Competition with endogenous and exogenous switching costs

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[DRAFT]

Preliminary version and incomplete

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(for the latest version, click `here`)

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. The presence of endogenous switching costs (the ability of providers to set switching fee) 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

*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, and Alejandro Melo for the productive discussions in Stony Brook. Special thanks to Guy Arie for his valuable feedback and comments. Thanks to Greg Duncan, 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 deeply grateful to the comments received from the participants of the IIOC 2017 in Boston, the International Game Theory Conference 2017 at Stony Brook, and the Econometric Society Summer School 2017 at Seoul, South Korea.

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fees or by offering coupons and discounts to frequent consumers.

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]
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). Many have been the regulatory attempts to reduce switching costs; in particular, in the telecommunications industry: to reduce exogenous switching costs, number portability has been widely implemented since late 90's, and more recently at least in Latin America regulatory agencies targeted the sales of locked mobile phones. Regulations also targeted switching fees, in April 2016, the FCC banned early termination fees (ETF) in business data services, and some countries like Peru, such fee is banned since 2013 in telecommunications services.

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; Pearcy, 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, Chen (1997) explains poaching practices with exogenous switching costs, and (Cabral, 2016) extends its infinite-period model to account for endogenous 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

[1] As 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.

[2] As 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.

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.

I develop a theoretical framework for a dynamic competition game under the presence of switching costs, where two providers in a subscription market 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 the presence of endogenous switching costs (in the form of switching fees, so providers receive them) 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.

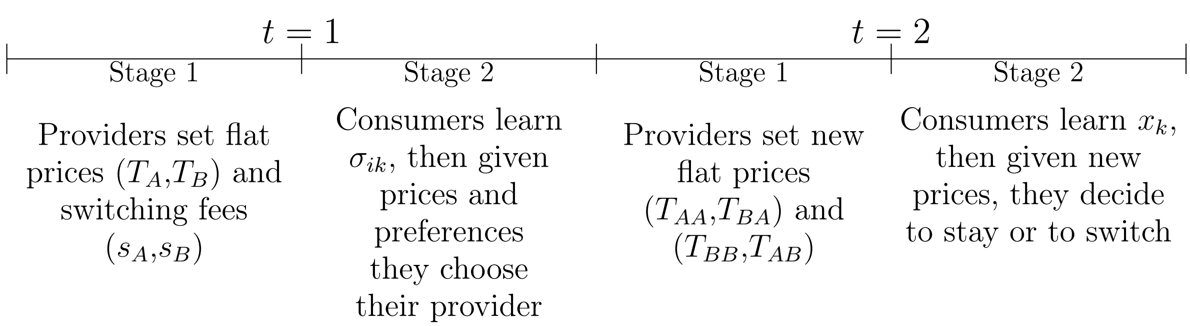
From the demand side, and following a discrete choice approach, consumers have per period linear indirect utility (payoff) functions and have the same discount rate $\delta \in (0, 1]$.[3] Every consumer has a valuation v for the service, which is assumed to be big enough so the market is covered. Also 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 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

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

[4] This 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.

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

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

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

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

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

$$R^i_k = R_{1ik} + \delta E_x[R^i_{2k}] \tag{1}$$

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

$$\pi^i_2 = n_{ii}T_{ii} + n_{ji}T_{ji} + n_{ij}s_i \quad \forall i, j \in \{A, B\}$$

The first period payoffs are $\pi^A_1 = \alpha T_A$ and $\pi^B_1 = (1-\alpha)T_A$, so provider i solves:

$$\max_{T_i, s_i} \pi^i = \pi^i_1 + \delta\pi^i_2 \tag{2}$$

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:

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

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

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

From this last equation, x_A represent the savings 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.

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

$$\begin{aligned}
n_{AA} &= \alpha \int_{x_A}^{\omega} \frac{1}{\omega} dx = \frac{\omega - (T_{AA} - T_{AB} - s_A)}{\omega} \\
n_{AB} &= \alpha \int_{0}^{x_A} \frac{1}{\omega} dx = \frac{T_{AA} - T_{AB} - s_A}{\omega} \\
n_{BB} &= (1-\alpha) \int_{x_B}^{\omega} \frac{1}{\omega} dx = \frac{\omega - (T_{BB} - T_{BA} - s_B)}{\omega} \\
n_{BA} &= (1-\alpha) \int_{0}^{x_B} \frac{1}{\omega} dx = \frac{T_{BB} - T_{BA} - s_B}{\omega}
\end{aligned}$$

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

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

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

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:

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

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

$$T_{BA}^* = T_{AB}^* = \frac{\omega}{3} \tag{7}$$

The equilibrium outcome for second-period prices do not depend on first-period market shares due to discriminatory pricing towards loyal consumers and switchers. 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.

[6]The 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 $\frac{\partial^2 \pi_2^B}{\partial {T_{BB}}^2} = -\frac{2(1-\alpha)}{\omega} < 0$

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

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

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

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

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 $s_A \geq -\frac{\omega}{3}$.

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]

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

Thus,

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

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 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]

[8] We 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.

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

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

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 :

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

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 get an interior solution, subgame perfect equilibria where optimal first period prices are: [11]

$$T_A^* = \frac{2}{3}(\theta_1 + 2\theta_2) - \delta(\frac{\omega}{3} + s_A) \tag{10}$$
$$T_B^* = \frac{2}{3}(2\theta_1 + \theta_2) - \delta(\frac{\omega}{3} + s_B) \tag{11}$$

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 $\forall i \in \{A,B\}$

$$-\frac{\omega(2\theta_1+3\theta_2)}{3(\theta_1+2\theta_2)} \leq s_A^* \qquad \text{thus}, \pi_{2A} \geq 0 \tag{12}$$
$$-\frac{\omega(3\theta_1+2\theta_2)}{3(2\theta_1+\theta_2)} \leq s_B^* \qquad \text{thus}, \pi_{2B} \geq 0 \tag{13}$$
$$s_i^* \leq v - \frac{11\omega}{18} \qquad \text{thus}, E[R_{2i}] \geq 0 \tag{14}$$

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 must satisfy the above conditions.

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

[11] The 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.

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

Thus, second period prices are given by the following:

$$T^*_{AA} = \frac{2\omega}{3} + s^*_A \tag{15}$$
$$T^*_{BB} = \frac{2\omega}{3} + s^*_B \tag{16}$$
$$T^*_{BA} = T^*_{AB} = \frac{\omega}{3} \tag{17}$$

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 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

$$\pi^*_{2A} = \frac{1}{9(\theta_1+\theta_2)}[\omega(2\theta_1 + 3\theta_2) + 3s_A(\theta_1 + 2\theta 2)] \tag{18}$$
$$\pi^*_{2B} = \frac{1}{9(\theta_1+\theta_2)}[\omega(3\theta_1 + 2\theta_2) + 3s_B(2\theta_1 + \theta 2)] \tag{19}$$

and multiperiod profits

$$\pi^*_A = \frac{\delta\omega}{9} + \frac{2(\theta_1 + 2\theta_2)^2}{9(\theta_1+\theta_2)} \tag{20}$$
$$\pi^*_B = \frac{\delta\omega}{9} + \frac{2(2\theta_1 + \theta_2)^2}{9(\theta_1+\theta_2)} \tag{21}$$

In this interior solution, multiperiod profits are not affected by the presence and setting of 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

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

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*

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

profits. Different combinations of optimal prices and switching fees lead to same payoffs' functions. Multiperiod profits and multiperiod payoffs of consumers are unaffected by the use 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).

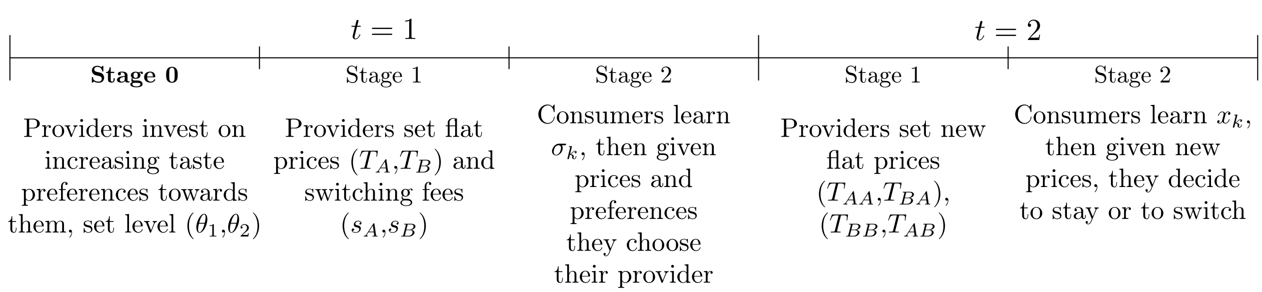
Increasing the taste parameter, either θ_1 or θ_2 will determine consumers' choice of a provider. Therefore providers have the incentive to invest in changing the magnitude of these preferences. The following section extends the model.

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:

$$\pi_1^A = \alpha T_A - \phi\theta_2^2$$
$$\pi_1^B = (1-\alpha)T_B - \phi\theta_1^2$$

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,

$$\theta_1^* = \theta_2^* = \frac{5}{12\phi} \tag{23}$$

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

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

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

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

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

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]

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

Second and first period profits are

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

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

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

For chosen switching fees that satisfies (25), an increase in them 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 unaffected on chosen switching fee's 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

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

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

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

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

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 not affected by the ability to set 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).

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.

2.4 Providers do not set switching fees or only one provider sets it

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

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

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

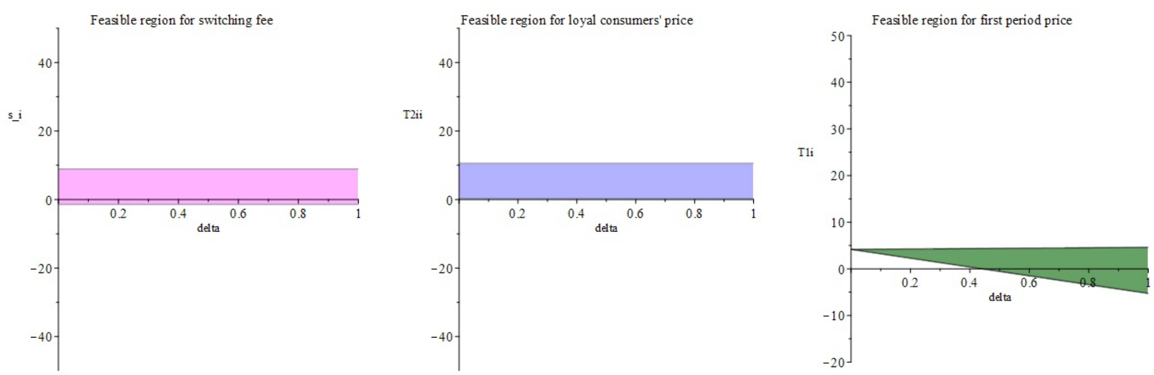
$$\max_{T_A, sA} \pi_A(T_A, s_A, T_B) = \pi_{1A} + \delta\pi_{2A}^*$$
$$\max_{T_B} \pi_B(T_A, T_B) = \pi_{1B} + \delta\pi_{2B}^*$$

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.

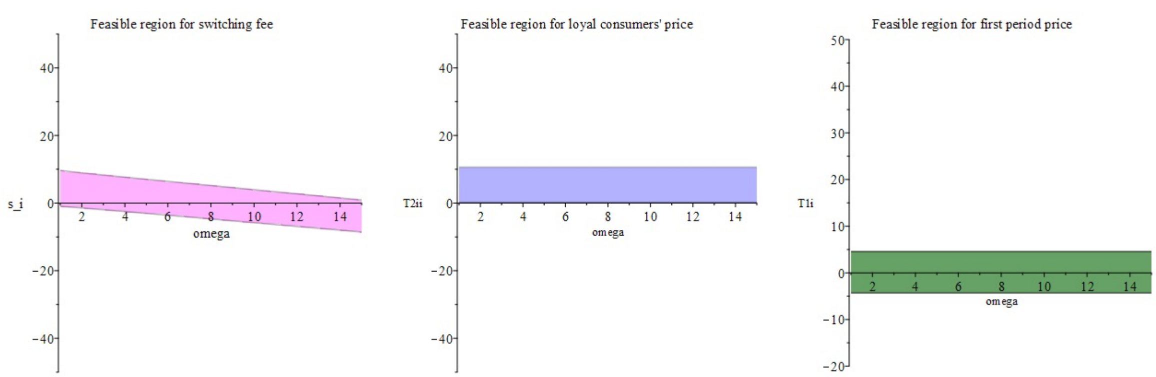


(a) Switching fee s_i (b) Price to loyal consumers T_{ii} (c) First period price T_i

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

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

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).

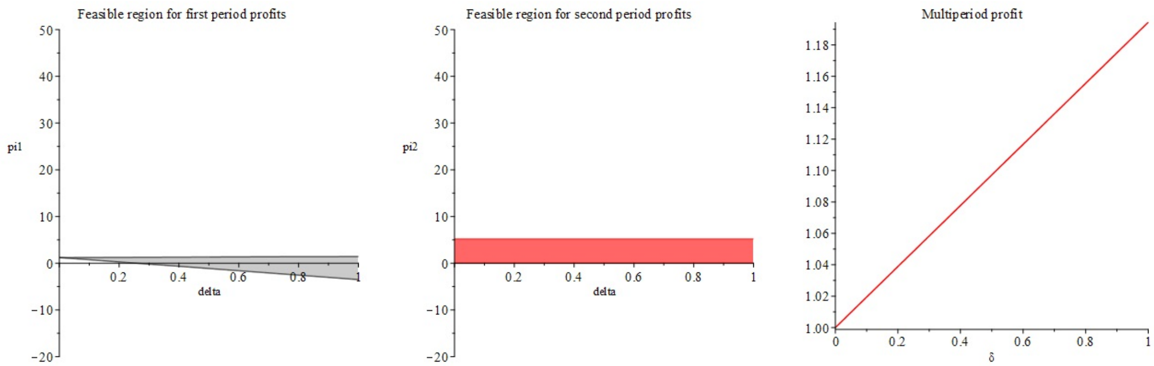


(a) Switching fee s_i (b) Price to loyal consumers T_{ii} (c) First period price T_i

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

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

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 determined.



(a) First period profits π_{1i} (b) Second period profits π_{2i} (c) Multiperiod profits π_i

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

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

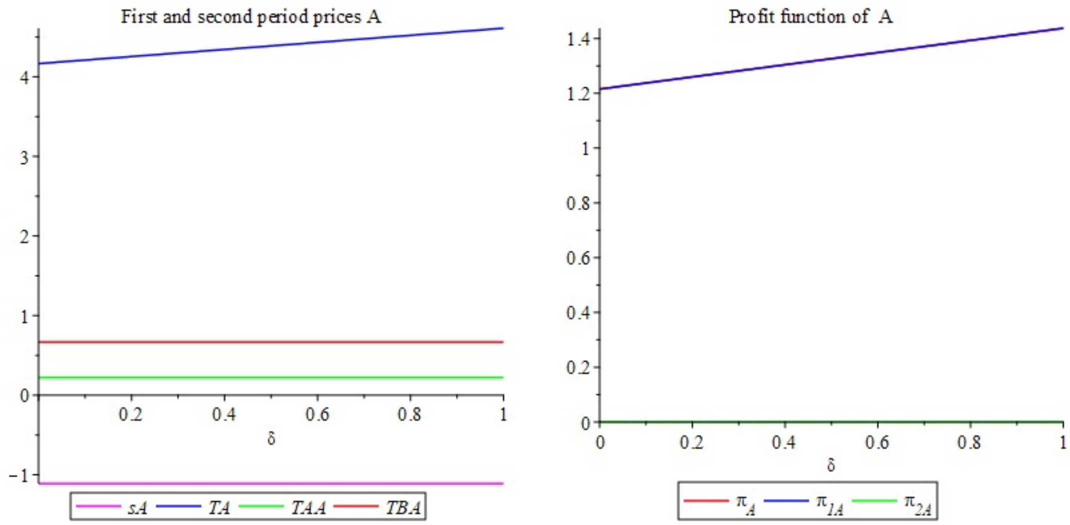
Figures 4 and 5 show the optimal prices and profits as functions of discount factor δ in different scenarios, when providers set minimum and maximum switching fee. Assuming providers always set s^{min}, Figure 4a shows that first-period prices are almost constant and always higher than second-period 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 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. First period profits also can be negative following the trend of first period prices; despite this, multiperiod profits are kept positive and slightly 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.

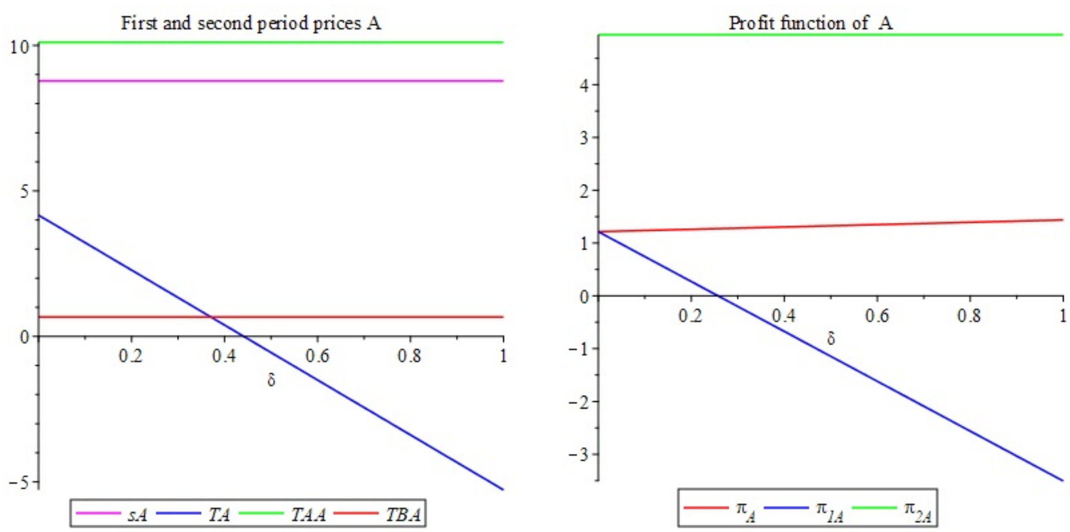
Figures 6 and 7 show the optimal prices and profits as functions of the switching cost parameter ω when providers set minimum and maximum switching fee (a posi-



(a) Optimal per period prices (b) Multiperiod and per period profits

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

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



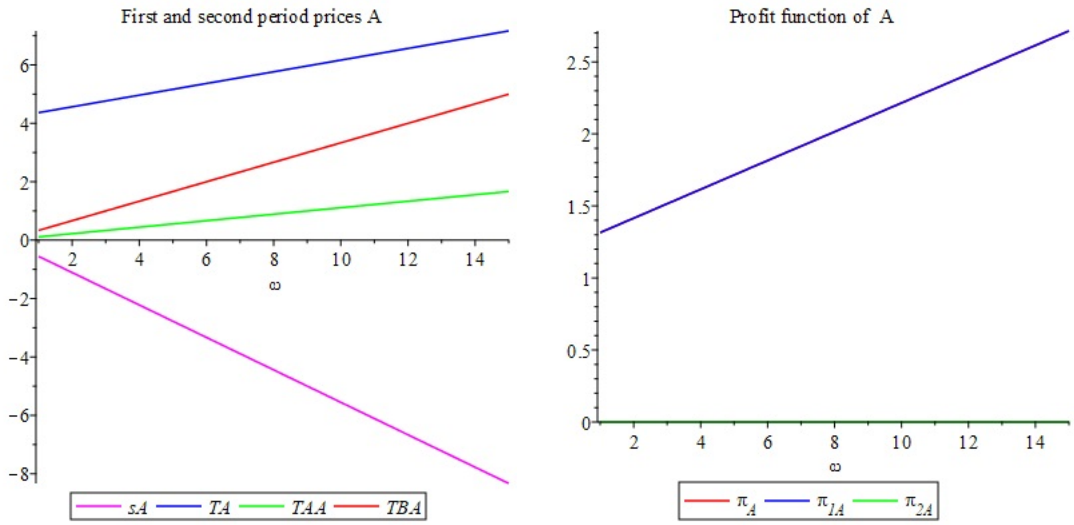
(a) Optimal per period prices (b) Multiperiod and per period profits

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

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

tive amount).[16] 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 in-

[16]Figures 9 and 10 show the optimal prices and profits as functions of both, δ and ω. In such scenario, first period prices and first period profits are decreasing in patience level and exogenous cost parameter ω. Loyals are charged higher than switchers and both prices increase with ω, and multiperiod and second period profits are also increasing in ω, but the latter increases more rapidly.

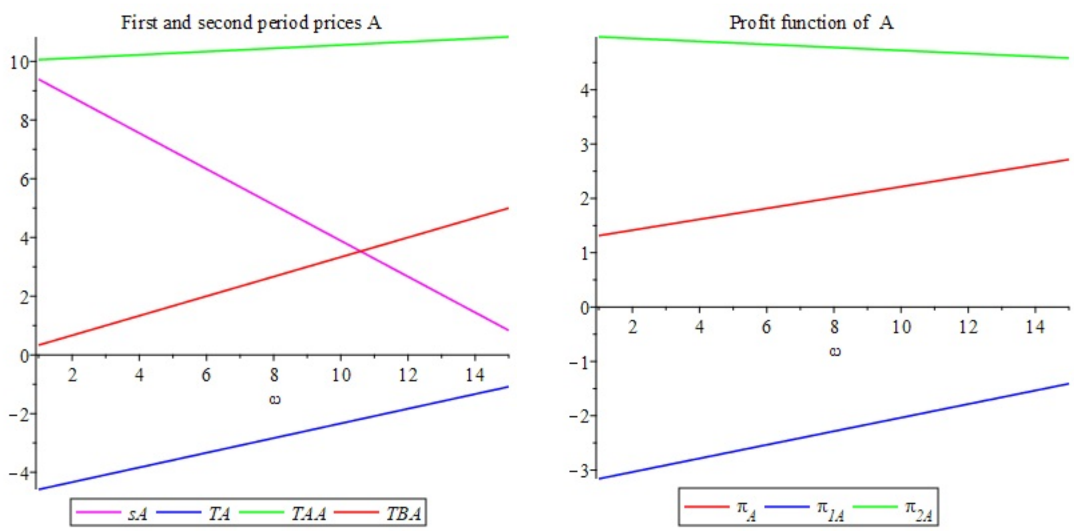


(a) Optimal per period prices

(b) Multiperiod and per period profits

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

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



(a) Optimal per period prices

(b) Multiperiod and per period profits

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

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

dependent 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. [17]

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:

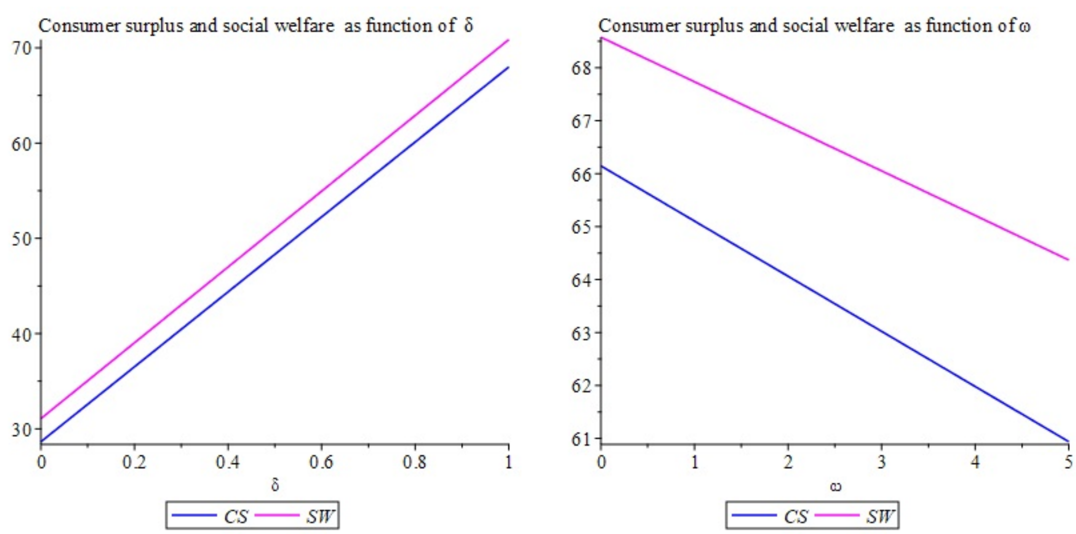
$$CS = \frac{5\delta(18v - 5\omega)}{108\phi} + \frac{5v}{6\phi} - \frac{25}{48\phi^2} \tag{28}$$

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

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

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, $\phi \leq 1$.

The ability of providers to set switching fees (endogenous switching costs) 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 consumer surplus is also unaffected by the presence of switching fees. However, consumer's multiperiod and per period payoff are affected by exogenous switching costs.



(a) CS and SW as functions of δ (b) CS and SW as functions of ω

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

Figure 8: Consumer surplus and social welfare functions

[17] Recall that the switchers' share rises with ω.

Given that multiperiod profits of providers are also unaffected by the setting of switching fees, social welfare (defined as the summation of consumer surplus and providers' profits) is also 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.

	s^{min} vs. s^{max}		A and B set $s_i = 0$	$s_i = 0$ vs. s^{max}		$s_i = 0$ vs. s^{min}	
	A (s^{min})	B (s^{max})	Firm i	A ($s_i = 0$)	B (s^{max})	A ($s_i = 0$)	B (s^{min})
Multiperiod profit π_i	**1.42**	**1.42**	**1.42**	**1.42**	**1.42**	**1.42**	**1.42**
π_{1i}	1.42	-3.03	0.92	0.92	-3.03	0.92	1.42
π_{2i}	0	4.94	0.56	0.56	4.94	0.55	0
T_i	**4.57**	**-4.33**	**3.57**	3.57	**-4.33**	3.57	**4.57**
s_i	-1.11	8.78	0	0	8.78	0	-1.11
T_{ii}	0.22	10.11	**1.33**	1.33	10.11	1.33	0.22
Cost of switching max	1.56	11.44	2.67	2.67	11.44	2.67	1.56
Cost of switching min	-0.44	9.44	0.67	0.67	9.44	0.67	-0.44
R_i	**14.33**	**14.33**	**14.33**	**14.33**	**14.33**	**14.33**	**14.33**
R_{1i}	5.43	**14.33**	**6.43**	6.43	14.33	6.43	5.43
ER_i	**9.89**	**0**	**8.78**	8.78	0	8.78	9.89
$R_{ii} = R_{ij}$	9.78	**-0.11**	8.67	8.67	-0.11	8.67	9.78
CS^i	**32.03**	**32.03**	**32.03**	**32.03**	**32.03**	**32.03**	**32.03**
CS	**64.06**	**64.06**	**64.06**	**64.06**	**64.06**	**64.06**	**64.06**
SW	**66.89**	**66.89**	**66.89**	**66.89**	**66.89**	**66.89**	**66.89**

Parameters values: $\delta = 0.9$, $v = 10$, $\omega = 2$, and $\phi = 0.2$.
Prices to switchers are $T^i_{2j} = 0.67$, and $\theta_1 = \theta_2 = 2.08$ for all the cases.
Cost of switching includes switching fee, maximum (minimum) exogenous switching cost $\omega(0)$ and switcher's price.

Table 1: Providers set different switching fee, s^{min}, $s_i = 0$ or s^{max}

By using some numerical exercises; Table 1 presents the different calculated values for multiperiod profits (for A and B), multiperiod consumer surpluses, and multiperiod payoff of a typical consumer, as well as per period profits and typical consumer's payoff under different scenarios. For the same discount factor ($\delta = 0.9$), this table 1 shows that for any combination of maximum or lowest switching fees used by the providers, multiperiod payoffs (profits, indirect utilities, and consumer surpluses) are kept unchanged. The observed differences come from the existing trade-off between inter-temporal payoffs when a low or high switching fee is chosen by the providers.

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. [18] [19] 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 abswence 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 haved 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

[18] Firms 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.

[19] Farrel (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.

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. [20]

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.

[20] Switching costs would make punishments less severe in collusive agreements.

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.

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Appendix

Proof Proposition 1:
No firm will profitable 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. □

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 :

$$\begin{aligned}R^A_{1k} &= v + \sigma_k - T_A\\ R^B_{1k} &= v + \sigma_k - T_B\end{aligned}$$

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

$$\begin{aligned}R^A &= R^A_1 + \beta E_x[R_{2A}]\\ R^B &= R^B_1 + \beta E_x[R_{2A}]\end{aligned}$$

where

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

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

$$E_x[R_{2A}] = v - \left(\int_{x_A}^{\omega} T^*_{AA}\frac{1}{\omega}dx + \int_0^{x_A}(T^*_{AB} + s_A + x)\frac{1}{\omega}dx\right) = v - \tfrac{11}{18}\omega - s_A$$

$$E[R_{2B}] = v - \left(\int_{x_B}^{\omega} T^*_{BB}\frac{1}{\omega}dx + \int_0^{x_B}(T^*_{BA} + s_B + x)\frac{1}{\omega}dx\right) = v - \tfrac{11}{18}\omega - s_B$$

Therefore,

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

Proof Proposition 4

<u>*Claim 1*</u>: There is no equilibrium where nobody switches.

Proof. Let's suppose $x_A > \omega \;\; \& \;\; x_B > \omega$ and analyze the game in the second period. In this case, consumers prefer to stay with their provider, which means that the payoffs of a consumer that chose A in the first period are as follows:

$$\begin{aligned} R_{AA} \geq 0 \;\; &\Rightarrow \;\; v \geq T_{AA} \\ R_{AB} \leq 0 \;\; &\Rightarrow \;\; v - s_A - x \leq T_{AB} \end{aligned}$$

Likewise, the payoff of a consumer that chose B in the first period are

$$\begin{aligned} R_{BB} \geq 0 \;\; &\Rightarrow \;\; v \geq T_{BB} \\ R_{BA} \leq 0 \;\; &\Rightarrow \;\; v - s_B - x \leq T_{BA} \end{aligned}$$

Since consumers are better off staying than switching, then $R_{AA} \geq R_{AB}$ and $R_{BB} \geq R_{BA}$. Therefore the following must hold:

$$\begin{aligned} T_{AB} + s_A + x \geq T_{AA} \\ T_{BA} + s_B + x \geq T_{BB} \end{aligned}$$

Given consumers preferences, providers set their second period prices that maximize their profits assuming the rival provider charges zero to newcomers; thus $T_{ii} > 0$ to loyal consumers and $T_{ji} = 0$ for $i \neq j \;\; i, j \in \{A, B\}$ to rival's consumers. Therefore, firm A solves the following problem:

$$\max_{T_{AA}} \pi_{2A} = \alpha T_{AA}$$
$$s.t. \quad \substack{R_{AA} \geq 0 \\ R_{AA} \geq R_{AB} \\ T_{BA} = 0 \\ x \sim U[0,\omega]}$$

which is reduced to the following:

$$\max_{T_{AA}} \pi_{2A} = \alpha T_{AA}$$
$$s.t. \quad {\scriptstyle T_{AA} \leq min\left\{v, s_A + x^{min}\right\}}$$

Given the distribution of x, then $x^{min} = 0$. Also, v is the reservation value of any consumer. By construction, $v \leq s_A + x$, therefore, s_A cannot be lower than v. Thus, since profits are increasing in T_{AA}, providers will price as high as possible, which means the maximizing price T_{AA} for firm A is v.

$$T^*_{AA} = v$$

Similarly for firm B, then

$$T^*_{BB} = v$$

Therefore, providers' profits in the second period are given by:

$$\begin{aligned}\pi^*_{2A} =& \alpha v \\ \pi^*_{2B} =& (1-\alpha)v\end{aligned}$$

Now, suppose firm A, *ceteris paribus*, increase its price T^*_{AA} to $\widehat{T_{AA}} = v+\epsilon \quad \forall \epsilon \in (0, \frac{\omega}{2})$. Since it is increasing its price a bit (by ϵ), there will be some consumers that switch. We can check that by looking at the preferences and payoffs of consumers. At the new price $\widehat{T_{AA}}$, consumers will stay when $R_{AA} \geq R_{AB}$, i.e.

$$\begin{gathered} v - (v+\epsilon) \geq v - 0 - v - x \\ x \geq \epsilon \end{gathered}$$

thus, provided that $x \in [0, \omega]$, the new choice probabilities are:

$$\begin{aligned}\widehat{P_{AA}} &= \int_\epsilon^\omega \frac{1}{\omega} dx = \frac{\omega - \epsilon}{\omega} \\ \widehat{P_{AB}} &= \int_0^\epsilon \frac{1}{\omega} dx = \frac{\epsilon}{\omega}\end{aligned}$$

And the shares of loyal consumers to A and switchers from A to B are $n_{AA} = \alpha\widehat{P_{AA}}$ and $n_{AB} = \alpha\widehat{P_{AB}}$, respectively. Then, new profits become:

$$\begin{aligned}\widehat{\pi^A_2} &= \alpha(1 - \frac{\epsilon}{\omega})(v+\epsilon) + \alpha\frac{\epsilon}{\omega}v \\ &= \alpha v + \frac{\alpha\epsilon}{\omega}(\omega - \epsilon) \\ &= \pi^{A*}_2 + \frac{\alpha\epsilon}{\omega}(\omega - \epsilon)\end{aligned}$$

Thus, since $\epsilon < \omega$ by construction, firm A would deviate to $\widehat{T_{AA}}$, increasing its price and getting higher profits ($\widehat{\pi^A_2} > \pi^{A*}_2$). Therefore, there is no an equilibrium where nobody switches. □

<u>*Claim 2*</u>: There is no equilibrium where everyone switches.

Proof. Let's suppose $x_A < 0$ & $x_B < 0$ and as before, I analyze the game in the second period. In this case, consumers prefer to switch rather than stay with their provider, which means that the payoff of a consumer that chose A in the first period are as follows:

$$\begin{aligned} R_{AA} \leq 0 \quad &\Rightarrow \quad v \leq T_{AA} \\ R_{AB} \geq 0 \quad &\Rightarrow \quad v - s_A - x \geq T_{AB}\end{aligned}$$

Likewise, the payoff of a consumer that chose B in the first period are

$$\begin{aligned} R_{BB} \leq 0 &\quad \Rightarrow \quad v \leq T_{BB} \\ R_{BA} \geq 0 &\quad \Rightarrow \quad v - s_B - x \geq T_{BA} \end{aligned}$$

Since consumers are better off switching than staying, then $R_{AA} \leq R_{AB}$ and $R_{BB} \leq R_{BA}$. Therefore the following must hold:

$$\begin{aligned} T_{AA} - s_A - x \geq T_{AB} \\ T_{BB} - s_B - x \geq T_{BA} \end{aligned}$$

Given the preferences of consumers, providers set their second period prices that maximize their profits assuming the rival provider charges zero to their consumers in order to retain them; thus $T_{ii} = 0 \; \forall i \in \{A, B\}$.

Therefore, firm A solves the following problem:

$$\max_{T_{BA}} \pi_{2A} = (1-\alpha)T_{BA} + \alpha s_A$$
$$s.t. \quad \substack{R_{BA} \geq 0 \\ R_{BB} \leq R_{BA} \\ T_{BB}=0 \\ x \sim U[0,\omega]}$$

which is reduced to the following:

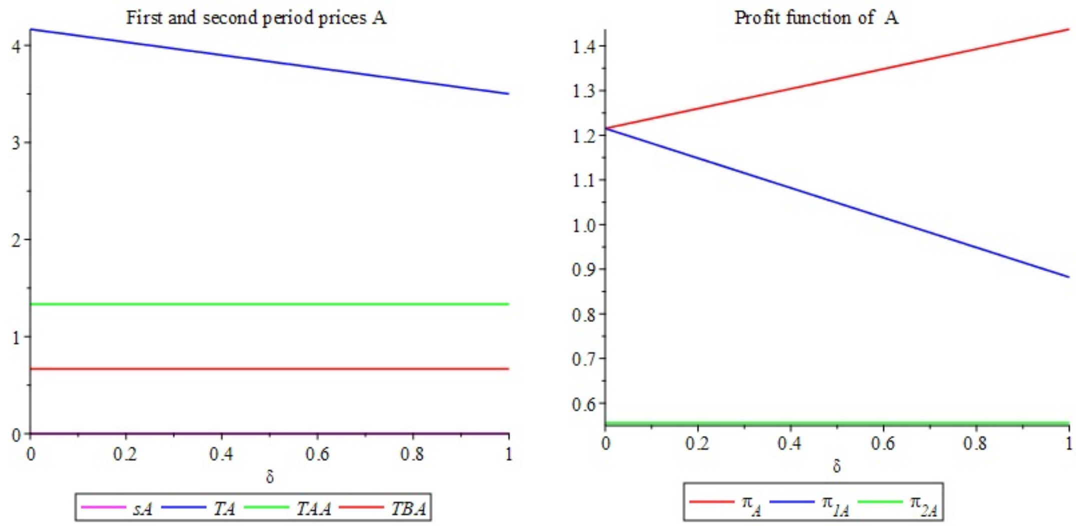
$$\max_{T_{BA}} \pi_{2A} = (1-\alpha)T_{BA} + \alpha s_A$$
$$s.t. \quad {\scriptstyle T_{BA} \leq min\{v - s_B - x^{max}, -s_B - x^{max}\}}$$

Given the distribution of x, then $x^{max} = \omega$. Recall that provider A charges $T_{AA} = 0$, which imply zero reservation value of consumers for the service, $v = 0$ because this value cannot be negative. Therefore, $T_{BA} = -s_B - \omega$, providers would make losses in the second period. Also, since reservation value of consumers does not change between periods, consumers would not be interested in buying the service if the first period prices are positive, recall that $v = 0$. Thus, providers would need to price zero in both periods, and finally they would just make losses by operating under this case, therefore providers would be better off by not operating. Hence, there is not an equilibrium where everyone switches.

□

Given that we claim 1 and 2 are true, we proved proposition 4.

Optimal prices and profit functions when providers set $s_i = 0$

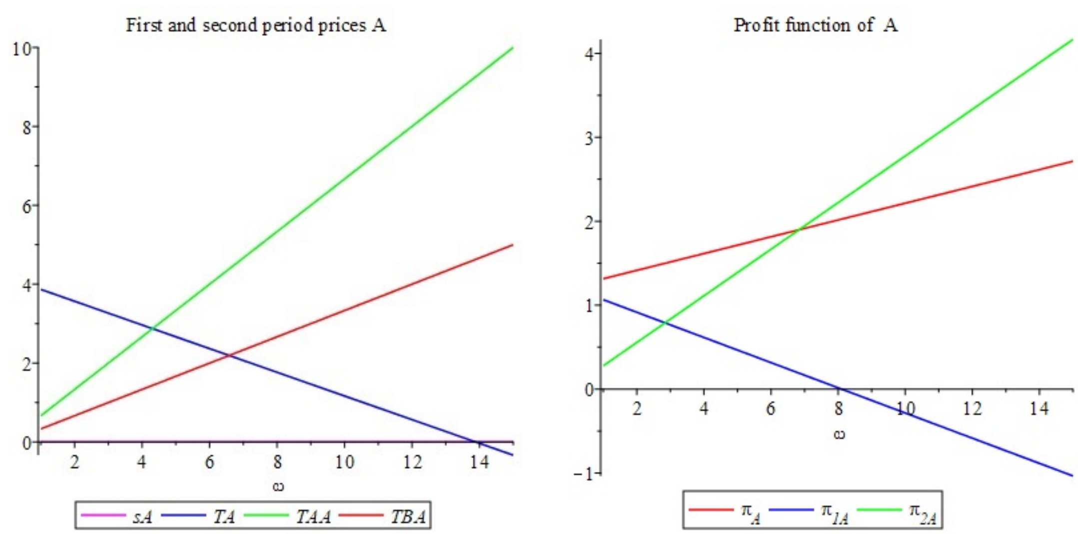


(a) Optimal per period prices

(b) Multiperiod and per period profits

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

Figure 9: Optimal prices and profits as functions of δ, when both providers set $s_i = 0$



(a) Optimal per period prices

(b) Multiperiod and per period profits

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

Figure 10: Optimal prices and profits as functions of ω, when both providers set $s_i = 0$