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To fight or not to fight: service commitment and price competition in differentiated markets

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Abstract

We study how service commitment would impact the firms' price decisions under competition over two periods, following the switching cost model of Klemperer (1987). Among many different types of switching costs observed in practice, we analyze the case where customer switching behavior is determined by previous experience, such as superior/inferior service quality. We show that even if two firms could make more profits with low service quality, they would end up playing either the Prisoner's Dilemma game by making homogeneous decisions (high service quality) or the game of Chicken by making heterogeneous decisions (high and low service quality). Second, our paper shows that if the service cost is high enough, the two firms could choose not to invest in services (low service quality). However, if the service cost is low enough, they would end up playing either the Prisoner's Dilemma game or the game of Chicken again.

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1 Introduction

Many service providers or retail firms often use endless price promotion strategies under the belief that once a customer, always a customer. Free subscriptions for the first month (e.g., Netflix or Hulu) or direct mail advertising with coupons for potential new customers (e.g., car dealerships or telecommunication providers) can be good examples of how this belief is applied in reality. Without considering service quality or capacity, however, the price promotion strategies could be just a waste of money because customers would not want to return in the future. For example, poor service quality can make customers disappointed because customers perceive the service failure as a firm's disrespectful behaviors, and stock-outs also have adverse effects on customers future behaviors in both short and long runs (Fitzsimons, 2000; Jing and Lewis, 2011). In our paper, we study how service commitment would impact the firms' price decisions under competition over two periods, using the switching cost model of Klemperer (1987).

We adopt his price competition model with a customer's switching cost to capture a customer's loyalty. That is, returning customers will be less (more) likely to switch to the other firm in the next period if the switching cost is positive (negative)[1]. Among many different types of switching costs observed in practice (Klemperer, 1995), we analyze the customer retention behavior determined by previous experiences, such as superior/inferior service quality (Xiao et al., 2012) and customer loyalty/reward programs (Shi et al., 2013). To sharpen our insights, we focus on the case where two firms decide whether to commit to high or no service in our model, which would naturally impact customer loyalty. Unlike Klemperer (1987), we assume that the switching cost is determined by the firm's service commitment and can be negative in our model if the customer is unsatisfied with the service quality. Caminal and Matutes (1990) and Shi (2013) study the two-period model with endogenous switching costs (e.g., through loyalty programs), building on Klemperer (1987), but our paper, to the best of our knowledge, is the first attempt discussing the model with a service dependent switching cost by allowing asymmetric competition.

We find two interesting results. First, we show that the two firms decide to choose more fierce price competition if the difference between high and no-service quality is not significant, which becomes the Prisoner's Dilemma game. However, if customers perceive the no-service quality level as substantially low, the two firms want to choose heterogeneous service decisions to avoid fierce price competition. In this case, a firm with high service quality will be a big winner. The other firm may end up committing to no-service because it could alleviate price competition in the first period. This game has now become the game of Chicken. Second, we find that our results are robust when the service cost is low, but if the cost is high, the two firms decide not to commit to high-quality services.

2 Model

We consider a two-period model where two firms, located at the end of a unit interval $[0, 1]$

[1]The former is called "the inertia market" (see Klemperer (1987) and references therein), and the latter is called, "the variety seeking market" (see Sajeesh and Raju (2010) and references therein).

(Hotelling 1929), compete against each other over prices in a differentiated market. We denote the firm located at 0 and 1 as firm A and B, respectively. Firm $j \in \{A, B\}$ sells a nondurable product to the market for price p_i^j in period $i \in \{1, 2\}$, and the marginal cost for the product is $c > 0$ for both firms across both periods. To analyze our model, we utilize the subgame perfect Nash equilibrium (SPNE) concept.

As in the Hotelling literature, we assume that customers are uniformly distributed along the unit line segment and have heterogeneous preferences for each firm. The customers' preference towards a specific firm can be explained by the distance of each firm in this linear city. We denote the distance from firm A as x and the distance from firm B as $1-x$. To avoid the boundary solutions, we assume the product value, v, is large enough for all customers to earn positive utility [2]. As a result, the market is fully covered for both periods. Customers would face a transportation cost, t, and combined with the distance, customers' disutility will be tx ($t(1-x)$) if buying from firm A (B).

In this paper, we allow the two firms to decide whether they commit to services. We introduce the time-zero period (pre-market period, hereafter) in which the two firms make service commitment decisions before they enter the two-period price competition. We denote the heterogeneous status as $\tau^j \in \{C, N\}$, where C (N) indicates service commitment (no-service commitment), respectively. In the first period, all customers are new to the market, so the customer's utility at location x from choosing firm A and B are $U_i^A(x) = v - tx - p_i^A$ and $U_i^B(x) = v - t(1-x) - p_i^B$, respectively. The first period demand, $D_1^j = \frac{t+p_1^{-j}-p_1^j}{2t}$, is determined by the marginal customer who is indifferent between buying from firm A or firm B. In the second period, we introduce a service-dependent switching cost, $S(\tau^j)$, as follows:

$$S(\tau^j) = \begin{cases} s, & \text{if } \tau^j = C, \\ \hat{s}, & \text{if } \tau^j = N. \end{cases} \tag{1}$$

Since customers with no service in the first period may want to switch to the other firm in the second period, we assume that $s > \hat{s}$. To ensure that the two firms compete in the second period, $s \in (0, t)$ (Klemperer, 1987), and $\hat{s} \in (-s, s)$. Note that our model reduces to that of Klemperer (1987) if $\hat{s} = s$.

To derive the second-period demand function, we divide the customer group into two segments: (i) for the segment of customers who purchased the product from firm A in the first period, the indifference location is given by $v - tx - p_2^A = v - t(1-x) - p_2^B - S(\tau^A)$; and (ii) for the segment of customers who purchased the product from firm B in the first period, the indifference location is given by $v - tx - p_2^A - S(\tau^B) = v - t(1-x) - p_2^B$. From the indifference locations, we derive the second-period demand for each firm as follows:

$$D_2^j(p_2^j, p_2^{-j}) = \underbrace{\alpha^j \left(\frac{t + p_2^{-j} - p_2^j + S(\tau^j)}{2t} \right)}_{\text{(i) firm } j\text{'s first-period customers}} + \underbrace{\alpha^{-j} \left(\frac{t + p_2^{-j} - p_2^j - S(\tau^{-j})}{2t} \right)}_{\text{(ii) firm } -j\text{'s first-period customers}}, \tag{2}$$

[2]This is a standard assumption adopted in the literature; (see, e.g., Fudenberg and Tirole (2000); Shin and Sudhir (2010); Sajeesh and Raju (2010).)

where α^j is the first period market share for firm j such that $\alpha^j = \frac{D_1^j}{D_1^j + D_1^{-j}}$. As each period profit for firm j is $\pi_i^j = (p_i^j - c)D_1^j(p_i^j, p_i^{-j})$, the total profit over the two periods is given by

$$\Pi^j = \underbrace{(p_1^j - c)D_1^j(p_1^j, p_1^{-j})}_{\text{first-period profit}} + \underbrace{(p_2^j - c)D_2^j(p_2^j, p_2^{-j})}_{\text{second-period profit}}, \qquad (3)$$

where $D_2^j(p_2^j, p_2^{-j})$ is defined in (2). We assume that the service investment cost is zero for our main analysis, but we will relax this assumption later in this paper.

3 Analysis

In this section, we first introduce the benchmark case where two firms choose symmetric service decisions (i.e., $(\tau^A, \tau^B) \in \{(C, C), (N, N)\}$). The price decision game with symmetric service cost has been studied by Klemperer (1987) and Sajeesh and Raju (2010); the following is a summary of the results obtained in the original papers:

Lemma 1 (Benchmark: Symmetric Service Commitment)**.** *For firm $j \in \{A, B\}$ and $\tau_j \in \{C, N\}$, the first-period equilibrium price is $p_1^{j*} = c + t - \frac{2}{3}S(\tau^j)$, and the second-period equilibrium price is $p_2^{j*} = c + t$. The first-period profit, the second-period profit, and the total profit are $\pi_1^{j*} = \frac{t}{2} - \frac{1}{3}S(\tau^j)$, $\pi_2^{j*} = \frac{t}{2}$, and $\Pi^{j*} = t - \frac{1}{3}S(\tau^j)$, respectively.*

The proof of Lemma 1 is omitted as it is the same as that of Klemperer (1987). Note that the first-period price is smaller (larger) than the second-period price if $S(\tau^j) > 0$ ($S(\tau^j) < 0$). This implies that when positive switching cost applies, the firms tend to do price promotions (i.e., price promotion wars) to lock in their customers in the first period by switching cost and extract more profits in the second period. If the switching cost is negative, the first-period price is higher than the second-period price. Comparing the two cases, we can easily see that the latter brings more profits than the former as the first-period competition eases.

3.1 Asymmetric Service Commitment

This section assumes that the two firms choose heterogeneous service commitment decisions. For simplicity, we denote firm A to be the firm with a higher service commitment and firm B to be the firm with no-service commitment. By backward induction, we first solve for the second-period price by taking a derivative of π_2^j with respect to p_2^j. First-order condition (FOC) yields the following: $p_2^A = c + t + \frac{1}{3}(s\alpha^A - \hat{s}\alpha^B)$ and $p_2^B = c + t - \frac{1}{3}(s\alpha^A - \hat{s}\alpha^B)$. Note that the second-order condition (SOC) yields a negative value. Using the second price found above, each firm maximizes the total profit $\Pi^j(p_1^j, p_2^j)$ in the first period. FOC and SOC verify the optimal first-period prices in the following lemma.

Lemma 2. *The first-period equilibrium prices are $p_1^{A*} = c - \frac{s+\hat{s}}{3} + \frac{t}{2} + \frac{t}{6}\left[\frac{81t^2 - 6s^2 - 6s\hat{s}}{27t^2 - (s+\hat{s})^2}\right]$ and $p_1^{B*} = c - \frac{s+\hat{s}}{3} + \frac{3t}{2} - \frac{t}{6}\left[\frac{81t^2 - 6s^2 - 6s\hat{s}}{27t^2 - (s+\hat{s})^2}\right]$, and the second-period equilibrium prices are $p_2^{A*} = c + t + \frac{9t^2(s-\hat{s})}{2(27t^2 - (s+\hat{s})^2)}$ and $p_2^{B*} = c + t - \frac{9t^2(s-\hat{s})}{2(27t^2 - (s+\hat{s})^2)}$. The total profits are $\Pi^{A*} = t - \frac{\hat{s}}{3} + \frac{27t^3(27t^2 - 4s\hat{s})}{8(27t^2 - (s+\hat{s})^2)^2} - \frac{t(27t^2 - 4s(s-\hat{s}))}{8(27t^2 - (s+\hat{s})^2)}$ and $\Pi^{B*} = \frac{t}{2} - \frac{s}{3} + \frac{27t^3(27t^2 - 4s\hat{s})}{8(27t^2 - (s+\hat{s})^2)^2} - \frac{t(81t^2 - 4s(s-3\hat{s}))}{8(27t^2 - (s+\hat{s})^2)}$.*

The proof is straightforward from backward induction, as described above. From Lemma 2, we find the following proposition:

Proposition 1. *In the asymmetric service commitment case,* $p_1^{A*} < p_1^{B*}$*,* $p_2^{A*} > p_2^{B*}$*,* $p_1^{A*} < p_2^{A*}$*,* $p_1^{B*} < p_2^{B*}$*, and* $\Pi^{A*} > \Pi^{B*}$*.*

Proof. We can easily check the results by the following derivations: $p_1^{A*} - p_1^{B*} = -\frac{t(s^2-\hat{s}^2)}{27t^2-(s+\hat{s})^2} < 0$, $p_2^{A*} - p_2^{B*} = \frac{9t^2(s-\hat{s})}{27t^2-(s+\hat{s})^2} > 0$, $p_1^{A*} - p_2^{A*} = \frac{-s(81t^2+3st-2s^2)-\hat{s}(27t^2-6s^2-\hat{s}(6s+3t+2\hat{s}))}{6(27t^2-(s+\hat{s})^2)} < 0$, $p_1^{B*} - p_2^{B*} = \frac{s(3t-s)(2s+9t)+\hat{s}(81t^2-6s^2-\hat{s}(6s-3t+2\hat{s}))}{-6(27t^2-(s+\hat{s})^2)} < 0$, and $\Pi^{A*} - \Pi^{B*} = \frac{(s-\hat{s})(6t-s-\hat{s})(2s+9t+2\hat{s})}{6(27t^2-(s+\hat{s})^2)} > 0$. ■

Proposition 1 implies a couple of interesting points to discuss. First, similar to the one shown in the benchmark, the firms offer lower prices in the first period than in the second period to increase the market share. This is interesting because even the firm with negative switching costs wants to offer a lower price in the first period, which is a stark difference from that of Sajeesh and Raju (2010). Second, the firm with a no-service commitment tends to offer less volatile prices over the two periods. Lastly, it is intuitive to see that the firm with higher switching costs would always outperform the firm with lower switching costs.

3.2 Pre-market Period Analysis

In the pre-market period, the two firms can simultaneously decide whether to commit to services. For ease of notation, we introduce $\Pi^j(.|\tau^j\tau^{-j})$ which is the total profit when firm j $(-j)$'s service commitment is τ^j (τ^{-j}). To find the equilibrium, we first define the following

	Service Commitment	**No Service Commitment**
Service Commitment	$\Pi^A(\cdot\,\vert CC)$ / $\Pi^B(\cdot\,\vert CC)$	$\Pi^A(\cdot\,\vert CN)$ / $\Pi^B(\cdot\,\vert NC)$
No Service Commitment	$\Pi^A(\cdot\,\vert NC)$ / $\Pi^B(\cdot\,\vert CN)$	$\Pi^A(\cdot\,\vert NN)$ / $\Pi^B(\cdot\,\vert NN)$

Figure 1: Pre-market Game

Equations 4 and 5 and derive Proposition 2.

$$\Pi^A(.|CC) - \Pi^A(.|NC) = -\frac{t(s-\hat{s})(27st^2 - \hat{s}(135t^2 - 4s^2 - 4\hat{s}(2s+\hat{s})))}{8(27t^2-(s+\hat{s})^2)^2}. \tag{4}$$

$$\Pi^A(.|CN) - \Pi^A(.|NN) = \frac{t(s-\hat{s})(135st^2 - 4s^3 - \hat{s}(8s^2 + 27t^2 + 4s\hat{s}))}{8(27t^2-(s+\hat{s})^2)^2}. \tag{5}$$

Proposition 2. *There exists a threshold,* $\tilde{s}$*, such that for* $\hat{s} > \tilde{s}$*, there is a unique pure equilibrium,* (C, C)*. For any* $\hat{s} \leq \tilde{s}$*, the two firms choose heterogeneous choices,* (C, N) *or* (N, C)*.*

Proof. First, we show $\Pi^j(.|CN) - \Pi^j(.|NN) > 0$. From Equation 5, $135st^2 - 4s^3 - \hat{s}(8s^2 + 27t^2 + 4s\hat{s}) > 135s^3 - 4s^3 - s(8s^2 + 27s^2 + 4s^2) > 0$ because $t > s > \hat{s}$ by assumption. Thus, $\Pi^j(.|CN) - \Pi^j(.|NN) > 0$ always holds. Given firm $-j$ choosing N, firm j's best response is always C. Next we find the threshold of $\hat{s}$ such that $\Pi^j(.|CC) - \Pi^j(.|NC) > 0$. From Equation 4, we prove that $27st^2 - \hat{s}(135t^2 - 4s^2 - 4\hat{s}(2s + \hat{s})) < 0$ if $\hat{s} \to s$. It is easy to see that for any $\hat{s} \leq 0$, $27st^2 - \hat{s}(135t^2 - 4s^2 - 4\hat{s}(2s + \hat{s})) > 0$ because $135t^2 - 4s^2 - 4\hat{s}(2s + \hat{s}) > 135t^2 - 4t^2 - 4t(2t + t) = 119t^2 > 0$. Let $119t^2$ is a lower bound, and $\hat{s}(135t^2 - 4s^2 - 4\hat{s}(2s + \hat{s})) > \hat{s}(119t^2)$ Thus, there must exist $\tilde{s}$, such that for $s > \hat{s} > \tilde{s} > 0$, $\hat{s}(119t^2) > 27st^2$. ■

It is interesting to see that when the switching cost under no-service commitment is close to that under high-quality service commitment, the two firms tend to fight more by choosing high-quality service commitment even if it will bring lower profits (i.e., (C, C)), which becomes "the Prisoner's Dilemma game." This result is consistent with that of Shi (2013). That is, both firms would benefit more if they were to choose not to commit to service improvements and avoid any price promotion wars. We, however, find that if the switching cost for no service is sufficiently low, the two firms will choose heterogeneous service commitment decisions (i.e., (C, N), (N, C)). This result resembles "the game of chicken", where only one firm could win big. The logic behind this result is as follows. If no service or service commitment would not make any significant difference in customer switching behaviors (that is, $\hat{s}$ is close to s), firm j prefers to choose the commitment to service and fight (i.e., $\Pi^j(.|NC) < \Pi^j(.|CC)$). However, if no service commitment negatively impacts customer switching behavior (i.e, $\hat{s}$ decreases), $\Pi^j(.|NC)$ could be greater than $\Pi^j(.|CC)$ because firm j would not be able to have more loyal customers in the future. Thus, firm j rather decides not to fight and focuses more on the current period.

Moreover, from Equations 4 and 5, we can easily verify that when the switching cost for no service becomes non-positive (i.e., $\hat{s} \leq 0$), the two firms always choose heterogeneous service commitment decisions. This result implies that if lower quality service is more likely to make customers switch to the other firm in the second period (i.e., customers are more sensitive to the lower service quality), both firms will not choose the same service commitment strategies anymore. Interestingly, in this case, one of the firms positions itself as a lower-quality firm and avoids any price wars in the first period, even if a service cost is not incurred.

Lastly, we introduce service cost, $k(s)$, to see how the results would change. For simplicity, we assume that $k'(s) > 0$, $k''(s) < 0$, and $k(\hat{s}) = 0$. Therefore, this cost will apply only to the firm with higher service commitment. Intuitively, one can imagine that if the cost is high enough, the two firms may not want to provide high-quality services. If the cost is low enough, the two firms may want to provide only high-quality services. However, if the cost is in the middle range, the heterogeneous equilibrium outcomes found in Proposition 2 (i.e., the game of Chicken) will arise. The following Corollary summarizes our intuition.

Corollary 1. *The pre-market game equilibrium will be a) (C, C), if $\Pi^A(.|CC) - \Pi^A(.|NC) > k(s)$, b) (N, N), if $\Pi^A(.|CN) - \Pi^A(.|NN) < k(s)$, and c) (C, N) or (N, C), if $k(s) \in [\Pi^A(.|CC) - \Pi^A(.|NC), \Pi^A(.|CN) - \Pi^A(.|NN)]$.*

Proof. Let $\Delta = \left[\Pi^A(.|CN) - \Pi^A(.|NN)\right] - \left[\Pi^A(.|CC) - \Pi^A(.|NC)\right] = \frac{t(s-\hat{s})^2(81t^2 - 2s^2 - 2\hat{s}(2s+\hat{s}))}{4(27t^2 - (s+\hat{s})^2)^2}$. It is easy to show that $\Delta > 0$. Then, the rest of the part can be directly derived as $k(s)$ is not a function of prices. ■

We recall that the two firms could make more profits if they decided to commit to no service, as it mitigates price promotion wars in the first period. Interestingly, Corollary 1 suggests that if the service cost is too high, the two firms are more likely to commit to no service, which brings them more profits.

4 Conclusion

Customers' utility should be positively or negatively affected by their previous service experiences as well as market prices. We adopt the classical switching model of Klemperer (1987) to capture how service-dependent switching costs would impact price decisions. In particular, we allow the firms to commit to different service levels in the pre-market period, which will ultimately affect customers' switching costs, so that asymmetric service competition can be possible. Our paper provides theoretical evidence that customers' perceived service satisfaction will determine firms' price competition decisions. The two firms may not need to engage in fierce price competition if heterogeneous service commitments are allowed. This gives us managerial insights into how a marketing department in the industry should make price promotion decisions while considering service capacity levels. Moreover, in reality, the firm's service capacity costs can increase the service quality levels. We verify that if service costs are either higher or lower, the two firms will end up choosing the same service commitment decisions, but if service costs are in the middle range, they will end up making heterogeneous service commitment decisions.

We contribute to the existing literature by showing that two firms would play either the Prisoner's Dilemma game or the game of Chicken, depending on their service levels. Our work can be extended in several different ways for future research. First, it would be interesting to see how our results will be changed when inventory is limited. One might expect that pure strategies disappear in this case, and therefore, only mixed strategies exist. Also, service quality information or a firm's types may not be available to the public in reality. These issues will be studied in future research.

5 Disclosure

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