

Competition with endogenous and exogenous switching costs

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Preliminary version and incomplete

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August, 2017

Abstract

This paper presents a general theoretical framework for a dynamic competition game in the presence of two types of switching costs: endogenous, which are set by providers, and exogenous that are specific to consumers. In a two-period game, the two providers compete in prices and switching fees, and can price discriminate between old (loyal) and new (switchers) consumers.

There are symmetric subgame perfect equilibria in pure strategies, where providers split the market equally in the first period and one third of the population switch in the second period. Equilibrium prices and switching fees are not uniquely determined, but providers' profits are. Endogenous switching costs only impact inter-temporal payoffs with countervailing effects, leaving multiperiod payoffs unaffected, whereas, exogenous switching costs affect consumer and social welfare. These results suggest that regulatory policies, in the telecommunications industry for example, should reduce exogenous switching costs (such as number portability, standardization or compatibility) rather than eliminate or regulate switching fees.

Keywords: Dynamic competition, duopoly, switching costs, introductory offers.

1 Introduction

Switching costs (SC) affect consumers in their daily life, and may hinder their free decision to change providers of certain product or service. These costs may be related to learning (software usage), information (medical history of patients for example), transactions (paperwork to terminate and initiate the consumption of certain service), or due to direct firms' practices to keep consumers by charging early contract termination fees or by offering coupons and discounts to frequent consumers.

*I would like to thank Yair Tauman and Sandro Brusco for their patience, guidance and constant help; to Yiyi Zhou, Ting Liu, and Roberto Burquet for the insightful comments during the workshops in Stony Brook. Special thanks to Greg Duncan for the valuable conversations and feedback, to Fahad Khalil, Jacques Lawarrée, Quan Wen and Xu Tan for their comments and suggestions in the Brown bag Microeconomics Workshops at the University of Washington, Seattle. I am also grateful to comments received from the participants of the International Game Theory Conference 2016 at Stony Brook. My e-mail address is tilsa.oremonago@stonybrook.edu.

Firms may benefit from the presence of switching costs and may use it strategically to keep their consumer base by locking them in. Consumers that stay for a long time may be more profitable than new ones in some markets. As an example, we can think of car insurance market vs. wholesale markets. In the former, consumers are profitable after one or two years, while in the latter they are immediately profitable. The literature suggests that firms strategically use switching costs to “lock-in” and “then-ripoff” consumers, which lessen competition and social welfare. This is more relevant in subscription markets where providers know their consumers in the following periods. Understanding the nature of switching costs and its impact on market outcomes and equilibrium conditions is important for researchers and policy makers, given their presumed detrimental effect, due to increasing average price or even changing price structures (NERA, 2003).

Switching costs can be considered endogenous when affect directly the profits of firms and these decide on their level; these costs include any fee or lock-in mechanism that directly affects firms’ profits.¹ On the other hand, switching costs are considered exogenous (to the firm) when affecting only to consumers and firms do not set their level. These include any other cost such as psychological costs of switching, learning costs, the opportunity cost of time spent on paperwork, among others.²

The relevant literature is vast, switching costs are usually explained by dynamic price models, from simple two-period models to infinite period models (Klemperer, 1983, 1987b,a; Farrel and Shapiro, 1988; Caminal and Matutes, 1990; Beggs and Klemperer, 1992; Padilla, 1995; To, 1996; Shaffer and Zhang, 2000; Dube et al., 2009; Percy, 2011; Cabral, 2012; Arie and Grieco, 2014; Fabra and Garcia, 2015; Cabral, 2016). Some explain market entry under the presence of switching costs (Klemperer, 1988; Farrel and Shapiro, 1988; Beggs and Klemperer, 1992; Wang and Wen, 1998). Most of the theoretical models use exogenous switching costs only, few as Caminal and Matutes (1990) and Shi (2013) add endogenous switching costs in the form of discounts. Also Chen (1997) explains poaching practices with exogenous switching costs.

This paper contributes to the literature by analyzing the effect of exogenous and endogenous switching costs. It is based on (Chen, 1997) but differs from it by distinguishing endogenous from exogenous switching costs, adding an individual taste shock and letting the endogenous switching costs level be set in the initial period and not in the switching period (second period). It also differs from (Shi, 2013) by considering introductory offers and making exogenous switching cost different across consumers. My ultimate aim is to understand what determines the endogenous component (switching fee), how its strategic use affects the market outcomes and consumer welfare, and how a reduction of the exogenous component (exogenous switching costs) impacts the market. This would also allow for improved policy recommendations.

¹As examples we can think of early termination fee in the telecommunications industry; the loyalty programs in the airline market; or cash rewards program in the credit card market. In this particular paper, I focus in the existence of switching fees in the form of ETF.

²As an example, we can think of the costs of unlocking a phone by a technician (locking phones are widely seen in mobile telecommunication market, and can be thought as given). Also incurred costs of security clearance paperwork relevant for the labor market in developing countries; or the time spent to get a medical examination and report to prove health condition in the insurance market.

I develop a theoretical framework for a dynamic competition game under the presence of switching costs, where two providers compete in prices and strategically use endogenous switching costs, while consumers face additionally an exogenous switching cost. I consider a two-period game where providers simultaneously set prices and switching fees in the first period; in the second period, providers use introductory offers since they can distinguish between old consumers and newcomers, to attract new consumers (rival's consumers).

Using a discrete choice approach, the model allows for heterogeneity across consumers. Thus, focusing on equilibria in pure strategies, I find symmetric subgame perfect equilibria, where the market is split equally between providers and one third of the population switches in the second period. Equilibrium tuples of prices and switching fees are not uniquely determined, but providers' profits and consumers' payoffs are. An important result is that endogenous switching costs (in the form of switching fees) only impact intertemporal payoffs with countervailing effects, leaving multiperiod payoffs unaffected. Also, second-period prices are increasing in exogenous switching costs, and loyal consumers are charged higher than newcomers (switchers). Moreover, since both, social welfare and consumer surplus are negatively affected by the exogenous switching cost parameter, the model suggests that lowering exogenous switching costs (by a regulatory change for example) would lead to higher consumer surplus and bigger social welfare.

This paper is organized as follows: Section 2 presents the model in detail, Section 3 presents the equilibrium analysis, Section 4 presents the related literature and Section 5 presents the conclusions.

2 The Model

There is a unit mass of consumers, who are heterogeneous in their preferences and exogenous switching cost. There are two competing providers A and B , who offer substitute services to their consumers.

For simplicity, I assume that providers' marginal cost is zero. The providers operate in two periods and have the same discount rate $\delta \in (0, 1]$. A contract with provider $i \in \{A, B\}$ in period 1 is a pair (T_i, s_i) , where T_i is the fee a consumer has to pay for the first period unlimited service of i , and s_i is a switching fee a consumer of i will have to pay to provider i if he switches in the second period from i to j , $j \neq i$ (an early termination fee ETF). A contract in period 2 with provider $i \in \{A, B\}$ specifies a fee T_{ii} a consumer that chose i in both periods has to pay for the second period unlimited service of i ; and a fee T_{ji} a consumer that switched providers from j to i has to pay for the second period service of i .

From the demand side, and following a discrete choice approach, consumers have per period linear indirect utility (payoff) functions and have the same discount rate $\delta \in (0, 1]$.³ Every consumer has a valuation v for the service, which is assumed to be big enough so the market is covered. Also every consumer k receives a taste shock σ_k – an idiosyncratic relative preference for provider A respect to B – revealed in the first period that last only that period; σ_k is uniformly distributed on the interval $[-\theta_1, \theta_2]$ and has density

³I took the approach reviewed in the section 2.5 of Anderson et al. (1992), also used by Cabral (2016).

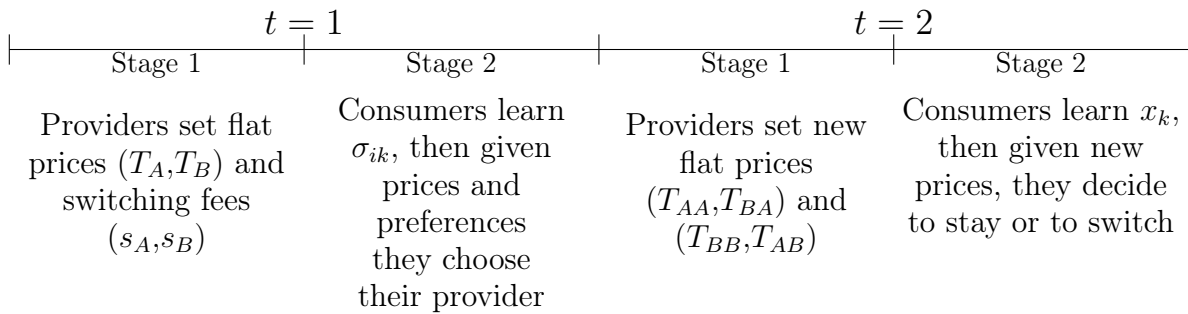
function $h(\sigma_k)$.⁴ Providers only know the distribution of idiosyncratic variables.

In the second period, the source of heterogeneity comes from the presence of an individual specific exogenous switching cost, x_k , which is uniformly distributed on the interval $[0, \omega]$ with density function $f(x)$. This exogenous switching cost x_k is learned by the consumers at the beginning of the second period and occurs independently of the first period shock. This exogenous cost refers to learning costs or costs (time, money, etc.) incurred by, for instance, canceling and account or unlocking a mobile phone set in the mobile telecommunications industry.

In the first period, after observing $((s_A, T_A), (s_B, T_B))$, every consumer chooses a provider from $\{A, B\}$. Then, given their chosen provider in the first period and the new prices in the second period, consumers decide either to stay with their provider i , or to switch to the other provider and pay a switching fee s_i , $i \in \{A, B\}$ to their previous provider and incur in additional switching costs x_k .

Timeline of the game

The game timeline is described below:



In the first stage of the first period, providers choose simultaneously (T_A, s_A) and (T_B, s_B) . In the second stage, consumers observe firms' choices and simultaneously choose provider (A, B) .

In the first stage of the second period, providers choose simultaneously their prices for newcomers, T_{BA} and T_{AB} , and for loyal consumers, T_{AA} and T_{BB} . Providers do not commit to keep previous period prices. Consumers observe the new prices, and simultaneously decide whether to stay with their providers or to switch providers.

The Payoffs

Consumers

In period 1, the payoff of a consumer k of firm A is

$$R_{1Ak} = v + \sigma_k - T_A$$

⁴This relative preference is such that if $\sigma_k \geq 0$, then a consumer likes A more than B, and if $\sigma_k < 0$ B is preferred over A.

and of a consumer k of firm B is

$$R_{1Bk} = v - \sigma_k - T_B$$

In period 2, the payoff of a consumer that chose firm $i \in \{A, B\}$ in period 1 is

$$R_{2k}^i = \max \{R_{ii,k}, R_{ij,k}\}$$

where,

$$\begin{aligned} R_{ii,k} &= v - T_{ii} && \text{if the consumer chose firm } i \text{ also in the first period} \\ R_{ij,k} &= v - T_{ij} - s_i - x_k && \text{if the consumer switched providers from } i \text{ to } j \end{aligned}$$

The decision variable in the first period is given by the idiosyncratic relative taste parameter, and in the second period the decision variable is the exogenous switching cost.

Thus, the multi-period net payoff of a consumer k who chooses firm i in period 1 is

$$R_k^i = R_{1ik} + \delta E_x[R_{2k}^i] \quad (1)$$

Providers

I denote α and $(1 - \alpha)$ the first period market shares of providers A and B , respectively. Likewise, in the second period, n_{ii} refers the share of consumers that consume from i in both periods, and n_{ij} , to the share of consumers that switched from i to j .

In the second period, providers' profits come from loyal consumers, newcomers and the switching fee collected from switchers that left. Thus, second period profits are given by

$$\pi_2^i = n_{ii}T_{ii} + n_{ji}T_{ji} + n_{ij}s_i \quad \forall i, j \in \{A, B\}$$

The first period payoffs are $\pi_1^A = \alpha T_A$ and $\pi_1^B = (1 - \alpha)T_A$, so provider i solves:

$$\max_{T_i, s_i} \pi^i = \pi_1^i + \delta \pi_2^i \quad (2)$$

I solve this game using backward induction, so I start finding the second-period equilibrium, and then continue with the first-period equilibrium in pure strategies.

2.1 The Second Period Equilibrium

Given their first period choices of provider and the second period new prices, consumers make their decision to switch or stay with their current provider.

A consumer k stays with his first-period provider if and only if his net payoff with this provider is at least as high as with the other (net of switching fee and costs), that means when $R_{ii} \geq R_{ij}$ (I omit the consumer index k for simplicity). Therefore, the probability that a consumer chooses to stay with his first period provider i is:

$$\begin{aligned} Pr[\text{stay in } i|i] &= Pr(R_{ii} \geq R_{ij}) \\ &= Pr(x \geq T_{ii} - T_{ij} - s_i) \\ &= Pr(x \geq x_i) \\ Pr[\text{switch to } j|i] &= 1 - Pr[\text{stay in } i|i] \end{aligned}$$

First, for consumers that chose A as their first-period provider, we understand they revealed their relative preference for A .⁵ Within this group, a consumer will be indifferent between staying in A (staying loyal) and switching to B if x is such that $R_{AA} = R_{AB}$ and $x \in [0, \omega]$, which means

$$\begin{aligned} v - T_{AA} &= v - T_{AB} - s_A - x \\ x &= (T_{AA} - T_{AB} - s_A) \\ x &= x_A \end{aligned}$$

From this last equation, x_A represent the saving any consumer get by switching (the benefit of switching), while x is the exogenous idiosyncratic cost of switching. Thus, x_A represents exogenous switching cost level for the A 's consumer who is indifferent between staying in A or switching to B , provided that $x_A \in [0, \omega]$. If $x_A > \omega$, then the benefit of switching surpasses the maximum idiosyncratic cost, therefore every consumer of A prefers to switch to B . If $x_A < 0$, then the benefit of switching is lower than the minimum idiosyncratic cost for an A 's consumer, therefore every consumer of A prefers to stay in A . If $0 \leq x_A \leq \omega$, then consumers with idiosyncratic exogenous switching cost x above x_A will stay with A and those consumers with idiosyncratic exogenous switching cost below x_A will switch to B .

Similar analysis holds for the case of consumers that chose B as their first period provider. Hence, a consumer will be indifferent between staying and switching when $R_{BB} = R_{BA}$, thus $x_B = T_{BB} - T_{BA} - s_B$ and $x = x_B$. Thus, consumers will stay or switch given that $0 \leq x_B \leq \omega$.

In general, provided that $x_i \in [0, \omega]$, the choice probabilities times the first period market share – α for A and $(1 - \alpha)$ for B – are the demands of loyal consumers and switchers from each firm.

$$\begin{aligned} n_{AA} &= \alpha \int_{x_A}^{\omega} \frac{1}{\omega} dx = \frac{\omega - (T_{AA} - T_{AB} - s_A)}{\omega} \\ n_{AB} &= \alpha \int_0^{x_A} \frac{1}{\omega} dx = \frac{T_{AA} - T_{AB} - s_A}{\omega} \\ n_{BB} &= (1 - \alpha) \int_{x_B}^{\omega} \frac{1}{\omega} dx = \frac{\omega - (T_{BB} - T_{BA} - s_B)}{\omega} \\ n_{BA} &= (1 - \alpha) \int_0^{x_B} \frac{1}{\omega} dx = \frac{T_{BB} - T_{BA} - s_B}{\omega} \end{aligned}$$

Therefore, taking into account the values of choice probabilities, and provided that $x_i \in [0, \omega]$, second period profits are

$$\pi_2^A = \alpha T_{AA} - \frac{\alpha}{\omega} (T_{AA} - T_{AB} - s_A) (T_{AA} - s_A) + \frac{(1 - \alpha)}{\omega} T_{BA} (T_{BB} - T_{BA} - s_B) \quad (3)$$

$$\pi_2^B = (1 - \alpha) T_{BB} - \frac{(1 - \alpha)}{\omega} (T_{BB} - T_{BA} - s_B) (T_{BB} - s_B) + \frac{\alpha}{\omega} T_{AB} (T_{AA} - T_{AB} - s_A) \quad (4)$$

⁵I assume that in the second period consumers do not have any other preference shock neither they keep the previous period's one.

Profit functions are quadratic and concave in their arguments (prices), so maximizing over prices (T_{ii} and T_{ji}) we expect an interior solution.⁶

Solving for the second-period equilibrium by using the first order conditions, the following is the unique solution. These results also satisfy the second order conditions:

$$T_{AA}^* = \frac{2}{3}\omega + s_A \quad (5)$$

$$T_{BB}^* = \frac{2}{3}\omega + s_B \quad (6)$$

$$T_{BA}^* = T_{AB}^* = \frac{\omega}{3} \quad (7)$$

The equilibrium outcome for second-period prices do not depend on first-period market shares. These prices are increasing in the exogenous switching cost ω , and the endogenous switching fee s_i only affects the prices that loyal consumers face.⁷

Also, given these values, second-period shares are $n_{AA} = \frac{2}{3}\alpha$, $n_{AB} = \frac{1}{3}\alpha$, similarly, $n_{BB} = \frac{2}{3}(1 - \alpha)$, $n_{BA} = \frac{1}{3}(1 - \alpha)$, which clearly indicates that a third of first period consumers switches in the second period. This is a similar result to Chen (1997) for the case of paying-consumers-to-switch.

Proposition 1. *Provided that $x_A, x_B \in [0, \omega]$, there exists a unique Nash equilibrium of the second period subgame, where second-period prices do not depend on first-period market shares, the endogenous switching fee s_i only affects the prices that loyal consumers face, and a third of the population switches.*

The equilibrium in proposition 1 is a second period Nash equilibrium in the subgame and the proof is provided in the appendix. Now, using (5), (6), and (7) into (3) and (4) profits are

$$\pi_2^{A*} = \frac{\omega}{9}(1 + 3\alpha) + \alpha s_A \quad (8)$$

$$\pi_2^{B*} = \frac{\omega}{9}(1 + 3(1 - \alpha)) + (1 - \alpha)s_B \quad (9)$$

As expected, second period profits depend heavily in their first market share, which may imply higher incentives of providers to lock-in consumers with higher switching fees. It is easy to check that $\frac{\partial \pi_2^{A*}}{\partial \alpha} = \frac{\omega}{3} + s_A > 0$ if $s_A \geq -\frac{\omega}{3}$.

⁶The second derivatives are negative: $\frac{\partial^2 \pi_2^A}{\partial T_{AA}^2} = -\frac{2\alpha}{\omega} < 0$, and $\frac{\partial^2 \pi_2^A}{\partial T_{BA}^2} = -\frac{2(1-\alpha)}{\omega} < 0$.

Likewise, $\frac{\partial^2 \pi_2^B}{\partial T_{AB}^2} = -\frac{2\alpha}{\omega} < 0$, and $\frac{\partial^2 \pi_2^B}{\partial T_{BB}^2} = -\frac{2(1-\alpha)}{\omega} < 0$

⁷Second period prices are positively affected by exogenous switching cost: $\frac{\partial T_{ii}}{\partial \omega} = \frac{2}{3} > 0$ and $\frac{\partial T_{ij}}{\partial \omega} = \frac{1}{3} > 0$

2.2 The First Period

In the first period, consumers make a choice between providers, therefore, the payoff of a consumer k will be given by :

$$\begin{aligned} R_{1Ak} &= v + \sigma_k - T_A \\ R_{1Bk} &= v - \sigma_k - T_B \end{aligned}$$

where σ_k is the relative preference for firm A respect to firm B , and is uniformly distributed on the interval $[-\theta_1, \theta_2]$.

In the first period, consumers take decisions based on heir multiperiod payoffs. Thus, each consumer compare R^A vs. R^B

$$\begin{aligned} R_A &= R_{1A} + \delta E_x[R_{2A}] \\ R_B &= R_{1B} + \delta E_x[R_{2B}] \end{aligned}$$

Therefore, ⁸

$$\begin{aligned} R^A &= v + \sigma_A - T_A + \delta(v - \frac{11}{18}\omega - s_A) \\ R^B &= v - \sigma_A - T_B + \delta(v - \frac{11}{18}\omega - s_B) \end{aligned}$$

Thus,

$$Pr[\text{choose } A] = Pr[R_A \geq R_B] = Pr[\sigma \geq \hat{\sigma}]$$

A consumer is indifferent between A and B when $\hat{\sigma} = \frac{T_A - T_B + \delta(s_A - s_B)}{2}$, hence, provided that $\hat{\sigma} \in [-\theta_1, \theta_2]$, and that $\sigma \sim U[-\theta_1, \theta_2]$ with density function $h(\sigma)$ we can get the choice probabilities.

Since we have a unit mass of consumers, these probabilities actually give us the first-period market shares of the providers, therefore:⁹

$$\alpha = \int_{\hat{\sigma}}^{\theta_2} h(\sigma) d\sigma = \frac{1}{2(\theta_2 + \theta_1)} (2\theta_2 - (T_A - T_B + \delta(s_A - s_B)))$$

and,

$$(1 - \alpha) = \int_{-\theta_1}^{\hat{\sigma}} h(\sigma) d\sigma = \frac{1}{2(\theta_2 + \theta_1)} (2\theta_1 + (T_A - T_B + \delta(s_A - s_B)))$$

So, first-period profits for providers are $\pi_1^A = \alpha T_A$ and $\pi_1^B = (1 - \alpha) T_B$.

Providers maximize their multiperiod profits over first period prices T_i and switching fees s_i :

$$\begin{aligned} \max_{T_A, s_A} \pi_A(T_A, T_B, s_A, s_B) &= \pi_{1A} + \delta \pi_{2A}^* \\ \max_{T_B, s_B} \pi_B(T_A, T_B, s_A, s_B) &= \pi_{1B} + \delta \pi_{2B}^* \end{aligned}$$

⁸We get the expected second period payoffs using the distribution of exogenous switching costs x_k . The calculation of expected second period consumer surplus is shown in the appendix

⁹Recall that for the indifferent consumer $\sigma = \hat{\sigma}$, so we can solve for $\hat{\sigma}$.

I omit the detailed multiperiod profit functions, which are quadratic in their arguments (first-period prices and switching fees).¹⁰ Solving the system of equations, we find subgame perfect equilibria where optimal first period prices are:¹¹

$$T_A^* = \frac{2}{3}(\theta_1 + 2\theta_2) - \delta\left(\frac{\omega}{3} + s_A\right) \quad (10)$$

$$T_B^* = \frac{2}{3}(2\theta_1 + \theta_2) - \delta\left(\frac{\omega}{3} + s_B\right) \quad (11)$$

There are not unique values for the switching fees, but they are bounded according to firms' and consumers' constraints. Since we do not impose exit barriers for firms, and to avoid they leave the market in the second period, we restrict second period profits to be at least zero. Consumers, in other hand, will have at least zero expected second period payoffs. Thus $\forall i \in \{A, B\}$

$$-\frac{\omega(2\theta_1 + 3\theta_2)}{3(\theta_1 + 2\theta_2)} \leq s_A^* \quad \text{thus, } \pi_{2A} \geq 0 \quad (12)$$

$$-\frac{\omega(3\theta_1 + 2\theta_2)}{3(2\theta_1 + \theta_2)} \leq s_B^* \quad \text{thus, } \pi_{2B} \geq 0 \quad (13)$$

$$s_i^* \leq v - \frac{11\omega}{18} \quad \text{thus, } E[R_{2i}] \geq 0 \quad (14)$$

Given the boundaries for switching fees, s^{min} and s^{max} , both are decreasing in the exogenous switching cost parameter ω .¹² An increase of the exogenous switching cost parameter would displace the feasible region for switching fees at a lower level, which would imply a substitudability between exogenous and endogenous switching costs: lower exogenous switching costs imply higher upper bound for switching fees. It is important to highlight that switching fees, s_A and s_B , are not necessarily equal, but they should satisfy the above conditions.

Thus, second period prices are given by the following:

$$T_{AA}^* = \frac{2\omega}{3} + s_A^* \quad (15)$$

$$T_{BB}^* = \frac{2\omega}{3} + s_B^* \quad (16)$$

$$T_{BA}^* = T_{AB}^* = \frac{\omega}{3} \quad (17)$$

First-period prices are decreasing in the exogenous cost parameter ($\frac{\partial T_i^*}{\partial \omega} < 0$) and in the discount factor ($\frac{\partial T_i^*}{\partial \delta} < 0$). Second-period prices are positively affected by exogenous switching cost parameter ($\frac{\partial T_{ii}^*}{\partial \omega} = \frac{2}{3}$ and $\frac{\partial T_{ij}^*}{\partial \omega} = \frac{1}{3}$) and are not affected by the discount factor ($\frac{\partial T_{ii}^*}{\partial \delta} = \frac{\partial T_{ij}^*}{\partial \delta} = 0$). So an external reduction of exogenous switching costs would reduce second period prices, for both loyal consumers and switchers; but this reduction

¹⁰The second derivatives are negative: $\frac{\partial^2 \pi^A}{\partial T_A^2} = \frac{\partial^2 \pi^B}{\partial T_B^2} = -\frac{1}{(\theta_1 + \theta_2)} < 0$, and

$\frac{\partial^2 \pi^A}{\partial s_A^2} = \frac{\partial^2 \pi^B}{\partial s_B^2} = -\frac{\delta^2}{(\theta_1 + \theta_2)} < 0$.

¹¹The assumption of having consumers and providers equally patient also guarantees the Hessian matrix of the system of equations to be negative semi-definite, sufficient condition to get an interior solution.

¹²They have negative partial derivatives respect to ω given that $\theta_1 > 0$ and $\theta_2 > 0$.

also would increase first period prices and both boundaries of endogenous switching fees (if the change is anticipated for the providers).

First period market share of A, $\alpha = \frac{\theta_1 + 2\theta_2}{3(\theta_1 + \theta_2)}$, is increasing in the taste parameter that favors it θ_2 , and decreasing in θ_1 (the taste parameter that favors the rival), conversely for the case of market share of provider B.¹³ Using (10) to (12) into the profit functions of the providers, second period profits are

$$\pi_{2A}^* = \frac{1}{9(\theta_1 + \theta_2)} [\omega(2\theta_1 + 3\theta_2) + 3s_A(\theta_1 + 2\theta_2)] \quad (18)$$

$$\pi_{2B}^* = \frac{1}{9(\theta_1 + \theta_2)} [\omega(3\theta_1 + 2\theta_2) + 3s_B(2\theta_1 + \theta_2)] \quad (19)$$

and multiperiod profits

$$\pi_A^* = \frac{\delta\omega}{9} + \frac{2(\theta_1 + 2\theta_2)^2}{9(\theta_1 + \theta_2)} \quad (20)$$

$$\pi_B^* = \frac{\delta\omega}{9} + \frac{2(2\theta_1 + \theta_2)^2}{9(\theta_1 + \theta_2)} \quad (21)$$

Multiperiod profits do not depend on switching fees, $\frac{\partial \pi_i^*}{\partial s_i} = 0 \forall i \in \{A, B\}$, but profits are increasing in the exogenous switching costs parameter ω and the taste parameter that favors the provider (for instance $\frac{\partial \pi_A^*}{\partial \theta_2} > 0$ and $\frac{\partial \pi_A^*}{\partial \theta_1} < 0$).

The indifferent consumer has an idiosyncratic taste level of $\hat{\sigma} = \frac{\theta_2 - \theta_1}{3}$ and gets multiperiod payoff of

$$R_i = v(1 + \delta) - \frac{5\omega\delta}{18} - (\theta_1 + \theta_2) \quad (22)$$

The results are summarized in the following proposition

Proposition 2. *If $v \geq \frac{5\omega}{18} \frac{\delta}{1+\delta} + \frac{\theta_1 + \theta_2}{1+\delta}$, then there are subgame perfect equilibria in pure strategies and a unique equilibrium outcome. Providers get positive multiperiod profits. Different combinations of optimal prices and switching fees reach the lead to same payoffs' functions. Multiperiod profits and multiperiod payoffs of consumers are independent of switching fees.*

First period market share of a provider increases with the taste parameter that favors it, and a third of the population switches in the second period.

The equilibria described in proposition 2, is supported by prices, profits and consumer payoff given by equations (10) to (22).

Increasing the taste parameter, either θ_1 or θ_2 will determine consumers' choice of a provider. Therefore providers have the incentive to invest in changing the magnitude of these preferences. The following section extends the model.

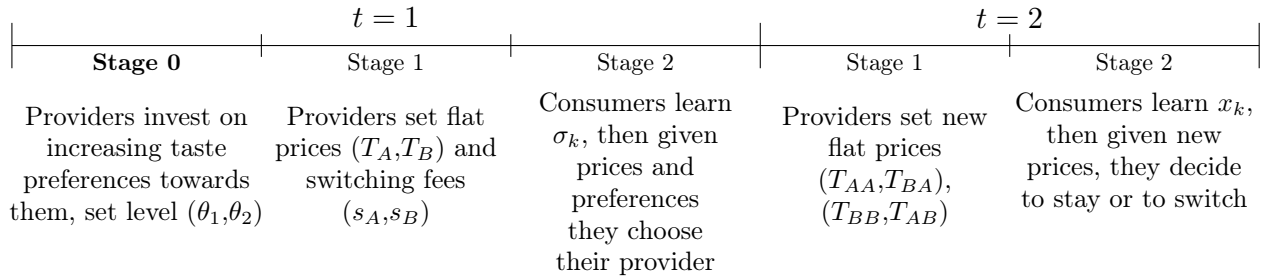
¹³It is easy to verify that $\frac{\partial \alpha}{\partial \theta_1} = -\frac{\theta_2}{3(\theta_1 + \theta_2)^2} < 0$ and $\frac{\partial \alpha}{\partial \theta_2} = \frac{\theta_1}{3(\theta_1 + \theta_2)^2} > 0$.

2.3 Providers invest on marketing

Given that providers increases market share and profits with relative preference parameter, we enable providers to invest on it. Thus, assuming this ‘marketing’ cost to be convex, and for any $\phi > 0$, providers’ first period profit changes to:

$$\begin{aligned}\pi_1^A &= \alpha T_A - \phi \theta_2^2 \\ \pi_1^B &= (1 - \alpha) T_B - \phi \theta_1^2\end{aligned}$$

In the stage zero of period one, providers decide how much to invest to increase the relative taste that favors them. Thus, the timeline of this extended model is depicted in the following diagram.



Second-period results still apply, but first-period results differ from previous analysis due to the introduction of convex costs of advertising. Thus, solving by backward induction, providers’ marketing investment lead to equal maximum relative preferences level,

$$\theta_1^* = \theta_2^* = \frac{5}{12\phi} \quad (23)$$

In the equilibria, $\hat{\sigma} = 0$ and providers A and B split the market equally, $\alpha = \frac{1}{2}$. Likewise, equilibrium prices are

$$\begin{aligned}T_A^* &= \frac{5}{6\phi} - \delta\left(\frac{\omega}{3} + s_A\right) & T_{AA}^* &= \frac{2}{3}\omega + s_A \\ T_B^* &= \frac{5}{6\phi} - \delta\left(\frac{\omega}{3} + s_B\right) & T_{BB}^* &= \frac{2}{3}\omega + s_B \\ & & T_{BA}^* &= T_{AB}^* = \frac{\omega}{3}\end{aligned} \quad (24)$$

and switching fees are such that $\forall i \in \{A, B\}$

$$-\frac{5\omega}{9} \leq s_i \quad \text{thus, } \pi_{2i} \geq 0 \quad (25)$$

$$s_i \leq v - \frac{11\omega}{18} \quad \text{thus, } E[R_{2i}] \geq 0, R_{ij} \geq 0 \quad (26)$$

Given the boundaries for switching fees, s^{min} and s^{max} , once again, an increase of the exogenous switching cost parameter would displace the feasible region for switching fees

at a lower level.¹⁴

Providers make multiperiod profits ¹⁵

$$\pi^{A*} = \pi^{B*} = \frac{\delta\omega}{9} + \frac{35}{144\phi} \quad (27)$$

Second and first period profits are

$$\pi_2^{i*} = \frac{5\omega}{18} + \frac{s_i}{2}$$

$$\pi_1^{i*} = \frac{35}{144\phi} - \delta\left(\frac{s_i}{2} + \frac{\omega}{6}\right) \quad \forall i \in \{A, B\}$$

Notice that $\frac{\partial \pi_{1i}^*}{\partial s_i} < 0$, $\frac{\partial \pi_{2i}^*}{\partial s_i} > 0$, and $\frac{\partial \pi^{i*}}{\partial s_i} = 0$.

An increase in switching fee affects positively to second-period profits but negatively to first-period profits. For the multiperiod profit maximizer firm, the effects cancel out and its multiperiod profits are independent on switching fee levels.

Multiperiod profits are increasing in the exogenous switching costs parameter ω and in the discount factor δ . First period profits are decreasing in exogenous switching costs and second period profits are increasing in them.

On the other hand, the indifferent consumer gets multiperiod payoff of

$$R_i = v(1 + \delta) - \frac{5\omega\delta}{18} - \frac{5}{6\phi} \quad \forall i \in \{A, B\}$$

Notice also that this payoff does not depend on switching fee.

Additionally, second period market shares are $n_{ii} = \frac{1}{3}$, $n_{ij} = \frac{1}{6}$. Thus the probability to stay loyal is $\frac{2}{3}$ and the probability to switch (the share of switchers) is $\frac{1}{3}$. The results of the two-period model are summarized in the following proposition.

Proposition 3. *If $v \geq \frac{5\omega}{18} \frac{\delta}{1+\delta} + \frac{1}{6\phi(1+\delta)}$, then there are subgame perfect equilibria in pure strategies where each firm gets a half of the market in the first period, and a third of the population switches in the second period.*

In these multiple equilibria, where different combinations of optimal prices and switching fees reach the same outcome(payoffs), multiperiod profits and multiperiod payoffs of consumers are independent of switching fees.

Negative switching fees – which mean providers care so much on the present and to extract as much consumer surplus as possible, they would even promise to pay consumers if they decide to leave – are possible in this model but up to a limit, s_i^{mi} . The feasible region remain constant across different level of discount factors, and is displaced downwards with bigger exogenous switching cost parameter (ω).

¹⁴They have negative partial derivatives respect to ω , $\frac{\partial s_i^{mi}}{\partial \omega} = -\frac{5}{9} < 0$, and $\frac{\partial s_i^{ma}}{\partial \omega} = -\frac{11}{18} < 0$.

¹⁵The threshold levels to switch in the second period are $x_A^* = x_B^* = \frac{\varepsilon}{3}$.

Proposition 4. *The subgame-perfect equilibrium outcome presented in proposition 3 is unique.*

To prove this last proposition, we have to prove that there is no equilibrium where none switches, and there is no equilibrium where everyone switches. The proof is shown in the appendix.

Providers do not set switching fees or only one sets it

In the scenario where the providers do not set switching fees and maximize profits over prices only. Providers solve

$$\begin{aligned}\max_{T_A} \pi_A(T_A, T_B) &= \pi_{1A} + \delta\pi_{2A}^* \\ \max_{T_B} \pi_B(T_A, T_B) &= \pi_{1B} + \delta\pi_{2B}^*\end{aligned}$$

The multiperiod payoffs are the same as if they would have set switching fees.

Moreover, if only one provider sets switching fee (and the other do not), such that

$$\begin{aligned}\max_{T_A, s_A} \pi_A(T_A, s_A, T_B) &= \pi_{1A} + \delta\pi_{2A}^* \\ \max_{T_B} \pi_B(T_A, T_B) &= \pi_{1B} + \delta\pi_{2B}^*\end{aligned}$$

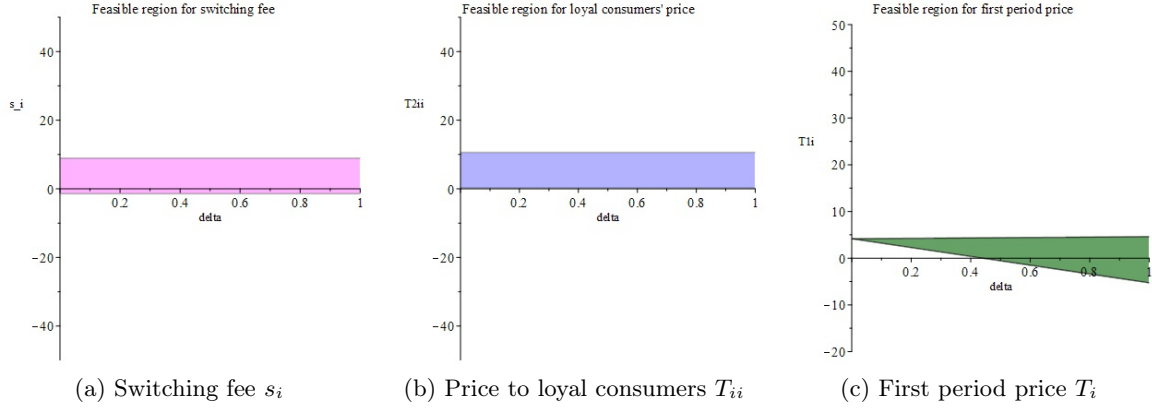
Then, the obtained payoffs are the same in all scenarios. Switching fees only intensify the intertemporal compensation through prices, and do not affect multiperiod payoffs.

3 Equilibrium analysis: implications

From the symmetric equilibrium conditions given in proposition 3, we can graphically observe the feasible region for switching fees depicted in figure 1. The figures (a) and (b) shows that feasible region for switching fees and price to loyal consumers remain constant across patience level. For first period prices, the upper bound marginally increases with patience level, but the lower bound decreases as the discount factor approaches to one; thus for higher δ , the feasible region of negative prices becomes bigger.

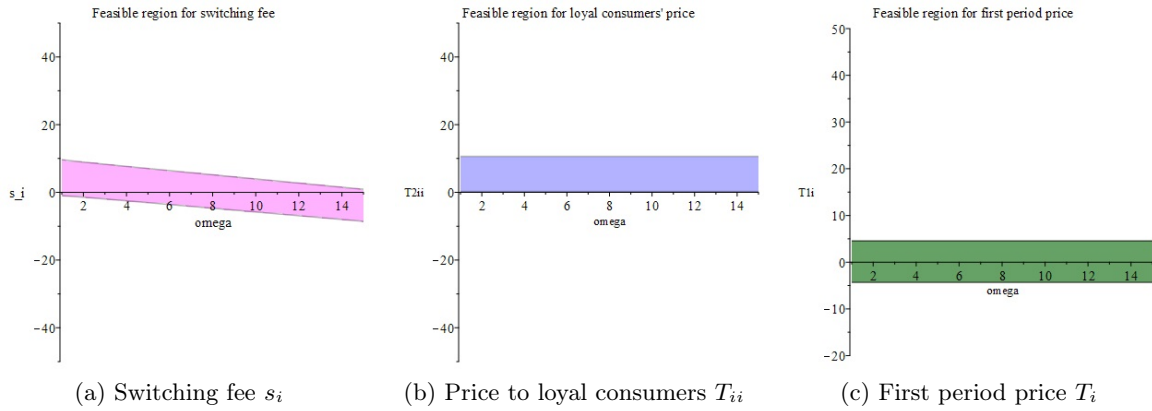
In the same fashion, fixing the patience level, we can check that the feasible region for optimal switching fees shifts downwards as the exogenous cost parameter increases – both upper and lower bounds decreases in ω –. Meanwhile, the feasible region for prices to loyal consumer remain constant and above zero, and the first period price remains also constant but it allows for negative prices (see figure 2).

Although there are many combinations of prices and switching fees, profits are set in a unique way; providers' profits are increasing in the discount rate and the exogenous switching cost parameter. Figure 3 shows the feasible regions for first, second and multiperiod profits. Providers may risk and get negative first period profits as discount factor increases. Despite of the multiplicity of equilibrium outcomes for period-profits due to the use of a range of switching fees, the multiperiod or lifetime profit is uniquely



Parameters values: $v = 10$, $\phi = 0.2$ and $\omega = 2$

Figure 1: Feasible regions for switching fees optimal prices as δ changes



Parameters values: $v = 10$, $\phi = 0.2$ and $\delta = 0.9$

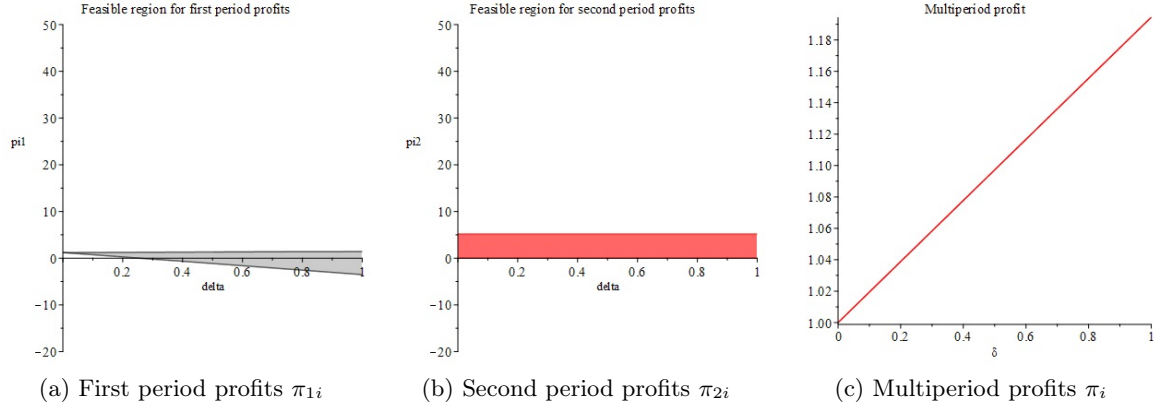
Figure 2: Feasible regions for switching fees optimal prices as ω changes

determined.

Figures 4 and 5 show the optimal prices and profits as functions of discount factor δ in different scenarios, when providers set minimum and maximum switching fee. Assuming providers always set s^{min} , Figure 4a shows that first-period prices are almost constant and always higher than second-period prices for loyal consumers and switchers; switchers are charged the same regardless of the discount factor.

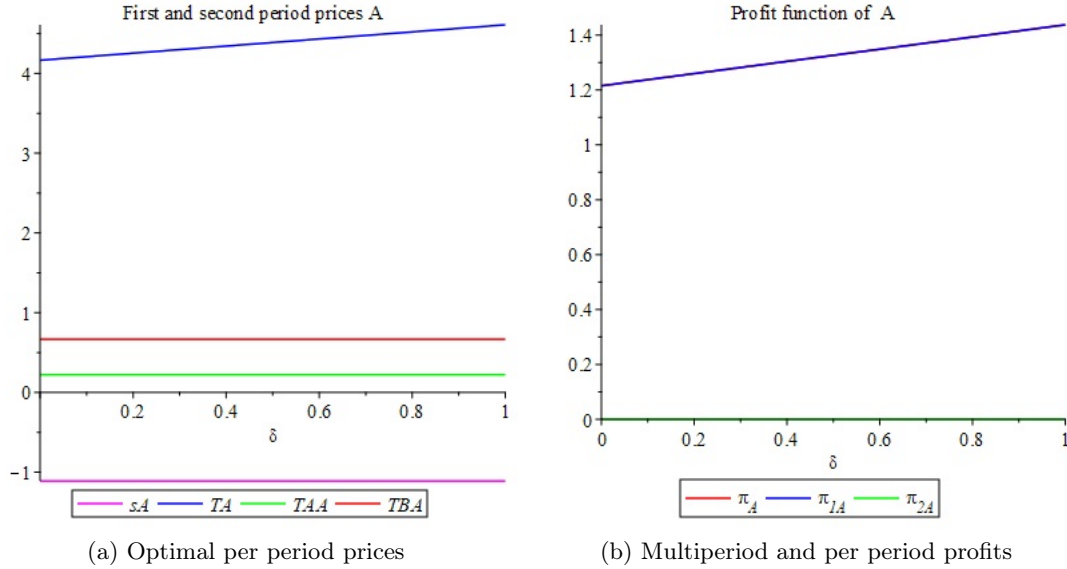
Likewise, figure 4b depicts the profit functions: multiperiod profit (red line) is always positive and increasing in δ ; first-period profits also are positive but they slightly decrease with patience level. Second-period profits are increasing in δ , but they are negative if $s_i = s^{min}$. This result indicates that the effect of a switching fee is intertemporally compensated in providers' profits.

When providers set a s^{max} , then second period prices and switching fees are positive, but first period prices quickly becomes negative as discount factor increases. Also first



Parameters values: $v = 10$ and $\omega = 2$

Figure 3: Feasible regions for optimal first period, second period and multiperiod profits across δ values

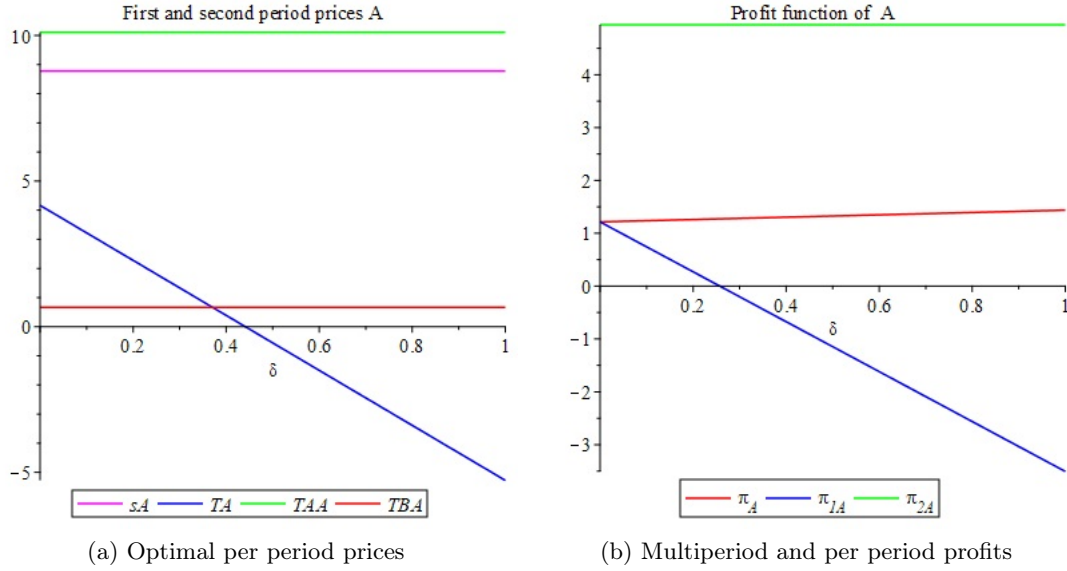


Parameters values: $v = 10$, $\phi = 0.2$ and $\omega = 2$.

Figure 4: Optimal prices and profits when both providers set $s_i = s^{min}$

period profit are negative and keep decreasing with patience level, as shown by Figure 5. In this scenario, providers extract the entire consumer surplus in the second period and charge a low (even negative) first-period prices. However, profits in the first period can be negative due to the entry costs F (here fixed at 1); despite this, multiperiod profits are kept positive and increasing in δ . It is important to highlight that the multiperiod profit function in both scenarios is the same, which is explained by the fact that switching fees do not affect multiperiod profits, their effect on period profits are compensated leaving multiperiod profits unaffected.

Figures 6 and 7 show the optimal prices and profits as functions of the switching cost parameter ω when providers set minimum and maximum switching fee (a positive



Parameters values: $v = 10$, $\phi = 0.2$ and $\omega = 2$.

Figure 5: Optimal prices and profits when both providers set $s_i = s^{max}$

amount). It is always the case that second period prices increases with ω , while switching fees decreases with ω . When switching fees are set at its minimum (a negative amount), first period prices equals the consumer valuation for the service v , and is independent of exogenous switching costs, when switching fee is set at its maximum, first period prices are negative but increasing in ω .

Multiperiod profits are always increasing in exogenous switching costs; when minimum switching fees are set, first period profits reach their maximum, while second period profits are negative but increasing in ω . At maximum switching fees, first period profits are negative (to compensate consumers firms set negative first period prices) but increasing in ω ; second period prices are positive but slightly decreasing in ω , this happens due to the effect of lower switching fees collected from more switchers.¹⁶

Consumer surplus and social welfare

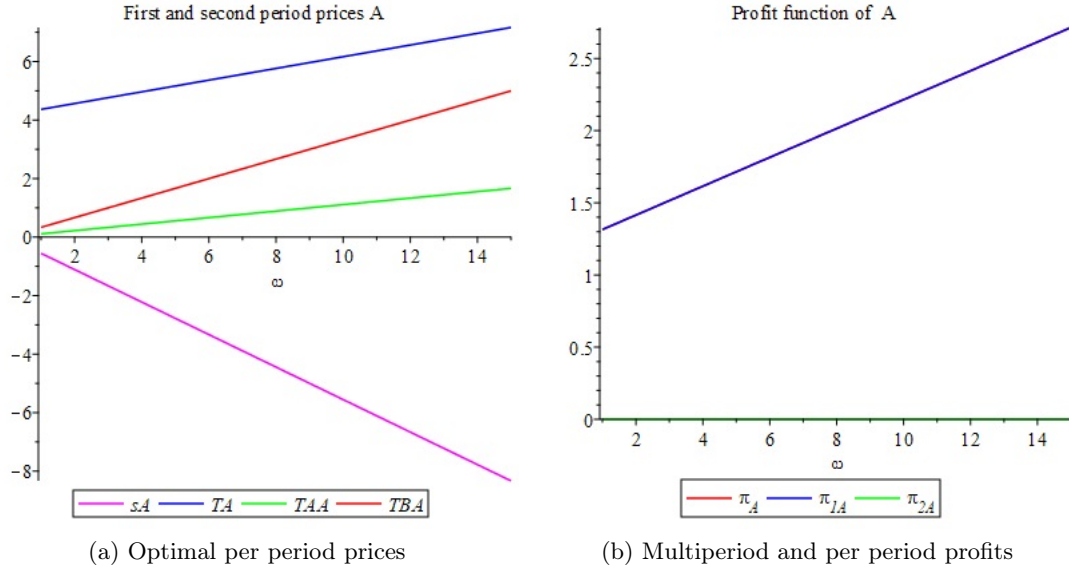
Let's now consider and depict the effect of the equilibrium outcomes on the consumer surplus and social welfare or total surplus (producer plus consumer surplus). Integrating over consumers, we get the following consumer surplus function:

$$CS = \frac{5\delta(18v - 5\omega)}{108\phi} + \frac{5v}{6\phi} - \frac{25}{48\phi^2} \quad (28)$$

Adding the producer surplus generated by the two providers, we get the following social welfare function:

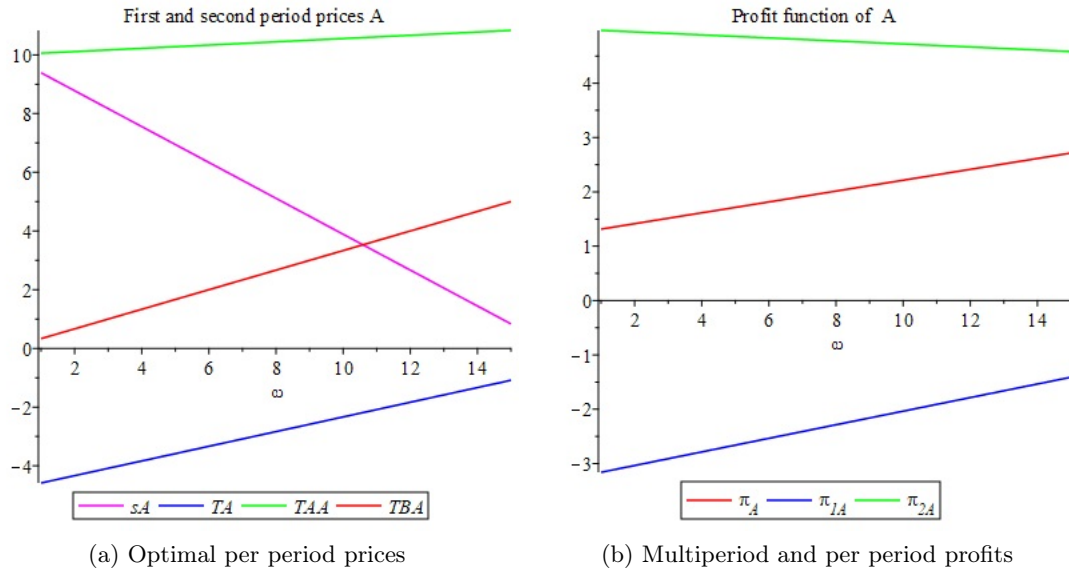
$$SW = \frac{5\delta(18v - 5\omega)}{108\phi} + \frac{5v}{6\phi} + \frac{2\delta\omega}{9} + \frac{35}{72\phi} - \frac{25}{48\phi^2} \quad (29)$$

¹⁶Recall that the switchers' share rise with ω).



Parameters values: $v = 10$ and $\delta = 0.9$.

Figure 6: Optimal prices and profits when both providers set $s_i = s^{min}$



Parameters values: $v = 10$, $\phi = 0.2$ and $\delta = 0.9$.

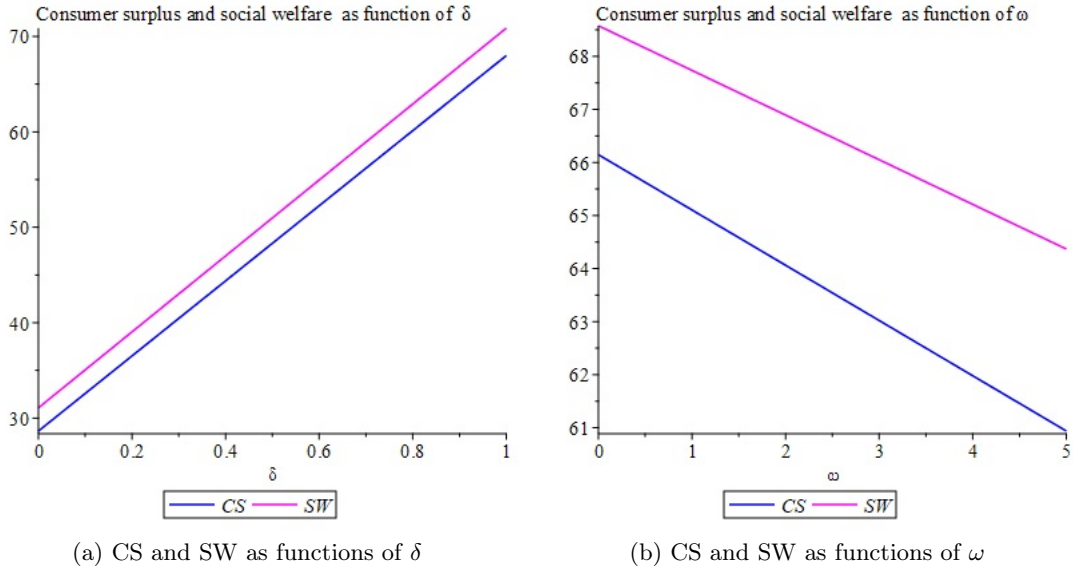
Figure 7: Optimal prices and profits when both providers set $s_i = s^{max}$

Proposition 5. *The presence of switching fees has no affect on consumers' multiperiod payoffs neither providers' multiperiod profits.*

Consumer surplus always decreases with exogenous switching costs ω , and total surplus (social welfare) decreases with ω only for small marketing cost parameter, $\phi \leq 1$.

As mentioned before, endogenous switching costs or switching fees do not affect the multiperiod payoff of consumers (they affect per period payoff, and these effects that are canceled out in the total discounted multiperiod payoff), therefore multiperiod con-

sumer surplus is also unaffected by switching fees. However, consumer's multiperiod and per period payoff are affected by exogenous switching costs.



Parameters values: $v = 10$, $\phi = 0.2$ and $\omega = 2$.

Figure 8: Consumer surplus and social welfare functions

Given that multiperiod profits of providers are also independent of switching fees, social welfare (defined as the summation of consumer surplus and providers' profits) is unaffected by switching fees (endogenous switching costs). This result may be striking, but it may explain why in some industries such as telecommunications, switching fees like ETF are being dismissed by some companies. It also agrees with the findings of Cullen et al. (2016) where equilibria where providers with and without switching fees may coexist. In the model presented in this paper that may happen because the effect of switching fees are compensated inter-temporally in such a way that they do not affect payoffs of consumers either providers.

Figures 8a and 8b show the consumer surplus (CS) and social welfare (SW) as functions of the discount factor δ , and of the exogenous switching cost parameter ω whenever $\phi \leq 1$. Both functions are clearly increasing in the patience level (δ), driven basically for greater consumer welfare as patience level increases.

On the other hand, consumer surplus decreases more rapidly with the exogenous switching cost parameter than in the case of social welfare. Thus, less exogenous switching costs would have a greater impact in the short term for consumers.

3.1 Discussion and policy implications

The model developed in this paper, show that exogenous switching costs are more relevant than endogenous switching costs in the decision making of consumers. For the providers, switching fees would not affect multiperiod profits, but would accentuate a

trade off between present and future profits. Providers with high switching fees would compensate consumers with lower first period prices, but would charge higher second period prices to loyal consumers; low switching fees would be associated to high first period prices and lower second period prices to loyals. Thus consumers with lower first period surplus get compensated with higher second period surplus, and vice versa.

Second period prices are positively affected by exogenous switching cost parameter ω . Therefore an unanticipated external reduction of exogenous switching costs would reduce second period prices, for both loyal consumers and switchers; however, if the change is anticipated for the providers this reduction also would increase first period prices and the possibility of higher switching fees.

On the other hand, since profits are increasing in exogenous switching costs ω , providers will have incentives to keep a high ω (opposing to regulatory changes such number portability or standardization or even by increasing searching costs). Also, given that profits are increasing in relative taste parameters, providers have greater incentives to invest in advertising to influence consumer preferences, when they do, in a symmetric case, firms invest until they both get same relative taste level.

According to the model, firms charge higher to loyal consumers than to newcomers in the second period when a maximum switching fee is charged, and otherwise if the minimum switching fee is applied. Furthermore, when s^{max} is used by both providers, then these charge higher to loyal consumers in the second period respect to first period prices.

Once again, switching fees do not play any role in lifetime payoffs (profits and consumer surplus). The negative effect of switching fees on first period profits cancels out with the positive effect it has in the second period profits. Hence, policies that target exogenous switching costs reduction may have higher impact on social welfare than those that ban any existence of switching fees (endogenous SC); external reduction of exogenous switching costs increases social welfare, by increasing consumer surplus.

The model suggests that regulatory policies that reduce exogenous switching costs such as number portability (in telecommunication industries, or banking industries), compatibility, standardization, or reduction of administrative barriers, would be more effective in increasing social welfare than policies that reduce endogenous switching costs such as switching fees (ETF in telecommunication industry).

4 Related literature

Farrel and Klemperer (2007) discuss switching costs and network effect. Fudenberg and Tirole (2000) and Chen (1997) focuses more on the strategies used by firms to attract customers from their competitors. Toolsema (2009) adds an interesting approach by differentiating intra and interfirm switching costs, but she restricts her analysis to a static monopoly pricing structure. Shapiro (1999) deals directly with the exclusivity of services within industries with network effects.

Markets with switching costs are usually discussed in dynamic models. However, a

static approach is also used in Klemperer (1988) and Shaffer and Zhang (2000). Klemperer (1988) analyzes firms' entry decisions in markets with switching costs. According to that model, when switching costs are unavoidable, entry is found to be socially undesirable due to the welfare losses caused by the switching costs that consumers have to face and the incumbents' output that would have been efficiently provided with no entry. Beggs and Klemperer (1992) show using two-period models, that switching costs seem to lead to higher equilibrium prices and higher profits, thus markets with switching costs become more attractive to the entry of new firms, and market shares would converge to the same rate if firms exhibit similar costs. This may be the reason why switching costs reduce demand elasticity.

The effect of switching costs on competition is ambiguous. By modeling a two-period economy that produces a homogeneous good, Klemperer (1987b) finds that switching costs lead to increased competition in the first period to get the larger portion of the market in order to maximize second-period rents.¹⁷ ¹⁸ Competition intensity, however, is reduced in the following period, when also firms produce less. Thus due to switching costs, welfare is expected to fall. In a similar study, but with differentiated goods, Klemperer (1987a) finds that the effect on competition is ambiguous for the first period, but damaging in the second period due to the firms' incentive to take advantage of their loyal established consumers. Fabra and Garcia (2015) find switching costs becomes pro-competitive in the long-run when market shares tend to be symmetric, when market structure is asymmetric then switching costs lead to higher prices. Under the absence of price discrimination between loyal and non-loyal consumers, Arie and Grieco (2014) show switching costs have a significant compensating effect that lead firms to reduce prices, instead of increasing them, to attract switchers from the rival.

Caminal and Matutes (1990) present a duopoly model with endogenous switching costs and differentiated product. They consider pricing practices to retain customers as well pre-commitment to prices or coupons in the initial period. They find that price commitment enhances competition, while coupons shrink it. Firms would prefer switching costs to be absent, but since their next period rents depend on retained consumers, they would usually use switching costs in the form of coupons or discounts.

Some other researchers have used an infinite-period model with overlapping generations. Markets include established consumers and newcomers. Some of the models also include switchers and a replacement rate of established consumers (Farrel and Shapiro, 1988; Padilla, 1995; To, 1996; Cabral, 2012). In general, these studies solve for Markov perfect equilibria and get similar results. Farrel and Shapiro (1988) finds that incumbents supply only to their loyal/attached consumers and the entrants serve the newcomers. However, switching costs generate excessive entry, which creates inefficiencies in the market. In Padilla (1995), switching costs generate higher prices and profits in every period, and prices increase with firms' customer base, which also implies more difficulties in sustaining tacit collusion.¹⁹

¹⁷Firms fiercely compete for attracting customers in the first period, even when that means setting prices below costs. This happens because they would charge monopoly prices in the second period to their loyal consumers.

¹⁸Farrel (1986) shows that firms with larger market share in the first period charge higher prices in the second period, up to the level that the firm still gets the larger market share in the second period.

¹⁹Switching costs would make punishments less severe in collusive agreements.

Also, To (1996), based in Beggs and Klemperer (1992) where market shares evolve monotonically, finds that when consumers face finite horizon, market dominance and prices alternates among firms. With a different perspective, and also based on an infinite-period model, Cabral (2012) finds conditions for switching costs to affect prices in opposite directions. According to the study, switching costs in markets already competitive strengthen the competitive behavior by intensifying competition for new customers. However in markets with lower initial competition, switching costs make the market even less competitive because the switching costs' effect on reinforcing market power of larger firms dominates.

5 Conclusions

The model developed in this paper shows that exogenous switching costs are more relevant than endogenous switching costs in the decision making of consumers. For the providers, switching fees would not affect multiperiod profits but would accentuate a trade-off between present and future profits. Providers with high switching fees would compensate consumers with lower first period prices, but would charge higher second-period prices to loyal consumers; low switching fees would be associated with high first-period prices and lower second-period prices to loyals. Thus consumers with lower first-period surplus get compensated with a higher second-period surplus and vice versa.

Second-period prices are positively affected by exogenous switching cost parameter ω . Therefore an unanticipated external reduction of exogenous switching costs would reduce second-period prices, for both loyal consumers and switchers; however, if the providers anticipate the change, this reduction also would increase first-period prices and the possibility of higher switching fees. However, since the adverse effect of switching fees on first-period profits cancels out with their positive effect on the second-period profits, then regulatory policies should focus more on policy measures that reduce exogenous switching costs such as standardization, compatibility, number portability, red-tape reduction, etc.

On the other hand, since multiperiod profits are increasing in exogenous switching costs ω , therefore providers will have incentives to keep a high ω (opposing to regulatory changes such number portability or standardization or even by increasing searching costs). However, high exogenous switching costs induce firms to price very low or even negative in the first period to attract consumers, despite of charging a maximum switching fee; first period profits are decreasing in exogenous switching costs.

According to the model, providers charge higher to loyal consumers than to newcomers in the second period when patience level is high. When both providers charge a maximum switching fee, then they charge higher to loyal consumers in the second period respect to first-period prices.

The effect of switching fees in multiperiod payoffs is null, hence policies that target exogenous switching costs reduction may have a higher impact on social welfare than those that ban any existence of switching fees (endogenous SC); external reduction of exogenous switching costs increases social welfare, by increasing consumer surplus.

References

- Anderson, S., A. Palma, and J. Thisse (1992). *Discrete choice theory of product differentiation*. The MIT Press.
- Arie, G. and P. Grieco (2014, 419). Who pays for switching costs? *Quantitative Marketing and Economics* (12), 379.
- Beggs, A. and P. Klemperer (1992). Multi-period competition with switching costs. *Econometrica* 60, 651–666.
- Cabral, L. (2012, April). Switching costs and equilibrium prices. New York University.
- Cabral, L. (2016, April). Dynamic pricing in customer markets with switching costs. *Review of Economic Dynamics* 20, 43–62.
- Caminal, R. and C. Matutes (1990). Endogenous switching costs in a duopoly model. *International Journal of Industrial Organization* 8, 353–373.
- Chen, Y. (1997). Paying customers to switch. *Journal of Economics and Management Strategy* 6, 877–897.
- Cullen, J., N. Schutz, and O. Shcherbakov (2016, April). Welfare analysis of equilibria with and without early termination fees in the u.s. wireless industry. International Industrial Organization Conference 2016.
- Dube, J., G. Hitsch, and P. Rossi (2009, August). Do switching costs make markets less competitive? *Journal of Marketing Research XLVI*, 435–445.
- Fabra, N. and A. Garcia (2015). Dynamic price competition with switching costs. *Dynamic Games and Applications* 5(4), 540–567.
- Farrel, J. (1986). A note on inertia in market share. *Economic Letters* 21, 73–75.
- Farrel, J. and P. Klemperer (2007). *Coordination and lock-in: Competition with switching costs and network effects*, Chapter 31, pp. 1970–2072. Elsevier.
- Farrel, J. and C. Shapiro (1988). Dynamic competition with switching costs. *RAND Journal of Economics* 19, 123–137.
- Fudenberg, D. and J. Tirole (2000). Customer poaching and brand switching. *RAND Journal of Economics* 31, 634–657.
- Klemperer, P. (1983). Consumer switching costs and price wars. Working Paper. Stanford Graduate School of Business.
- Klemperer, P. (1987a, September). The competitiveness of markets with switching costs. *The RAND Journal of Economics* 18(1), 138–150.
- Klemperer, P. (1987b). Markets with consumer switching costs. *Quarterly Journal of Economics* 102, 375–394.
- Klemperer, P. (1988). Welfare effects of entry into markets with switching costs. *Journal of Industrial Economics* 37, 159–165.

- NERA (2003). Switching costs: Economic models and policy implications. Technical report, Office of Fair Trading and Department of Trade and Industry.
- Padilla, A. (1995). Revisiting dynamic duopoly competition with consumer switching costs. *Journal of Economic Theory* 67, 520–530.
- Pearcy, J. (2011, January). Bargains followed by bargains: When switching costs make markets more competitive.
- Shaffer, G. and Z. Zhang (2000). Pay to switch or pay to stay: preference-based price discrimination in markets with switching costs. *Journal of Economics & Management Strategy* 9(3), 397–424.
- Shapiro, C. (1999). Exclusivity in network industries. *George Mason Law Review Spring*.
- Shi, M. (2013). A theoretical analysis of endogenous and exogenous switching costs. *Quantitative Marketing and Economics* (11), 205–230.
- To, T. (1996). Multiperiod competition with switching costs: an overlapping generations formulation. *Journal of Industrial Economics* 44, 81–87.
- Toolsema, L. (2009). Interfirm and intrafirm switching costs in a vertical differentiation setting: Green versus nongreen products. *Journal of Economics and M* 18(1), 263–284.
- Wang, R. and Q. Wen (1998, Winter). Strategic invasion in markets with switching costs. *Journal of Economics & Management Strategy* 7(4), 521–549.

Appendix

Proof Proposition 1:

No firm will profitably deviate from the equilibrium prices.

Proof. Suppose provider A deviates and use prices \widehat{T}_{AA} and T_{BA}^* , where $\widehat{T}_{AA} = T_{AA}^* + \Delta$, while provider B keep using equilibrium prices T_{BB}^* and T_{AB}^* . We can check, using (8) that new profits of provider A after deviation are

$$\begin{aligned}\widehat{\pi}_{2A} &= \alpha \widehat{T}_{AA} - \frac{\alpha}{\omega} (\widehat{T}_{AA} - T_{AB}^* - s_A^*) (\widehat{T}_{AA} - s_A^*) + \frac{(1-\alpha)}{\omega} T_{BA}^* (T_{BB}^* - T_{BA}^* - s_B^*) \\ &= \pi_{2A}^* + \frac{\alpha}{\omega} [\Delta \omega - \Delta (T_{AA}^* - T_{AB}^* - s_A^*) + \Delta (T_{AA}^* - s_A^*) - \Delta^2] \\ &= \pi_{2A}^* - \frac{\alpha \Delta^2}{\omega}\end{aligned}$$

Then, $\widehat{\pi}_{2A} < \pi_{2A}^*$.

Now, *ceteris paribus*, suppose A deviates to $\widehat{T}_{BA} = T_{BA}^* + \Delta$; then in similar fashion and using (8) that new profits are

$$\begin{aligned}
\widehat{\pi_{2A}} &= \alpha T_{AA}^* - \frac{\alpha}{\omega} (T_{AA}^* - T_{AB}^* - s_A^*) (T_{AA}^* - s_A^*) + \frac{(1-\alpha)}{\omega} \widehat{T_{BA}} (T_{BB}^* - \widehat{T_{BA}} - s_B^*) \\
&= \pi_{2A}^* + \frac{1-\alpha}{\omega} [-\Delta T_{BA}^* + \Delta (T_{BB}^* - T_{BA}^* - s_B^*) - \Delta^2] \\
&= \pi_{2A}^* - \frac{\alpha \Delta^2}{\omega}
\end{aligned}$$

Once again, $\widehat{\pi_{2A}} < \pi_{2A}^*$.

Therefore, regardless of the deviation ($\Delta > 0$ or $\Delta < 0$), profits are always lower than the profit achieved with equilibrium prices, and providers do not have any profitable deviation. \square

Expected second period consumer surplus

In the first period, consumers make a choice between providers, therefore, the payoff of a consumer k will be given by :

$$\begin{aligned}
R_{1k}^A &= v + \sigma_k - T_A \\
R_{1k}^B &= v + \sigma_k - T_B
\end{aligned}$$

where σ_k is the relative preference for firm A respect to firm B , and is uniformly distributed on the interval $[-\theta_1, \theta_2]$.

However in the first period, consumers do not take decisions only based on their current period payoffs, but based on their multiperiod payoffs. Thus, each consumer compare R^A vs. R^B

$$\begin{aligned}
R^A &= R_1^A + \beta E_x[R_{2A}] \\
R^B &= R_1^B + \beta E_x[R_{2A}]
\end{aligned}$$

where

$$E[R_{2i}] = P_{ii}R_{ii} + P_{ij}R_{ij} \quad \forall i, j \in \{A, B\}$$

Therefore, we get $E_x[R_{2A}]$ and $E_x[R_{2B}]$ using the distribution of exogenous switching costs x_k

$$\begin{aligned}
E_x[R_{2A}] &= v - \left(\int_{x_A}^{\omega} T_{AA}^* \frac{1}{\omega} dx + \int_0^{x_A} (T_{AB}^* + s_A + x) \frac{1}{\omega} dx \right) = v - \frac{11}{18}\omega - s_A \\
E_x[R_{2B}] &= v - \left(\int_{x_B}^{\omega} T_{BB}^* \frac{1}{\omega} dx + \int_0^{x_B} (T_{BA}^* + s_B + x) \frac{1}{\omega} dx \right) = v - \frac{11}{18}\omega - s_B
\end{aligned}$$

Therefore,

$$\begin{aligned}
R_A &= v + \sigma - T_A + \beta(v - \frac{11}{18}\omega - s_A) \\
R_B &= v - \sigma - T_B + \beta(v - \frac{11}{18}\omega - s_B)
\end{aligned}$$

Proof Proposition 4

[Proof in process]