching costs alongside asymmetric market shares. This setting encompasses many markets in which established firms are challenged by new entrants. We identify circumstances under which such interventions can be counterproductive, both with regard to the stated consumer protection objective and the complementary aim to promote competition.

JEL classification: L11, L13, D4

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1 Introduction

The presence of sticky consumers who fail to switch to cheaper tariffs is arguably one of the most intractable issues faced by competition and consumer protection authorities in

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many market economies.[1] Such customer inertia has been observed in markets involving utilities, including retail energy, basic telecom services, and retail financial services such as current accounts or credit card accounts. These utilities provide essential services that every consumer must purchase to satisfy basic needs and to actively participate in economic and social life.[2] Consumers often show little preference for variety, so that competing offers are perceived as closely substitutable, as long as a minimum level of service quality and reliability is guaranteed. Therefore, the potential lock-in of consumers and their exploitation are significant policy concerns.

Many of these markets have experienced entry by so-called "challenger" firms. Yet challenger firms typically face barriers to entry and expansion because of high customer acquisition costs due to customer inertia. And they risk that the make-up of their customer base is overexposed towards active customers who regularly shop around in search for a better deal.[3] This gives rise to asymmetric market structures, in terms of market shares and switching costs, at least initially. This configuration, therefore, provides the typical background for regulatory intervention to reduce demand side frictions, with the dual objectives of protecting sticky consumers and promoting competition from "challengers".

In this paper, we study regulatory policy interventions aimed at protecting sticky consumers vulnerable to exploitation. We consider a setting in which two homogeneous-good producers with asymmetric market shares - a dominant firm and a challenger - compete for customers whose switching costs are heterogeneous, to the disadvantage of the challenger.[4] Heterogeneous switching costs allow us to distinguish between the firms' "front-book" – made up by new, switching customers – and "back-book" – made up by inert, locked-in customers. We investigate how the distribution of demand-side frictions and market shares interact under various pricing regimes that arise from regulatory intervention.

The regimes our analysis focusses on are history-based price discrimination (HBPD); uniform pricing (UP); HBPD with leakage - i.e. PD whereby facilitating switching to the best tariff within the firm entails a profit sacrifice - , akin to most-favoured-customer clauses (MFCCs); and HBPD with a "peg", equivalent to ratio-based price discrimination - whereby discounts are pegged to the undiscounted tariff.[5] We evaluate these regimes in terms of their implications for price levels, consumer switching and competition. And we investigate

[1] See, for example, [Authority for Consumers and Markets, 2014, Canadian Radio-television and Telecommunications Commission, 2017, Competition and Markets Authority, 2016a,b, Financial Conduct Authority, 2015, Hortaçsu et al., 2017, OECD, 2017].

[2] [Competition and Markets Authority, 2018, UNCTAD, 2018].

[3] [Authority for Consumers and Markets, 2014, Financial Conduct Authority, 2015].

[4] In Section 4.1 we make assumptions that ensure that the distribution of switching costs of customers of the dominant firm first-order stochastically dominates that of customers of the challenger.

[5] We provide examples in Section 5.3 and 5.4.

under what circumstances there may be a trade-off between the consumer protection policy objective to protect "back-book" consumers and the competition policy objective to sponsor "challenger" rival firms.

We find that UP is the least competitive regime, with firms just competing for the dominant firm's marginal customer. This is followed by MFCC where each firm competes with itself to discriminate against its back-book, and where both firms compete for the dominant firm's marginal customer, as in UP; and by ratio-based price discrimination, where the ratio constraint acts as a commitment device to limit the extent of poaching, but both firms make incursions into each other's customer base. HBPD is the most competitive regime, with firms segmenting consumers into the two markets constituted by each firm's customer base.

We also show that an asymmetric regulatory intervention aimed at imposing MFCCs only on the dominant firm would tend to favour the challenger firm. And we argue that the dominant firm may use history-based price discrimination as a means to deter entry by a uniform-pricing challenger.

The paper proceeds as follows. Section 2 connects our study to the large existing literature on price discrimination. Section 3 lays out the policy background of our study and motivates the setup we consider for our model. Section 4 formalises our modelling framework and its underlying technical assumptions. Within the framework of a model with given asymmetric market shares and heterogeneous switching cost distributions, section 5 presents results on the four pricing regimes that are central to this paper. Section 6 extends the framework to a dynamic model that endogenises the asymmetric market structure and the heterogeneous switching cost distributions. Section 7 concludes.

2 Related Literature

Our paper builds on the setting of Chen [1997], but adopts a more general model for continuous switching cost distributions than Chen [1997] does. Our (and Chen's) modelling approach goes beyond the standard approach in the theoretical industrial organisation literature on how behavioural biases affect market outcomes; that approach simply partitions consumers into "sophisticates" and "naives" (e.g., Armstrong [2015], Armstrong and Vickers [2019], Heidhues and Kőszegi [2017]). In section 3 below, we provide a substantive contextual interpretation and justification to our modelling assumption of continuously distributed switching costs.

Our framework is related to Gehrig et al. [2012] who study the welfare implications of HBPD under asymmetric market shares with horizontally differentiated products.[6] We prefer instead to abstract from product differentiation and heterogeneous brand preferences to model competition in "essential markets".[7] We decided to cast our analysis in terms of welfare-reducing heterogeneous switching costs, rather than welfare-enhancing brand preferences, because in the typical essential markets that were subject to regulatory scrutiny and that contextualize our study brand preference does not appear to play a significant role.[8]

We prefer to use a heterogeneous-switching-cost rather than product-differentiation approach because the latter does not fit the context of essential markets. 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; marginal consumers that firms compete over are located farther away from either firm and pay a higher 'delivered' price.[9] In contrast to this, the main competition concern in the context of essential markets with customer interia is that loyal "back-book" customers arguably are the ones being exploited and pay higher prices, compared to marginal, "front-book" customers.

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 vis-à-vis the rival firm. This is in contrast to the view that "challenger" firms, which start by definition with very small market shares, might be over-exposed to the dominant firms' "front-book" customers who are intrinsically active switchers.

Accordingly, our approach is to model differentiated consumers rather than differentiated products, i.e. consumers' heterogeneous switching costs rather than brand preferences. 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

[6] Holmes [1989] investigates symmetric differentiated product oligopolies and shows that uniform prices necessarily lie between discriminatory prices. Corts [1998] relaxes Holmes' symmetry assumption and shows that, when firms differ in their assessment of their weak and strong markets, price discrimination can lead to all-out competition benefitting all consumers.

[7] Armstrong and Vickers [2019] adopt a similar approach, although they stick to the standard "sophisticates" vs "naives" partition and also do not model the presence of an incumbency advantage in terms of asymmetric market shares.

[8] For example, a 2014 YouGov survey of banking customers concludes that few people display unwavering loyalty to their provider, and two in five banking customers state that they would consider switching their account to another provider. Similarly, a GfK survey conducted in the course of the CMA's 2016 energy market investigation found that, with electricity being a homogeneous product, no factor other than price was relevant to energy customers.

[9] See, for example, Bester and Petrakis [1996]. Esteves [2014] study brand preferences in a dynamic duopoly model.

asymmetric baseline market shares.[10] However, we do not impose restrictions on the type of distribution and minima and also study additional pricing regimes, HBPD with leakage and with a peg, besides HBPD and UP.

Furthermore, our analysis of HBPD with leakage adds a new perspective on MFCCs. Unlike in Besanko and Lyon [1993], where MFCCs apply to all customers indiscriminately and thus act as a non-discrimination commitment device, in our setting the use of MFCCs amounts to a form of third-degree price discrimination.

3 Policy Context

Consumer inertia, segmentation into "front-book" and "back-book" customers, and assertions of subsequent exploitation, are recurrent policy concerns.[11] From a competition policy perspective, sticky "back-book" customers are said to convey unfair competitive advantages to dominant firms because they are typically more profitable than "front-book" customers who are more active, regularly shop around in search for a better deal, and have lower switching costs.[12]

The distinction between "front-book" and "back-book" often emerges because firms set contract terms that translate into consumer switching costs. To motivate our setting with heterogeneous switching costs, consider balance transfer credit cards as an example. Credit card providers differ with regard to the terms they offer on new accounts that are set up when consumers transfer existing balances from the old card to the new one. Such terms include a balance transfer fee, the rate and its duration on the balance transferred, annual percentage rates (APRs), etc. The terms differ along multiple dimensions and are therefore hard to compare. More importantly, some aspects of the terms – notable APRs – typically differ depending on the consumer's "personal circumstances". So what consumers see when

[10] Caillaud and De Nijs [2014] provide a dynamic version of Shaffer and Zhang [2000].

[11] For example, in September 2018 the official consumer representative body in the UK submitted a "super-complaint" calling on the national competition and consumer authority, the Competition and Markets Authority (CMA), to launch a cross-sectoral market study to investigate the allegation that disengaged customers who fail to regularly shop around end up being charged excessive prices across a number of essential services. According to the Competition and Markets Authority [2018], "[e]ssential services refer to services that consumers need to participate in society and the economy, and where significant harm might arise if consumers are not able to access the service." They range from mobile and broadband to retail financial services such as home insurance and saving accounts. For example, Citizens Advice [2018] found that 8 in 10 people are currently charged significantly higher prices for remaining with their existing supplier in one or more essential markets. Their best estimate of the individual cost of this "loyalty penalty" stands at almost £900 per year. The CMA considered a variety of remedies, such as: (i) limiting price differences through tying; (ii) requiring suppliers to upgrade inactive customers to their best tariff (i.e., the cheapest based on the specific consumption profile); and (iii) imposing an absolute price-cap.

[12] [Productivity Commission, 2018].

they shop around is only representative, but eliciting the precise terms that apply to the individual consumer is costly because it requires going through a screening process at the respective banks, and it is even costlier for consumers with subprime credit histories.

Another example is overdraft facilities on current accounts. Ahead of switching banks, it is usually impossible to find out what the terms of an overdraft facility – limit and fees – will be. This is a particularly acute concern for "overdraft prisoners", i.e. consumers who excessively used their existing overdraft facility or are in breach of their current overdraft limit and consequently find it very difficult to switch.

Compounding the issue of customer inertia creating entry and expansion barriers, incumbents can recur to the use of behavioural-based price discrimination (BBPD) in order to stifle the growth of "challenger" firms or deter entry altogether [Chen, 2008]. 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.[13] The combined effect of the initial asymmetry of market shares and the potential exploitation of a large portion of locked-in consumers suggests potentially very large consumer detriment.[14]

A number of consumer protection interventions have been considered by regulatory authorities, from price discrimination with and without pegging constraints over MFCCs to bans on price discrimination. These vary in terms of their distributional consequences. But they may also be contentious from a competition policy perspective. For example, on the one hand, it is well-established that the use of HBPD under oligopoly can intensify pricing rivalry where competing firms exhibit best-response asymmetry, in that they hold opposing view as to which consumers are "strong" and which are instead "weak" [Armstrong, 2006]. On the other hand, the use of HBPD by the dominant firm may be part of an exclusionary anticompetitive strategy aimed at foreclosing a potential entrant whilst mitigating the entailed profit sacrifice [Chen, 2008, Fumagalli and Motta, 2013, Gehrig et al., 2012, Karlinger and Motta, 2012].

The investigation of the implications of discriminatory pricing on competition with asymmetric market shares is policy relevant because, at least in Europe, the abuse of market dominance is only an issue, in light of Article 102 of the Treaty on the Functioning of the European Union, if the firm in question holds a dominant position.[15]

[13] See, for example, [Financial Conduct Authority, 2017] and [Competition and Markets Authority, 2016a], para 8.232ff, which provides evidence of price discrimination between new start-ups and established businesses with respect to business current accounts.

[14] [Competition and Markets Authority, 2016a,b, Hortaçsu et al., 2017].

[15] Baker and Salop [2015] advocate a similar approach, stating " U.S. antitrust law could do more to address inequality if the antitrust laws also addressed monopolistic "exploitative" conduct along the lines of the European prohibition against abuse of dominance".

4 Model Setting and Assumptions

We start by laying out our assumptions on our homogenous-good duopoly model. The model has two asymmetries: Each firm's customers exhibit a distribution of switching cost – i.e. customers have heterogeneous switching costs –, and these distributions differ across firms; and the two firms have asymmetric market shares. In Section 5, we then explore a series of pricing regimes within this setup in a static model in which the dominant firm, with a larger market share, has a customer base whose switching costs tend to be higher than those of the customers of the smaller, challenger firm. In Section 6.4, we discuss how this asymmetric market structure can be endogenised.

4.1 Heterogeneous Switching Costs

Suppose customers, with a total mass of unity, purchase a homogeneous product produced by one of two firms, A and B.

Customers of firm A have switching costs s_A that are distributed with CDF $F_A(s)$ for $s \in \mathcal{S}_A \subseteq \mathbb{R}_+$, and customers of firm B have switching costs s_B with CDF $F_B(s)$, $s \in \mathcal{S}_B \subseteq \mathbb{R}_+$. We assume that $0 = \min\{s : s \in \mathcal{S}_A\} = \min\{s : s \in \mathcal{S}_B\}$. Our setting 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 $F_A(s) = F_B(s)$ for all $s \in \mathcal{S}$. Firms do not observe their or their rival's customers' switching costs, but they know their respective distributions. We assume that both CDFs are continuously differentiable so that their pdfs $f_A(s)$ and $f_B(s)$ exist.

We make the following assumption:

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

$$f_A(s)f_B(t) - f_A(t)f_B(s) \geq 0 \quad \forall s \geq t.$$

The MLR assumption has been discussed and used widely in microeconomic theory [Athey, 2002, Karlin et al., 1956, Lebrun, 1998, Maskin and Riley, 2000].

The MLR assumption implies that the distribution of firm A's customers' switching costs F_A first-order stochastically dominates that of firm B's customers' switching costs, i.e. $F_A(s) \leq F_B(s)$ for all $s \in \mathcal{S}_A \cup \mathcal{S}_B$.[16] It also implies that $\mathbb{E}[s_A] \geq \mathbb{E}[s_B]$.[17] So the setup allows for firm A's customers to be more likely to have higher switching costs than firm B's, and thus for their average switching costs to be higher. In other words, the model allows for firm A's customers to be more likely to be locked-in than firm B's.

[16] 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 $\sup \mathcal{S}_B \leq \inf \mathcal{S}_A$.

[17] This follows from $f_B(t)sf_A(s) \geq f_A(t)sf_B(s)$, integrating w.r.t. s and t over $\mathcal{S}_A \cup \mathcal{S}_B$.

Furthermore, the MLR assumption implies the hazard rate (H) inequality:[18]

$$\frac{f_B(s)}{1-F_B(s)} \geq \frac{f_A(s)}{1-F_A(s)} \quad \forall s \in \mathcal{S}_A \cup \mathcal{S}_B.$$

Similarly, the MLR assumption implies the reverse hazard rate (RH) inequality[19]:

$$\frac{f_A(s)}{F_A(s)} \geq \frac{f_B(s)}{F_B(s)} \quad \forall s \in \mathcal{S}_A \cup \mathcal{S}_B.$$

We make the following second assumption:

Assumption 2: (*Log-Concavity*) The densities $f_A(s)$ and $f_B(s)$ are log-concave.[20]

The implications of assuming log-concave densities have been discussed in Bagnoli and Bergstrom [2005]. They include that:

(i) the cumulative distribution functions $F_A(s)$ and $F_B(s)$ are log-concave;

(ii) the hazard rates $\frac{f_A(s)}{1-F_A(s)}$ and $\frac{f_B(s)}{1-F_B(s)}$ are monotonically increasing; and

(iii) the reverse hazard rates $\frac{f_A(s)}{F_A(s)}$ and $\frac{f_B(s)}{F_B(s)}$ are monotonically decreasing.[21]

We will make use of these in deriving the key analytical results of this paper.

4.2 Asymmetric Market Structure

Suppose firms A's market share is $x_0 \in (\frac{1}{2}, 1]$ – i.e. we think of firm A as the dominant firm – and B's market share is $1 - x_0$ – we think of it as the challenger firm. We treat x_0, F_A and F_B as predetermined, and we discuss in Section 6.4 how this market structure can be endogenised.

We also assume firms have the same constant marginal cost which we normalize to zero.[22]

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. We assume throughout that consumers' valuations for the

[18] This follows from rearranging and integrating w.r.t. t up from s. This inequality implies that the model allows, for any s, that firm A's demand exhibits a lower own-price elasticity than firm B's demand.

[19] 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.

[20] Recall that a density $f(s)$ is log-concave if $\ln(f(s))$ is concave, i.e. if $f''(s) - \frac{(f'(s))^2}{f(s)} \leq 0$ for all s in the support of f.

[21] Property (i) follows from Theorem 1 of Bagnoli and Bergstrom [2005], (ii) from their Corollary 2, and (iii) from property (i).

[22] As we do not wish to consider cost efficiencies in our analysis, this is without consequence for our results. We discussion extensions to asymmetric cost structures in section 6.1.

homogeneous product exceed prices so that every consumer is served, and that consumers are price-takers.[23]

5 Analysis of Asymmetric Market Structure

In this section, we consider four pricing regimes: history-based price discrimination (HBPD), uniform pricing (UP), HBPD with leakage (or MFCCs), and ratio-based price discrimination. We show that, in terms of a consumer protection authority's objective of low prices, in our setting HBPD dominates ratio-based price discrimination and HBPD with leakage (MFCCs), both of which in turn dominate UP.[24] And we discuss implications of these rankings for consumer welfare and competition.

5.1 History-Based Price Discrimination

In this subsection we develop the history-based price discrimination model. In this setting, firms can discriminate between customers based on their purchase history. Under our Assumption 1, customers have sorted themselves such that the dominant firm A's customers tend to have higher switching costs than those of the challenger firm B.[25]

Each firm chooses a price to its retained, "back-book" customers – p_A and p_B –, and it offers a discount – m_a and m_B – to those consumers who previously did not buy from it, but from its rival, i.e. to its rival's "front-book" customers. A Nash equilibrium, relative to x_0, in discriminatory prices in our setting involves for each firm two strategic variables, firm specific prices p for retained customers and discounts m to these prices offered to customers poached from the respective rival firm, (p_A, p_B, m_A, m_B), where each firm takes its rival's prices as given.

Consider a customer of firm A. If the customer stays with firm A, he will face price p_A. If he switches to firm B, he will be charged at B's poaching price $p_B - m_B$ and incur a cost of switching. Given these prices, firm A's and B's marginal customers who are just indifferent

[23] In principle, our analysis applies to business-to-business relationships as well, as long as buyers face suppliers that make take-it-or-leave-it offers.

[24] Without restrictions on model parameters, no ranking in terms of pricing between ratio-based price discrimination and MFCCs is possible. However, we will show that there is bi-directional customer switching between firms with the former, while there is only one-directional switching with the latter.

[25] We discuss in Section 6.4 how such sorted customer bases and the asymmetric market structure can come about endogenously.

between staying or switching therefore have switching costs

$$\sigma_A = p_A - p_B + m_B. \quad (1)$$

$$\sigma_B = p_B - p_A + m_A. \quad (2)$$

Therefore, firm A can expect to retain a fraction $\Pr(s_A \geq \sigma_a) = 1 - F_A(\sigma_A)$ of its customer base x_0 – these are its locked-in or back-book customers –, and to lose a fraction $F_A(\sigma_A)$; a symmetric argument holds for firm B. Hence,

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

Then, the firms' profits are given by

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

After straightforward algebra, it follows that the firms' profit maximization problems yield the following first-order conditions for an interior solution,[26]

$$p_A^D = \frac{1 - F_A(\sigma_A^D)}{f_A(\sigma_A^D)} \quad (3)$$

$$p_B^D = \frac{1 - F_B(\sigma_B^D)}{f_B(\sigma_B^D)} \quad (4)$$

$$p_A^D - m_A^D = \frac{F_B(\sigma_B^D)}{f_B(\sigma_B^D)} \quad (5)$$

$$p_B^D - m_B^D = \frac{F_A(\sigma_A^D)}{f_A(\sigma_A^D)}, \quad (6)$$

where p_i^D and m_i^D denote firm i's optimal price and discount, and $\sigma_i^D = p_i^D - p_j^D + m_j^D$, $i, j \in \{A, B\}$ and $i \neq j$. The first-order conditions show that the firms' discounted prices, $p_i^D - m_i^D$, are set with respect to its rival's "front-book", i.e. with respect to the rival firm's customers' switching cost distribution. Thus, they serve as a poaching devices to induce the

[26]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. Superscript D denotes the optimal values under HBPD.

rival firm's customers to switch. The respective marginal customers that are being poached have switching costs σ_i^D that satisfy

$$\sigma_A^D = \frac{1 - 2F_A(\sigma_A^D)}{f_A(\sigma_A^D)} \tag{7}$$

$$\sigma_B^D = \frac{1 - 2F_B(\sigma_B^D)}{f_B(\sigma_B^D)}. \tag{8}$$

The marginal customers σ_i^D and undiscounted prices, p_i^D, are determined by the firms' "back-book", i.e. their respective own customers' switching cost distributions, as a device to exploit their lock-in.

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.[27] This shows that Chen's original results are robust to distributions satisfying our Assumption 1.

What is the reason for the irrelevance of x_0? With HBPD, both firms treat their home turf – x_0 for firm A and $1 - x_0$ for firm B – as separate markets on which they compete setting prices: p_A^D for A's "back-book" customers, and B's poaching price $p_B^D - m_B^D$ for A's "front-book" customers; and similarly, $p_A^D - m_A^D$ for B's "front-book" customers and p_B^D for B's "back-book" customers. On these markets, profits are linear in the respective market sizes x_0 and $1 - x_0$, respectively, and hence x_0 is irrelevant for the optimal pricing strategies which are determined by F_A – (3) and (6) – and F_B – (5) and (4) –, respectively.[28]

Under our assumptions, we can obtain the following results.

Lemma 5.1. *Under Assumptions 1 and 2, the dominant firm A's back-book customers have higher switching costs than the challenger firm B's back-book customers. Formally, $\sigma_A^D \geq \sigma_B^D$.*

The proof of Lemma 5.1, as proofs of all subsequent results, are in Appendix A. Figure 1 illustrates this (and subsequent) results on the respective marginal customer's switching costs. 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.

The preceding Lemma is useful in order to establish the following

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[27] This could arise, for example, as a consequence of network effects. See, for example, the discussion in Farrell and Klemperer [2007]. An alternative explanation could be that normally consumer inertia takes time to set in, so firms that have been active for longer are bound to have a larger stock of "back-book" customers and thus a larger customer base than newer firms that can only grow gradually as they compete for the new cohort of unaffiliated consumers and manage to retain them long enough for them to mature into "back-book" customers.

[28] Indeed, it is straightforward to show that separate optimizations over the two markets – i.e. with respect to p_A and $p_B - m_B$ over A's customer base, and with respect to p_B and $p_A - m_A$ over B's customer base – yield the HBPD outcomes (3) – (6).

Proposition 5.1. *Under Assumptions 1 and 2, the dominant firm A's back-book customers pay higher prices than the challenger firm B's back-book customers; and the dominant firm offers larger discounts than the challenger. Formally,* $p_B^D \leq p_A^D$*, and* $m_B^D \leq m_A^D$.

Figure 2 illustrates this Nash equilibrium. The 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.

It may be worth noting that, without further restrictions, it is possible that $m_B^D < 0$. The reason is that B's discounted price is set with respect to its rival's customers' switching cost distribution F_A, while its undiscounted price is set with respect to that of its own customers, F_B.[29] Therefore, it is *not* necessarily the case that the challenger's poaching price $p_B^D - m_B^D$ undercuts the dominant firm's poaching price $p_A^D - m_A^D$.[30]

5.2 Uniform Pricing

Consumer protection agencies see the persistent exploitation of "back-book" customers by means of HBPD as problematic.[31] They traditionally rely on disclosure remedies to induce consumers to switch. Support for disclosure remedies has been waning, however, in light of evidence that the use of prompts and alerts is ineffective towards a core of "back-book" customers with high switching costs.[32] Accordingly, there are calls for stronger remedial interventions aimed at directly restricting firms' ability to exploit "back-book" customers on fairness grounds.[33]

[29] It is easy to construct analytical examples that exhibit this feature. We thank Ken Hori for pointing this out.

[30] 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 $f_A(s) = f_B(s) = \frac{1}{\theta} 1_{\{s \in [0,\theta]\}}$, $\theta > 0$.

[31] This concern is compounded to the extent that inert customers are often "vulnerable" due to certain demographic characteristics such as low income, old age or generally limited awareness [Competition and Markets Authority, 2016b, 2018, Financial Conduct Authority, 2018b].

[32] [Adams et al., 2018, Financial Conduct Authority, 2018a]. For example, during the second half of 2015 the FCA tested the use of a return switching form where customers were sent a letter with an indication of potential gains from switching to the best internal rate (i.e., offered by the same provider) and the best competitor rate based on a non-personalised balance example (£5,000), plus a tear-off return switching form pre-filled for a switch to the best internal rate, along with a prepaid envelope. In the nine weeks following the receipt of the letter, internal switching increased from a baseline of less than 0.5% to slightly above 8.5%, whereas external switching hardly changed. See Adams et al. [2016]

[33] See Competition and Markets Authority [2016b], Financial Conduct Authority [2018a,b], UK Department for Business, Energy and Industrial Strategy (BEIS) [2018]. The BEIS Consumer Green paper states (para. 41): "We believe there should be a new approach by government and regulators to safeguard consumers who, for whatever reason, remain loyal to their existing supplier so that they are not materially disadvantaged. Exploitation of these customers by charging them significantly higher prices and providing poorer service is a sign of a market that is not working well and should be tackled vigorously." See also UK Government,"Victory

A straightforward option would be to ban price discrimination altogether, so that firms are only allowed to set one price for both, "back-book" and "front-book" customers, be they existing and prospective ones.[34] This remedy effectively implements a uniform pricing regime, so that each firm charges the same price to all of its customers.

With uniform prices, either some of firm A's customer switch – if firm A's uniform price exceeds firm B's uniform price –, or some of firm B's customers switch, but not both. Consider the first of these two cases. In this case, firm A's marginal customer is just indifferent between paying firm A's price p_A or firm B's price p_B and incurring the cost of switching to B. Hence, firm A's marginal customer's switching cost $\sigma_A = p_A - p_B > 0$.

In this case, firm A only retains a fraction $1 - F_A(\sigma_A)$ of its customer base x_0, while firm B retains its entire customer base $1 - x_0$ and expects to gain a fraction $F_A(\sigma_A)$ of A's customer base. Hence, firms' expected demands are

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

Only the distribution of switching costs of firm A's customers who have the option to switch matters in this case. The distribution of firm B's customers' switching cost is irrelevant.

The firms' profits are

$$\begin{aligned} \pi_A(p_A, p_B) &= p_A x_0 \left(1 - F_A(\sigma_A)\right) \\ \pi_B(p_A, p_B) &= p_B \left(1 - x_0 + x_0 F_A(\sigma_A)\right), \end{aligned} \tag{9}$$

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

$$p_A^u = \frac{1 - F_A(\sigma_A^u)}{f_A(\sigma_A^u)} \qquad p_B^u = \frac{1 - x_0 + x_0 F_A(\sigma_A^u)}{x_0 f_A(\sigma_A^u)}, \tag{10}$$

where superscript u distinguishes optimal prices and marginal switching costs with UP.

With uniform prices, firm A's marginal customer has switching cost

$$\sigma_A^u = p_A^u - p_B^u = \frac{2x_0 \left(1 - F_A(\sigma_A^u)\right) - 1}{x_0 f_A(\sigma_A^u)} = \frac{1 - 2F_A(\sigma_A^u)}{f_A(\sigma_A^u)} - \frac{1 - x_0}{x_0 f_A(\sigma_A^u)}. \tag{11}$$

for consumers as cap on energy tariffs to become law - New bill will protect millions more households from unfair price rises", Press release, 19 July 2018, available at `https://www.gov.uk/government/news`.

[34] A similar outcome would result from a requirement that firms automatically upgrade consumers to their cheapest available tariff. Although such a draconian intervention would normally be considered to be a sort of backstop remedy of last resort, the UK Financial Conduct Authority recently proposed this type of remedy twice, for savings accounts and overdraft charges [Financial Conduct Authority, 2018a,b].

Comparing (11) with (7), as illustrated in Figure 1, shows that $\sigma_A^u < \sigma_A^D$ for $x_0 > \frac{1}{2}$.[35]

The expression (11) also shows that σ_A^u and hence the optimal uniform prices depend on x_0. First, (11) shows that σ_A^u increases with x_0. Second, if F_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 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.[36] While the situation of F_A (and / or F_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.[37]

The first-order conditions above have an interesting interpretation.[38] Firm A's reaction function is the same as in the case of HBPD as it relates to its customer base. For the challenger firm B, however, its reaction function is

$$\frac{\partial[p_B F_A(p_A - p_B)]}{\partial p_B} = -\frac{1 - x_0}{x_0}, \tag{12}$$

i.e. its reaction function relating to the dominant firm's customer base shifts out, relative to the case of HBPD. This is illustrated in Figure 2. Hence, the challenger firm competes less vigorously with uniform prices than under HBPD. And this softening of competition is stronger if the challenger's market share $1 - x_0$ is larger.[39] This result is formally given by the following proposition.

Proposition 5.2. *Under Assumptions 1 and 2, with uniform pricing, as compared to HBPD, competition for the dominant firm's customer base softens: firm A retains a higher fraction of its customer base as its back-book and charges a price that exceeds the prices charged to back-book (and hence also) customers under HBPD. The challenger's customers also pay a higher price. Formally,* $\sigma_A^u \leq \sigma_A^D$, $p_A^u \geq p_A^D$ *and* $p_B^u \geq p_B^D - m_B^D$.

This result shows that in our setting with heterogeneous switching costs, where both firms hold the different views about the two markets – each firm considers its own customer base as

[35] Expression (11) also shows that $x_0 > \frac{1}{2}$ is necessary and sufficient for an equilibrium with $p_A^u > p_B^u$ to exist.

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

[37] For example, this may be thanks to interventions such as Open Banking in the UK which is meant to reduce the inconvenience of disengaged consumers when shopping around.

[38] We are indebted to John Vickers for pointing this out.

[39] B's reaction function satisfies $\frac{\partial}{\partial p_B} p_B F_A(p_a - p_B) = -\frac{1-x_0}{x_0}$. B's profit earned on customers switching away from A is concave, $\frac{\partial^2}{\partial p_B^2} p_B F_A(p_A - p_B) = -2f_A(p_A - p_B) + p_B f_A'(p_- p_B) = -2f_A(p_A - p_B) + \frac{F_A(p_A - p_B) f'(p_A - p_B)}{f_A(p_A - p_B)} < 0$ because F_A is log-concave.

its strong market – and hence there is "best-response asymmetry", price discrimination need not necessarily intensify competition for all consumers: While all of A's customers and B's "front-book" customers benefit from price discrimination, B's "back-book" customers may or may not benefit from price discrimination, compared to uniform pricing.[40] Proposition 5.2 reinforces the observation that with uniform prices competition focuses on the dominant firm's customer base only, and the challenger competes less vigorously.[41] This result differs from the unambiguous predictions in models of heterogeneous brand preference and "best-response asymmetry", e.g. Bester and Petrakis [1996] and Corts [1998]. The 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 some, if not all, locked-in customers.

Note that our argument implies that, while $\sigma_A^u \leq \sigma_A^D$, for x_0 high enough $\sigma_A^u \geq \sigma_A^D - \sigma_B^D$. So for high initial market share x_0, firm A loses more market share under uniform prices than under HBPD. Therefore, this type of intervention would give rise to a trade-off between the competition policy objective of sponsoring the challenger firm and the consumer protection objective of protecting "back-book" consumers, but in the opposite direction to what is intended, as under uniform pricing consumers are worse off while the challenger can expand more. 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.

Since uniform pricing is less competitive than HBPD - as seen from (12) -, it is more profitable for both firms. However, the uniform pricing outcome suffers from the problem that it is not sustainable as an equilibrium unless both firms can commit to charging a single price, because price discrimination is always a dominant strategy (Thisse and Vives [1988]). In the model, as in many real-world situations, firms lack that commitment. We will see below how (ratio-based) constraints on the extent of price discrimination can act as a commitment device that allows firms to credibly approximate the uniform pricing outcome.

[40] Beckert et al. [2020] provide empirical evidence that in a spatially-differentiated product market price discrimination, compared to UP, benefits most, but not all customers. In that application, switching costs relate primarily to transport.

[41] Figure 2 depicts a case where the shift in the challenger's reaction function is sufficient for the challenger's uniform price p_B^u to exceed p_B^D.

5.3 Price Discrimination with Leakage (MFCCs)

From a consumer protection policy perspective, the traditional view is that consumer disengagement is best addressed by improving transparency. For example, authorities can impose disclosure remedies such as requiring firms to send reminders to their customers when a promotional period is about to expire, perhaps detailing how much they could gain by upgrading to another promotional deal offered by the same provider that is typically targeted at new customers.[42] Nevertheless, firms can still rely on HBPD to the extent that existing inert customers might struggle to take corrective action in response to prompts and alerts by the current firm or from third-party intermediaries.

In this sense, it could be argued that HBPD subject to disclosure effectively resembles most-favoured-customer clauses (MFCCs) when consumers face heterogeneous "hassle" cost to enforce their right to have their current service provider match the lower price offered to other (potentially new) customers.[43] We label this configuration HBPD with "leakage", as this intervention effectively imposes a profit sacrifice, due to the risk of revenue cannibalisation as a result of "internal" switching, when poaching rivals' customers.

We model HBPD with leakage as follows. A firm offers its inducement m_j^L, $j = A, B$, aimed at its rival's customers as in subsection 5.1, to its own customers as well. Suppose internal switching to the sweetened tariff is only a fraction $\alpha \in (0, 1)$ as costly as external switching. If 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.[44] The reason is that B's equilibrium poaching

[42] [Financial Conduct Authority, 2015]. See [Competition and Markets Authority, 2016a] for a more sophisticated version of this type of remedy, labelled Open Banking, whereby the largest incumbent banks are required to adopt a standardised application programme interface (API) through which smaller banks and third party intermediaries such as price comparison websites will be allowed to access, with the customer's consent, data on individual consumption profiles and applied tariffs in order to be able to show consumers tailored price comparisons. The UK Financial Services Consumer Panel commissioned a study (published in June 2019) into automatic upgrades of bank customers; see `https://www.fs-cp.org.uk/sites/default/files/automatic_upgrades_research_report.pdf`.

[43] See Akman and Hviid [2006] for a discussion of MFCCs from the perspective of competition law. MFCCs have been considered by Besanko and Lyon [1993]. In their analysis, they treat MFCCs as an insurance for customers, in the sense that the firm adopting an MFCC cannot discriminate between customers and must charge the same price to all customers. In our analysis, MFCCs are treated as an option offered to existing customers that they may or may not exercise, depending on their idiosyncratic inertia. This is motivated, for example, by features of the UK cash savings market where providers report that informing existing customers about better accounts with higher interest rates only generates a small response in (internal) switching (Financial Conduct Authority [2015], Annex 1.2). Another difference between the model of Besanko and Lyon [1993] and ours is that our model determines inert, locked-in customers endogenously, while in the model of Besanko and Lyon [1993] the number of "non-shoppers" is exogenously given.

[44] This is shown formally in Lemma 5.2 below.

price is lower than A's, and therefore B's customers have no incentive to switch to A: They would pay a higher price and in addition incur switching costs.

Let superscript L denote optimal values under HBPD with leakage. And denote the level of switching costs of the marginal internal switcher by $\sigma_j^{L_i}$, and the switching costs of the marginal external switcher by $\sigma_j^{L_e}$, $j = A, B$. Then, prices and discounts satisfy

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

Therefore,

$$\sigma_j^{L_i} = \frac{m_j^L}{\alpha} \tag{13}$$

$$\sigma_j^{L_e} = \begin{cases} \frac{p_j^L - p_k^L - (m_j^L - m_k^L)}{1-\alpha} & \text{if } p_j^L - p_k^L - (m_j^L - m_k^L) > 0 \\ 0 & \text{otherwise} \end{cases}, \quad j,k = A,B; j \neq k. \tag{14}$$

Lemma 5.2. *With MFCCs, each firm has back-book customers with high switching costs, some of whom – with relatively low switching costs – in equilibrium switch internally; and front-book customers, with the lowest switching costs, who in equilibrium may, or may not, switch externally. Formally, the switching costs of the internally and externally marginal customers are* $\sigma_j^{L_i} > \sigma_j^{L_e}$, $j = A, B$.

Proposition 5.3. $\sigma_A^{L_e} > 0$ *(and* $\sigma_B^{*e} = 0$*) if, and only if,* $x_0 \geq \frac{1}{2}$. *And*

$$\sigma_A^{L_i} = \frac{m_A^L}{\alpha} = \frac{1 - F_A(\sigma_A^{L_i})}{f_A(\sigma_A^{L_i})} \tag{15}$$

$$\sigma_B^{L_i} = \frac{m_B^L}{\alpha} = \frac{1 - F_B(\sigma_B^{L_i})}{f_B(\sigma_B^{L_i})} \tag{16}$$

$$\frac{p_A^L - m_A^L}{1-\alpha} = \frac{1 - F_A(\sigma_A^{L_e})}{f_A(\sigma_A^{L_e})} \tag{17}$$

$$\frac{p_B^L - m_B^L}{1-\alpha} = \frac{1 - x_0 + x_0 F_A(\sigma_A^{L_e})}{x_0 f_A(\sigma_A^{L_e})}. \tag{18}$$

Corollary 5.3.1. *The dominant firm's front-book is the same under uniform pricing and MFCCs:* $\sigma_A^{L_e} = \sigma_A^u$.

These results are also illustrated in Figures 1 and 2. The corollary to Proposition 5.3 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 UP. The intuition for this result is straightforward. According to (13) both firms act as monopolists when partitioning their own customer base into front-book and back-book customers. Given that partition, both firms set uniform prices with respect to their front-book customers. But to set these prices, (9) implies that only x_0 and $F_A(\sigma_A^e)$ matter, so the result $\sigma_A^{L_e}$ is the same as σ_A^u.

This is an important result because it shows that MFCCs in our setup can be thought of as a toughened version of uniform pricing, while not permitting the challenger to make further inroads into the dominant firm's turf. Indeed, (17) and (18), together with 5.3.1, imply that discounted prices are lower than uniform prices,

$$p_A^L - m_A^L = (1-\alpha)p_A^u \tag{19}$$

$$p_B^L - m_B^L = (1-\alpha)p_B^u. \tag{20}$$

And discount levels m_A^L and m_B^L are set with respect to the firms' own back-book, i.e. their own respective customer bases' switching costs. In fact, with regard to competition for A's customers, the shift in B's reaction function is characterised by

$$\frac{\partial}{\partial p_B}[p_B F_A(p_A - p_B)] = -(1-\alpha)\frac{1-x_0}{x_0} + \alpha F_A(p_A - p_B) > -\frac{1-x_0}{x_0}, \tag{21}$$

and hence, B is seen to compete more vigorously than with uniform prices, yet less vigorously than with discriminatory prices.

Furthermore, prices charged to back-book customers are

$$\begin{aligned} p_A^L &= (1-\alpha)\frac{1-F_A(\sigma_A^{L_e})}{f_A(\sigma_A^{L_e})} + \alpha\frac{1-F_A(\sigma_A^{L_i})}{f_A(\sigma_A^{L_i})} = (1-\alpha)p_A^u + \alpha\frac{1-F_A(\sigma_A^{L_i})}{f_A(\sigma_A^{L_i})} \\ p_B^L &= (1-\alpha)p_B^u + \alpha\frac{1-F_B(\sigma_B^{L_i})}{f_B(\sigma_B^{L_i})}, \end{aligned}$$

so that Lemma 5.2, together with Assumption 2, implies that

$$p_A^L \leq p_A^u,$$

while p_B^L may or may not exceed p_B^u, depending on the distribution F_B relative to F_A. So A's profit margins on front-book and back-book customers are lower with MFCCs than their margins with uniform pricing, as are the margins that B earns on customers poached from A and on its internal switchers. Hence, MFCCs tend to be more competitive than uniform prices.

Also, as $\alpha \downarrow 0$,

$$p_j^L \ \uparrow \ p_j^u \qquad \text{and} \qquad m_j^L \downarrow 0, \ \ j \in \{A, B\},$$

i.e. as the cost of internal switching vanishes, prices with MFCCs tend to the uniform prices. Since the extent to which consumers switch externally is the same ($\sigma_A^{L_e} = \sigma_A^u$), front-book customers of both firms benefit from MFCCs. Locked-in back-book customers of both firms (who do not switch) also benefit. For internal switchers, consumers benefit if their respective cost of switching – $\sigma_A \in (\sigma_A^u, \sigma_A^{L_i})$ and $\sigma_B \in [0, \sigma_B^{L_i})$ – does not outweigh the respective price difference,

$$\begin{aligned} p_A^U - (p_A^L - m_A^L) &= \alpha \frac{1 - F_A(\sigma_A^u)}{f_A(\sigma_A^u)} \\ p_B^u - (p_B^L - m_B^L) &= \alpha \frac{1 - x_0(1 - F_A(\sigma_A^u))}{x_0 f_A(\sigma_A^u)}. \end{aligned}$$

By (15) and (16), the average cost of internal switching does not depend on the cost advantage of internal switching (α), while the price advantage under MFCCs relative to uniform pricing does. Indeed, the smaller the cost of internal switching, the *less* this is reflected in a price gain, i.e. the less MFCCs benefit those customers whose switching they are designed to facilitate.

Finally, comparing (7) with (15), and (8) with (16), it follows that

$$\begin{aligned} \sigma_A^{L_i} &> \sigma_A^D > \sigma_A^{L_e} = \sigma_A^u \\ \sigma_B^{L_i} &> \sigma_B^D > 0. \end{aligned}$$

These inequalities imply the following result.

Proposition 5.4. *Under Assumptions 1 and 2, prices charged to back-book and customers are higher with MFCCs than with HBPD:*

$$\begin{aligned} p_A^L > p_A^D \qquad & p_B^L > p_B^D \\ p_A^L - m_A^L > p_A^D - m_A^D \qquad & p_B^L - m_B^L > p_B^D - m_B^D. \end{aligned}$$

Therefore, MFCCs soften competition relative to history-based price discrimination. Since with MFCCs $\sigma_A^{L_i} > \sigma_A^D$ and $\sigma_B^{L_i} > \sigma_B^D$, customers of both firms are more likely to also bear a switching cost. This reinforces the consumer welfare reducing effect of MFCCs relative to history-based price discrimination.

When the dominant firm is an established incumbent and the challenger is a new entrant competing for the market, the challenger has less scope to price discriminate compared to the incumbent, for whom price discrimination is a dominant strategy. In such situations, asymmetric interventions imposing leakage may benefit the entrant:

Proposition 5.5. *An asymmetric regulatory intervention whereby the imposition of "leakage" is solely directed at the incumbent increases the entrant's profit, and this increase is larger the less costly is internal switching, i.e. the smaller is α.*

When the cost of internal switching is low, then this limits the incumbent's temptation and ability to price discriminate, and this facilitates an outcome that approximates uniform pricing which is the least competitive and most profitable regime.[45]

5.4 Pegged Prices - Ratio-Based Price Regulation

Another regulatory intervention that has been proposed recently is to constrain the dispersion of discriminatory prices, by pegging the magnitude of discounts to the level of the regular, undiscounted price.[46] We therefore label this pricing regime HBPD with a peg, or ratio-based price discrimination. Under this pricing regime, "front-book" customers would effectively be relied upon to protect "back-book" customers from unfair exploitation due to excessive prices.[47] The pegging constraint would make price discrimination against customers with high switching cost more difficult. Arguably, it would also increase clarity and transparency about pricing structures and mitigate concerns about inequitable treatment.

We model the peg as bounding the ratio between the regular and discounted prices, e.g. such that the discount m_i is no more than a fraction $\beta \in (0, 1)$ of the regular price p_i, i.e. $m_i \leq \beta p_i$ for $i \in \{A, B\}$.

Adding the ratio constraints $m_A \leq \beta p_A$ and $m_B \leq \beta p_B$ to the firms' profit maximization problems with HBPD, the solutions $p_A^R, p_B^R, m_A^R, m_B^R$ and σ_A^R, σ_B^R now satisfy the following result.

[45] To the best of our knowledge there is no extant economic literature researching the incentive to use MFCCs where customers face heterogeneous 'hassle' costs to claim for compensation, so that it translates into a form of third-degree price discrimination. Besanko and Lyon [1993] analyse firms' incentives to adopt MFCCs where consumers are partitioned between "non shoppers", who never consider switching, and "shoppers", who have no brand preference. However, the MFCC applies to every customer indiscriminately, so the use of an MFCC also amounts to a non-discrimination commitment device. Besanko and Lyon [1993] show that there can be configurations where firms have a unilateral incentive to use contemporaneous MFCCs.

[46] [Financial Conduct Authority, 2018a,b].

[47] In this sense, this configuration is reminiscent of the relationship between 'tourists' and 'locals' in the classic model of price dispersion of Varian [1980], with the difference that in that seminal paper firms randomise over a range of (uniform) prices as they face a trade-off between exploiting the former and competing for the latter: see Armstrong [2015] for a discussion.

Proposition 5.6. *Under Assumptions 1 and 2, compared to HBPD, ratio-based price discrimination softens competition: The both firms retain fractions of their back-book customer bases, and charge prices, that are no less than under HBPD:*

$$\begin{aligned} \sigma_A^R &\leq \sigma_A^D & \sigma_B^R &\leq \sigma_B^D \\ p_A^R &\geq p_A^D & p_B^R &\geq p_B^D \\ p_B^R - m_A^R &\geq p_A^D - m_A^D & p_B^R - m_B^R &\geq p_B^D - m_B^D. \end{aligned}$$

This proposition encompasses UP and HBPD as special cases. Its proof shows that UP is a special case, for $\beta = 0$, while it implies HBPD for β sufficiently close to one. The ratio constraint acts like a commitment device that limits the extent to which firms can succumb to the prisoners' dilemma to discriminate. Unlike MFCCs however, and like HBPD, ratio-based price discrimination does not protect the challenger's customer base.

In conclusion, comparing the four regimes studied in this paper, UP is the least competitive, with firms just competing for the dominant firm's marginal customer. This is followed by MFCC where each firm competes with itself to discriminate against its back-book, and where both firms compete for the dominant firm's marginal customer, as in UP; and by ratio-based price discrimination, where the ratio constraint acts as a commitment device to limit the extent of poaching, but both firms make incursions into each other's customer base. HBPD tends to be the most competitive regime, with firms segmenting consumers into the two markets constituted by each firm's customer base.[48]

6 Extensions

In this section, we provide an informal discussion of some extensions to our model.

6.1 Asymmetric Costs

An often cited regulatory concern is that a challenger's customer acquisition cost are higher than the dominant firm's customer retention cost. This wedge is a marginal cost supplement for poaching the rival's customers, to the detriment of the challenger. Our model can be adapted to such asymmetric marginal costs, with the challenger's marginal cost exceeding those of the dominant firm, $c_A < c_B$. The cost differential $\Delta = c_A - c_B < 0$ favouring the dominant firm implies that it finds it easier to defend its turf, so that, for HBPD for example,

[48] This is with the caveat that, as we showed, there may be circumstances where the challenger's back-book customers may pay a discriminatory price above the uniform price.

σ_A^D is lower, and σ_B^D higher, than in the case of symmetric marginal cost; similarly, the cost differential lowers σ_A^u with UP.[49]

6.2 Entry Deterrence

In his study of dynamic price discrimination with asymmetric firms and consumers with brand preferences, Chen [2008] concludes that HBPD is beneficial to consumers as long as it is not used as a means by the incumbent dominant firm to deter entry (or induce exit) of the smaller challenger firm.[50] In Appendix B we show that when there are sunk costs associated with entry, HBPD on the part of the incumbent dominant firm, as opposed to uniform pricing, erects a higher entry barrier for a (uniform-pricing) challenger. In light of ratio-based pricing and MFCCs being less competitive than HBPD, this suggests that such regulatory constraints would tend to facilitate entry.

6.3 Oligopolistic Markets

Many markets of interest may accommodate more than two firms. There can be several dominant firms, or several challenger firms, or both. If a firm can only distinguish between current customers and non-customers, i.e. not by which rival firm poached customers have been served, then the duopolistic market structure is a good approximation.

With more firms, competition is more vibrant, and this can be captured by F_A and F_B respectively putting more probability mass on lower switching cost, leading to lower prices. If there are more dominant firms, competition before the challengers show up is more intense, so challengers have to compete more aggressively to gain market share. If there are more challenger firms and a monopolist dominant firm, the challengers compete not only with the dominant firm but also with each other because the most efficient challenger will set the competitive benchmark.

6.4 Endogenising the Market Structure

We argued above that, from a competition policy perspective, the asymmetric market structure and heterogeneity of switching cost distributions across firms introduced in sections

[49] In Figure 1, Δ shift the curve "HBPD, firm A" down, and $-\Delta$ shifts the curve "HBPD, firm B" up; similarly, Δ shifts "UP" down.

[50] Entry deterrence in the presence of switching costs absent price discrimination and with complete information has been studied by Klemperer [1987] who considers limit pricing, i.e. cuts in a uniform price to deter entry; and by Farrell and Shapiro [1988a] who show that when an incumbent cannot price discriminate switching costs can actually promote entry. See also [Chen, 2008, Fumagalli and Motta, 2013, Gehrig et al., 2012, Karlinger and Motta, 2012].

4.1 and 4.2 that underpin the central analyses of the paper are often of particular interest, because a typical initial market configuration involves a dominant firm facing a challenger, and the challenger having acquired low switching cost consumers has a customer base that is more prone to switching than that of the dominant firm. There are many conceivable possible avenues to endogenise such asymmetries in a dynamic model.[51] It is not difficult to see that technical obstacles emerge rapidly, and handling these in a general setting such as ours, for each of the pricing regimes, goes beyond the scope of the paper.

We sketch one such avenue. Under some simplifying assumptions, the asymmetric market structure of the previous section can emerge as the second period in a two-period model, following an initial period in which an incumbent homogenous-good monopolist (A) faces a challenger entrant (B). We follow Farrell and Shapiro [1988b] in assuming that, after the first-period, some new customers (with switching cost distribution F) will replace some old customers. Unlike Farrell and Shapiro [1988b], we assume that the new customers *exogenously* replace customers at both firms,[52] so that the support of the switching cost distributions F_A and F_B of the firms' customer bases post entry is the same, and the two distributions satisfy Assumption 1. We therefore take the second period switching cost distributions F_A and F_B as exogenous.[53]

7 Conclusions

This paper studies options for price regulation to protect sticky consumers in asymmetric oligopolistic markets where firms' customers have heterogeneous switching costs. We evaluate these options against criteria such as the extent of discrimination, of consumer switching and thereby of market penetration by a challenger, and of unintended consequences such as a general rise in price levels.

We show that in a setting with asymmetric market shares and heterogeneous switching costs, MFCCs and ratio-based price discrimination are more competitive than UP, but less competitive than HBPD. Therefore disclosure remedies - in the form of price discrimination with leakage, or MFCCs - and remedies to limit price dispersion - in the form of price pegs - dissipate much of the benefits of price discrimination.

We also show that the pricing regime affects the extent to which the challengers makes inroads into the dominant firm's turf. Such penetration is the same whether prices are uniform or discriminatory but subject to MFCCs, and but less than when prices are dis-

[51] For example, Caillaud and De Nijs [2014], Esteves [2014] study behaviour-based price discrimination in a dynamic setting.

[52] Farrell and Shapiro [1988b] assume that the new customers join the firm with the lower price.

[53] The detailed dynamic analysis is available from the authors upon request.

criminatory without constraints, although in that case there is also reverse penetration by the incumbent. Subject to additional pegging constraints, bidirectional penetration occurs but is more muted than with HBPD. Furthermore, we show that HBPD by an incumbent can deter a challenger's entry altogether, while HBPD with leakage and ratio-based PD may facilitate entry.

These findings, in turn, imply that in settings like ours consumer protection objectives may well be in conflict with competition objectives. The objective of low prices, best supported by the intense competition in the market afforded by HBPD, may soften competition for the market, deter entry and induce the largest extent and cost of consumer switching. MFCCs and ratio-based price discrimination may therefore strike a balance as they moderate price levels and the extent of switching, and they do not erect prohibitive barriers to entry. When internal switching is not too costly, disclosure remedies such as MFCCs may be preferable if entry is to be encouraged and the challenger is to be protected from its turf being penetrated in reverse by the incumbent.

Our results are relevant in many dynamic, newly emerging retail and business-to-business markets where disruptive entrants exist or are encouraged, market shares are asymmetric, customers are price-takers and exhibit heterogeneous switching costs. These characteristics are salient in many markets that have come or currently are under regulatory scrutiny.

Our findings challenge policy makers to balance concerns about equitable and fair treatment of buyers and consumers with competition objectives that aim at reducing barriers to entry. And thus they are relevant for competition bodies, such as the FTC, the DoJ and the CMA, when calibrating their objectives.[54]

The erosion of trust in institutions, including markets, has emerged as a theme of increasing political salience. Market regulators therefore feel a duty to stem this erosion of trust and restore the confidence that markets can benefit everyone. It is therefore important for them to anticipate potential distributional implications of regulatory interventions, and to weigh up trade-offs between them and other policy objectives.

[54]The CMA's recent annual plans re-calibrate its objectives, stressing that the competition and consumer protection regimes need to work in tandem alongside each other, to ensure that vulnerable consumers are not exploited and that markets work in their favour. The protection of vulnerable consumers has thus become an objective of particular strategic importance. See, for example, the CMA's Annual Plans 2018-19 and 2019/20 that define helping vulnerable people as one of the CMA's strategic priorities. Some of the FTC's work has specifically focussed on the elderly; see, for example, Federal Trade Commission [2018].

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A Proofs

Proof of Lemma 5.1: The result follows immediately from equations (7) and (8) and assumptions 1 and 2. A graphical representation of this result is given in Figure 1.

An alternative argument proceeds as follows. Assumption 1 implies H and RH. Suppose the opposite were true, i.e. $\sigma_A < \sigma_B$. Then, by RH and Assumption 2, for $\sigma_A^D < s < \sigma_B^D$,

$$\frac{F_A(\sigma_A^D)}{f_A(\sigma_A^D)} \leq \frac{F_A(s)}{f_A(s)} \leq \frac{F_B(s)}{f_B(s)} \leq \frac{F_B(\sigma_B^D)}{f_B(\sigma_B^D)},$$

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

$$\frac{1-F_B(\sigma_B^D)}{f_B(\sigma_B^D)} \leq \frac{1-F_B(s)}{f_B(s)} \leq \frac{1-F_A(s)}{f_A(s)} \leq \frac{1-F_A(\sigma_A^D)}{f_A(\sigma_A^D)},$$

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

Proof of Proposition 5.1: From $\sigma_A^D \geq \sigma_B^D$ and the first-order conditions, it follows that $2(p_A^D - p_B^D) \geq m_A^D - m_B^D$. So it is sufficient to prove that $m_A^D \geq m_B^D$.

From the definitions of σ_A and σ_B,

$$\sigma_A^D + \sigma_B^D = m_A^D + m_B^D,$$

and from the first-order conditions,

$$\begin{aligned}
\sigma_A^D &= p_A^D - p_B^D + m_B^D = m_A^D + \frac{F_B(\sigma_B^D)}{f_B(\sigma_B^D)} - \frac{F_A(\sigma_A^D)}{f_A(\sigma_A^D)} \\
\sigma_B^D &= p_B^D - p_A^D + m_A^D = m_B^D + \frac{F_A(\sigma_A^D)}{f_A(\sigma_A^D)} - \frac{F_B(\sigma_B^D)}{f_B(\sigma_B^D)}.
\end{aligned}$$

Lemma 5.1, together with Assumption 2, implies that $\frac{F_B(\sigma_B^D)}{f_B(\sigma_B^D)} - \frac{F_A(\sigma_A^D)}{f_A(\sigma_A^D)} \leq 0$. Therefore, $0 \leq m_A^D - \sigma_A^D = \sigma_B^D - m_B^D$, and hence

$$m_B^D \leq \sigma_B^D \leq \sigma_A^D \leq m_A^D.$$

Figure 2 provides a graphical representation of this result. □

Proof of Proposition 5.2: It is sufficient to prove that $\sigma_A^u \leq \sigma_A^D$ which implies, by the first-order conditions for firm A and Assumption 2, that $p_A^u \geq p_A^D$. This, together with

$\sigma_A^D > \sigma_B^D > 0$ under HBPD, as shown in Lemma 5.1, by Assumption 2 implies also $p_B^u \geq p_B^D - m_B^D$. Figure 2 illustrates the result about the Nash equilibrium prices.[55]

Suppose to the contrary that $\sigma_A^u > \sigma_A^D$. Then, $p_A^u \leq p_A^D$ by the first-order conditions and Assumption 2. This ranking of prices of firm A, together with the supposition, implies also that $p_B^u \leq p_B^D - m_B^D$.[56] Therefore, $p_B^u - c \leq p_B^D - c - m_B^D$, and hence

$$\frac{1 - x_0 + x_0 F_A(\sigma_A^u)}{x_0 f_A(\sigma_A^u)} \leq \frac{F_A(\sigma_A^D)}{f_A(\sigma_A^D)}.$$

Notice that $x_0 = 1$ implies $\sigma_A^u = \sigma_A^D$. Since the lefthand side of the inequality is decreasing in x_0, Assumption 2 implies that $\sigma_A^u < \sigma_A^D$ for $\frac{1}{2} < x_0 < 1$, a contradiction to the supposition. Again, Figure 1 represents this result graphically. □

Proof of Lemma 5.2: 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

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

or iff

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

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

Proof of Proposition 5.3: Suppose external switching is from A to B and $\sigma_A^e > 0$. Then,

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

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

[56] This is because, under the supposition, $p_A^D - p_A^u > p_A^u - p_B^u = \sigma_A^u > \sigma_A^D = p_A^D - p_B^D + m_B^D$.

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

$$\begin{aligned}
\sigma_A^{*i} &= \frac{m_A^{*L}}{\alpha} = \frac{1-F_A(\sigma_A^{*i})}{f_A(\sigma_A^{*i})} \\
\sigma_B^{*i} &= \frac{m_B^{*L}}{\alpha} = \frac{1-F_B(\sigma_B^{*i})}{f_B(\sigma_B^{*i})} \\
\frac{p_A^{*L}-m_A^{*L}}{1-\alpha} &= \frac{1-F_A(\sigma_A^{*e})}{f_A(\sigma_A^{*e})} \\
\frac{p_B^{*L}-m_B^{*L}}{1-\alpha} &= \frac{1-x_0+x_0F_A(\sigma_A^{*e})}{x_0f_A(\sigma_A^{*e})}.
\end{aligned}$$

Therefore,

$$\begin{aligned}
\sigma_A^{*e} &= \frac{p_A^{*L}-m_A^{*L}}{1-\alpha} - \frac{p_B^{*L}-m_B^{*L}}{1-\alpha} \\
&= \frac{2x_0\left(1-F_A(\sigma_A^{*e})\right)-1}{x_0f_a(\sigma_A^{*e})},
\end{aligned}$$

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

Proof of Proposition 5.4: Since $\sigma_B^{L_e} = 0$, $\sigma_B^D > 0$ implies that $p_A^D - m_A^D < p_A^L - m_A^L$; $\sigma_A^D > \sigma_A^{L_e}$ implies $p_B^D - m_B^D < p_B^L - m_B^L$; and $\sigma_j^{L_i} > \sigma_j^D$ implies $p_j^L > p_j^D$, $j \in \{A, B\}$. □

Proof of Proposition 5.5: This result is another corollary Proposition 5.3. The Corollary 5.3.1 shows that $\sigma_A^e = \sigma_A^u$ does not depend on α. So the challenger's profit only depend on p_B^L - with $m_B^L = 0$ -, and (18) shows that this prices is increasing in α. If "leakage" is only imposed on A, then the challenger competes like in the case of UP, i.e. less vigorously - its reaction function shifts according to (12), rather than (21). At the same time, A also competes with himself, and the more so the lower is the cost of internal switching. Hence A's means to discriminate are reduced relative to conventional HBPD, and that benefits the challenger. In the limit, as α tends to zero, this yields the UP outcome which is the most profitable for both firms. □

Proof of Proposition 5.6: The firms' profit maximization problem, subject to the ratio constraints $m_A - \beta p_A \leq 0, m_B - \beta p_B \leq 0$, is to maximise

$$\begin{aligned}
\pi_A &= p_A x_0(1-F_A(\sigma_A)) + (p_A - m_A)(1-x_0)F_B(\sigma_B) + \lambda_A(m_a - \beta p_A) \\
\pi_B &= p_B(1-x_0)(1-F_B(\sigma_B)) + (p_B - m_B)x_0F_A(\sigma_A) + \lambda_B(m_B - \beta p_B),
\end{aligned}$$

and the first-order conditions yield

$$
\begin{aligned}
p_A^R &= \frac{1-F_A(\sigma_A^R)}{f_A(\sigma_A^R)} + \lambda_A^R \frac{\beta-1}{x_0 f_A(\sigma_A^R)} \\
p_B^R &= \frac{1-F_B(\sigma_B^R)}{f_B(\sigma_B^R)} + \lambda_B^R \frac{\beta-1}{(1-x_0) f_B(\sigma_B^R)} \\
p_A^R - m_A^R &= \frac{F_B(\sigma_B^R)}{f_B(\sigma_B^R)} + \lambda_A^R \frac{1}{(1-x_0) f_B(\sigma_B^R)} \\
p_B^R - m_B^R &= \frac{F_A(\sigma_A^R)}{f_A(\sigma_A^R)} + \lambda_B^R \frac{1}{x_0 f_A(\sigma_A^R)},
\end{aligned}
$$

where σ_j^R are defined analogously to σ_j^D and the Kuhn-Ticker Theorem yields $\lambda_j^R \geq 0$, $j \in \{A, B\}$. Also,

$$
\sigma_A^R = \frac{1-2F_A(\sigma_A^R)}{f_A(\sigma_A^R)} + \frac{1}{x_0 f_A(\sigma_A^R)}(\lambda_A^R(\beta-1) - \lambda_B^R) \tag{22}
$$

$$
\sigma_B^R = \frac{1-2F_B(\sigma_B^R)}{f_B(\sigma_B^R)} + \frac{1}{(1-x_0) f_B(\sigma_B^R)}(\lambda_B^R(\beta-1) - \lambda_A^R). \tag{23}
$$

Since $\lambda_A^R(\beta-1) - \lambda_B^R$ and $\lambda_B^R(\beta-1) - \lambda_A^R$ are non-positive, Assumption 2 implies that $\sigma_j^R \leq \sigma_j^D$ and so $p_j^R \geq p_j^D$, $j \in \{A, B\}$. When β is large enough so that the ratio constraints do not bind, $\lambda_A^R = \lambda_B^R = 0$ and (22) and (23) imply the HBPD result. When $\beta = 0$, then, from Proposition (5.2) $\sigma_B^R = 0$ and so (23) implies $\lambda_A^R + \lambda_B^R = 1 - x_0$, so that (22) implies that $\sigma_A^R = \sigma_A^u$. □

B Price Discrimination as Entry Deterrence

In order to investigate the incumbent's HBPD as an entry deterrence strategy in our setting, suppose that the market is dynamic, in the sense that over time some customers leave the market while others join the market. Specifically, for a market size τ, suppose that the fraction of 'new' customers that the challenger can capture, $(1-x_0)\tau$, to 'old' customers served by the incumbent, $x_0\tau$, is a constant $\kappa = \frac{1-x_0}{x_0}$, and that τ itself is ex ante uncertain. Then the challenger's profits - when pricing uniformly and facing a price discriminating incumbent and conditional on x_0 - are

$$
\pi_B^*(\tau) = \tau \frac{(\kappa\,(1 - F_B(\sigma_B^*)) + F_A(\sigma_A^*))^2}{\kappa f_B(\sigma_B^*) + f_A(\sigma_A^*)}.
$$

Notice that

$$\begin{aligned}
\sigma_A^* &= p_A^* - p_B^* = \frac{1-F_A(\sigma_A^*)}{f_A(\sigma_A^*)} - \frac{\kappa\,(1-F_B(\sigma_B^*)) + F_A(\sigma_A^*)}{\kappa f_B(\sigma_B^*) + f_A(\sigma^* A)} \\
\sigma_B^* &= p_B^* - p_A^* + m_A^* = \frac{\kappa\,(1-F_B(\sigma_B^*)) + F_A(\sigma_A^*)}{\kappa f_B(\sigma_B^*) + f_A(\sigma^* A)} - \frac{F_B(\sigma_b^*)}{f_B(\sigma_B^*)},
\end{aligned}$$

i.e. the switching costs of the marginal customer depend on κ, but not on τ.

Then, if the challenger firm has not entered the market yet, its expected profit from entering is given by

$$\mathbb{E}\left[\pi_B^*(\tau)\right] = \mathbb{E}\left[\tau\right] \frac{\left(\kappa\,(1-F_B(\sigma_B^*)) + F_A(\sigma_A^*)\right)^2}{\kappa f_B(\sigma_B^*) + f_A(\sigma_A^*)},$$

When the incumbent prices uniformly,

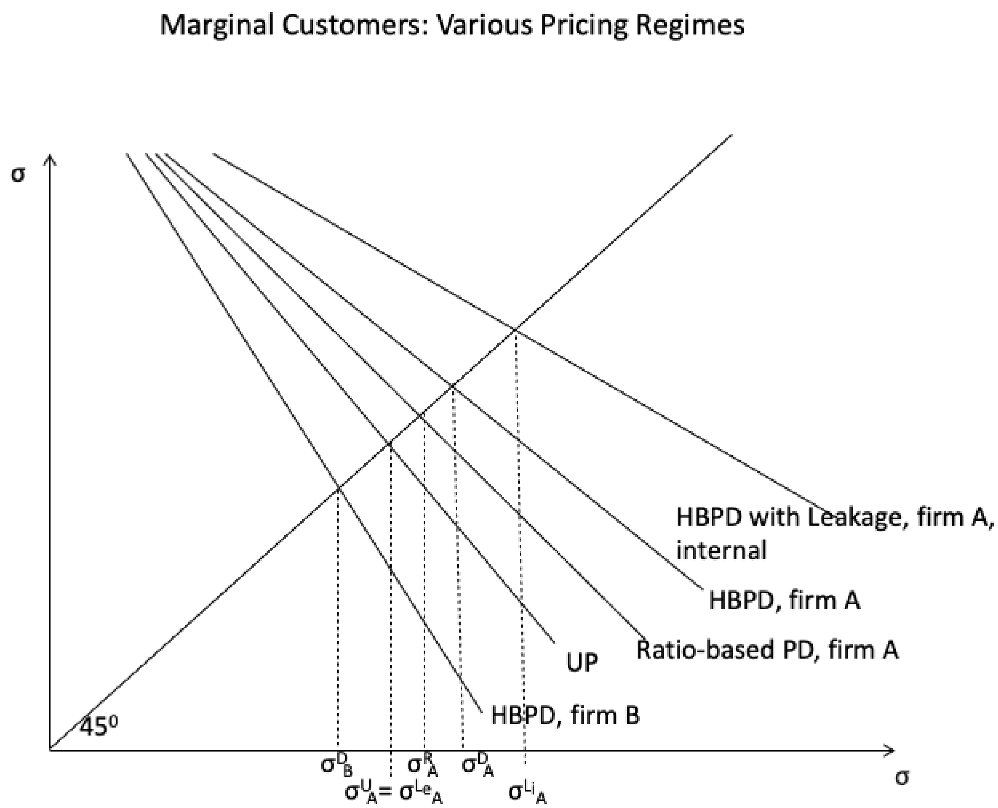
$$\mathbb{E}[\pi_B^{*u}(\tau)] = \mathbb{E}\left[\tau\right] \frac{\left(\kappa + F_A(\sigma_A^{*u})\right)^2}{f_A(\sigma_A^{*u})},$$

and this is seen to exceed $\mathbb{E}[\pi_B^*(x_0)]$.[57] So, as the challenger compares expected profit from entry with any sunk cost associated with entry, price discrimination on the part of the incumbent, as opposed to uniform pricing, erects a higher entry barrier for a uniform-pricing challenger.

C Figures

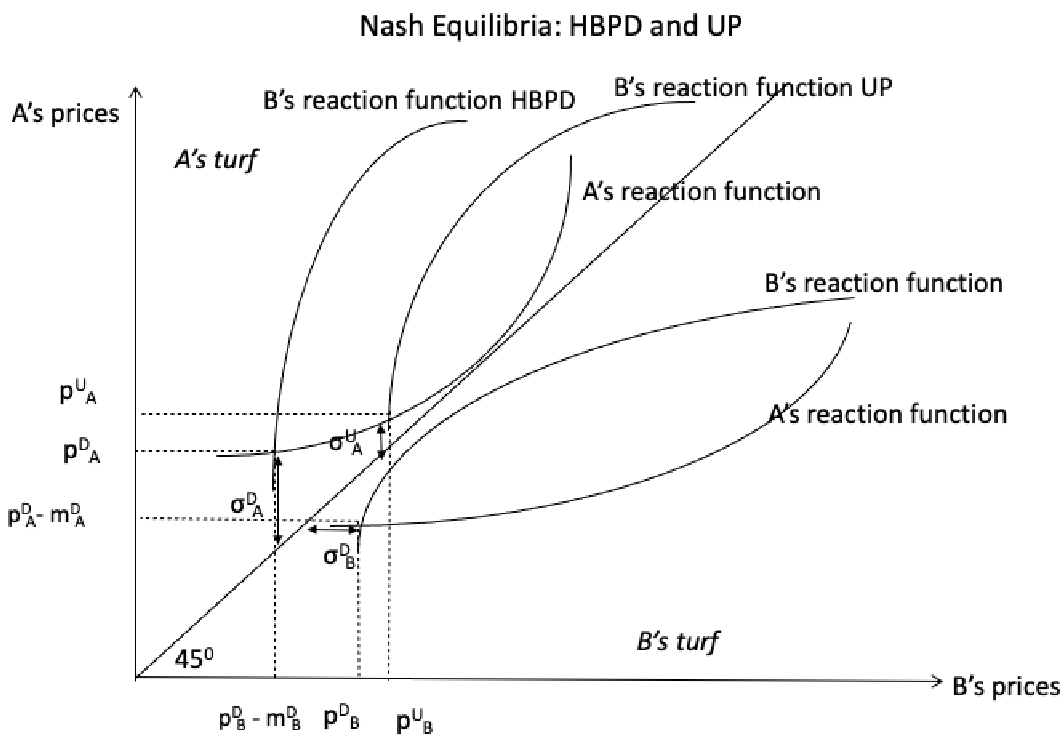
[57] The numerator of the fraction inside the expectation is larger for every x_0 because $\sigma_A^{*u} \geq \sigma_A^*$, and the denominator is smaller.

Figure 1: **Marginal Customers**



Notes: HBPD with Leakage, firm A, internal depicts (15); HBPD, firm A, depicts (7); Ratio-based PD, firm A, depicts (22); UP depicts (11); HBPD, firm B, depicts (8).

Figure 2: **Nash Equilibria**



Notes: The area above (bellow) the 45 degree line refers to A's (B's) turf or customer base where A's (B's) price exceeds B's (A's) "poaching" price. B's reaction function under UP shifts out / down relative to its reactions function under HBPD; see (12). A's reaction functions crossing B's from above ensure the stability of equilibria.