Management Science

Customer Recognition in Experience vs. Inspection Good Markets

Bing Jing

To cite this article:
Bing Jing (2016) Customer Recognition in Experience vs. Inspection Good Markets. Management Science 62(1):216-224.
http://dx.doi.org/10.1287/mnsc.2014.2114

MANAGEMENT SCIENCE
Vol. 62, No. 1, January 2016, pp. 216–224
ISSN 0025-1909 (print) | ISSN 1526-5501 (online)

http://dx.doi.org/10.1287/mnsc.2014.2114

Customer Recognition in Experience vs. Inspection Good Markets

Bing Jing
Cheong Kong Graduate School of Business, Beijing 100738, People's Republic of China, bjing@ckgsb.edu.cn

We study the effects of customer recognition and behavior-based price discrimination (BPD) in a two-period experience good duopoly with a discrete value distribution, and we investigate the role of consumers' ex ante valuation uncertainty in dynamic price competition through comparison with an inspection good duopoly. Several results are reached. First, the firms may reward repeat purchase when the probability of a high value is relatively low and when the high–low value difference is large; otherwise, they may engage in poaching. Second, BPD frequently increases each firm's total profits, even in the poaching equilibrium. These results contrast with the inspection good duopoly, and the driver is that consumers' period 2 product preference depends on their realized values in period 1. Third, consumers' ex ante valuation uncertainty may increase or decrease firm profits without BPD, and it weakly increases firm profits with BPD, relative to the inspection good duopoly.

Keywords: behavior-based price discrimination; customer recognition; experience goods; inspection goods
History: Received April 11, 2013; accepted September 4, 2014, by J. Miguel Villas-Boas, marketing. Published online in *Articles in Advance* April 10, 2015.

1. Introduction

In many product and service markets, a consumer does not discern her precise value of the good before actual consumption. We examine behavior-based price discrimination (BPD) enabled by customer recognition in such experience good markets. We observe BPD practiced in favor of repeat customers in some experience good markets. For example, coupons are often sealed inside or printed on packages of tea, instant coffee, peanuts, or cereals. Some car rental firms, hair salons, and restaurants reward their customers with coupons that are good for future occasions. In other markets, however, it is new buyers who receive better deals. For instance, newspapers, magazines, and wireless services often offer nonsubscribers much lower rates than existing subscribers. Credit card and various club solicitations routinely waive annual fees for the first year. In a two-period experience good duopoly, we investigate when firms discriminate against their repeat versus first-time customers and the impacts of BPD on the firms' profits, welfare, and consumer surplus. We compare this duopoly with an inspection good market to reveal the effects of consumers' valuation uncertainty and learning through the first purchase on BPD.

In our model, the firms are located at the end points of a unit Hotelling interval, which represents either the geographical space or some observable product attribute other than the focal experience attribute. Consumers are uniformly distributed along the interval and live for both periods, each demanding one unit of the good per period. Each purchase involves a transportation cost that increases in the consumer–firm distance. Each product has an experience attribute that captures a consumer's idiosyncratic match. Consumers' prior valuations of the products follow identical and independent distributions. For simplicity, we assume a discrete distribution with two possible values, high and low. In period 1, each firm sets a single price because of a lack of purchase history. In period 2, the firms recognize their own previous customers and thus can charge different prices for repeat buyers and switchers.

We obtain several results. First, the firms reward repeat customers when the probability of realizing a high value is relatively low and when the high–low value difference is large relative to the unit transportation cost. In this case, sufficiently many consumers realize a low value from the first purchase. Without BPD, more than half of the consumer population would switch brands, intensifying period 2 competition. Therefore, BPD induces the firms to curb brand switching through rewarding repeat business. Otherwise, the market's intrinsic tendency of brand switching is relatively weak, and BPD requires offering better deals to switchers. Second, BPD always increases each firm's total profits when repeat purchases are rewarded. Surprisingly, BPD still frequently increases firm profits even when poaching prevails. The reason is that BPD decreases each firm's demand elasticities in period 2 and lowers the value of a larger period 1 market share, weakening the period 1 price rivalry. Third, BPD always lowers social welfare. Without BPD, in period 2, a consumer realizing a low value in period 1 may wish to switch. Even though her true value of the other, not-yet-purchased product remains unknown, it has a higher expected value. She decides whether to switch by weighing the expected gain in product value against the additional transportation cost. The amount of switching is thus efficient. BPD reduces social welfare by inducing too little or excessive switching. Consumer surplus then decreases when BPD increases firm profits. Finally, we examine the effects of consumers' ex ante valuation uncertainty on firm profits by comparing these effects with those of an inspection good duopoly, where consumers observe their values of the products prior to purchase. Without BPD, consumers' valuation uncertainty leads to higher firm profits under certain conditions and lower profits otherwise. Under BPD, it weakly increases firm profits.

This paper is related to the literature on customer recognition and BPD and is close to Villas-Boas (1999) and Fudenberg and Tirole (2000), who examine BPD in infinite-horizon and two-period duopolies of inspection goods (where ex ante consumers observe their product valuation), respectively. In both models, poaching arises, and BPD reduces each firm's profits. The underlying rationale is that without valuation uncertainty, a consumer's first purchase conveys her product preference, and her only motive to switch is a lower price. Each firm then extends a lower price to the rival's previous customers than to its own. Pazgal and Soberman (2008) reach similar results in their symmetric duopoly.[1] Our equilibrium properties and profit effects of BPD thus significantly differ from those in Villas-Boas (1999) and Fudenberg and Tirole (2000). The reason is that *valuation uncertainty introduces a new motive for switching*: *if a consumer realizes a low value in period* 1, *switching brands then implies a higher expected product value*. Therefore, the first purchase need not indicate her relative product preference in period 2. Those realizing a high value prefer the purchased product, but those realizing a low value may prefer to switch. The salience of this value-driven switching motive drives the direction of BPD in the experience good market.

Several models of BPD incorporate stochastic consumer preference across periods. In Caminal and Matutes (1990) and §6 of Fudenberg and Tirole (2000), consumers' preferences are independent across periods. With independent preferences, consumers' period 1 choices do not affect their period 2 preferences, and the outcome is repetitions of the static equilibrium. Shin and Sudhir (2010) incorporate heterogeneous purchase quantities and stochastic (but correlated) preferences across periods. We note two crucial differences between their model and ours. First, at the beginning of each period, consumers observe their exact values of each product in Shin and Sudhir's model, but ex ante, consumers do not observe their values of each product in ours. Second, when the firms have equal period 1 market shares, at equal period 2 prices, a customer is always more likely to prefer the same brand purchased before in Shin and Sudhir's model but is more likely to prefer the other brand under certain conditions in ours.[2] Consequently, our results also diverge. In our model, consumers' valuation uncertainty alone warrants rewarding one's own customers under certain market conditions, whereas Shin and Sudhir's model shows that *both* sufficient heterogeneity in purchase quantity *and* stochastic preference are required for rewarding one's own best customers (see p. 673).[3] Consistent with Shin and Sudhir, Chen and Pearcy (2010) also find that stochastic consumer preference always leads to poaching.

There exist several other models of BPD. In a two-period monopoly of experience goods, Jing (2011) identifies the market conditions for BPD to yield higher firm profits and social welfare than price commitment. Chen (1997), Shaffer and Zhang (2000), and Taylor (2003) explain poaching based on consumers' switching costs. Villas-Boas (2004b) shows that BPD may lead to price cycles in a long-lived monopoly. Kim and Choi (2010) examine firms' incentives to share their customer purchase history. Acquisti and Varian (2005) and Taylor (2004) show that in certain environments consumers may be able to conceal their preference to avoid BPD. Although concealing an identity is possible in some online settings, consumers may not have an incentive to do so when firms reward their previous customers. Besides, concealing one's identity may not be feasible in offline settings, subscription-based markets (e.g., credit cards, telecommunications), or the travel industry.

In a two-period duopoly of experience goods, Villas-Boas (2004a) shows that the nature of price competition depends on the skewedness of the consumer value distribution. When the distribution is negatively (positively) skewed, a firm benefits (suffers) tomorrow from having a larger market share

[1] Pazgal and Soberman (2008) also explore the case of an ex ante asymmetric duopoly.

[2] This happens when $t < 2(1-\lambda)\lambda(H-L)$ in our model; see §3.2.

[3] After period 1, each firm observes the purchase quantity of each of its customers in Shin and Sudhir (2010), whereas the consumers in our model discover their true value of the product purchased. Therefore, they focus on "firm learning," whereas we focus on "consumer learning."

today. Villas-Boas (2006) extends this model to an infinite horizon with overlapping generations of consumers. Bergemann and Valimaki (2006) show that the monopoly price of an experience good declines over time in a mass market but may increase in a niche market. However, these models do not address the effects of customer recognition and BPD.

Finally, our model is also somewhat related to the literature on customer relationship management (Rossi et al. 1996; Kim et al. 2001, 2004; Pancras and Sudhir 2007; Singh et al. 2008). Our current model can be viewed as providing a learning-based theory for changing customer preferences in Rossi et al. (1996) and Pancras and Sudhir (2007): a customer may switch and try out another product if the previously purchased product does not sufficiently fulfill her expectations. To our knowledge, Kim et al. (2001) is the first formal analysis of loyalty programs. Kim et al. (2001) and Fong and Liu (2011) show that reward programs weaken price rivalry. Kim et al. (2004) analyze how service providers may deploy loyalty programs to enhance yield management. Syam and Hess (2006) and Musalem and Joshi (2009) investigate how firms allocate marketing resources between customer acquisition and retention. More recent research has studied customer cost-based pricing (Shin et al. 2012) and product personalization based on purchase history (Zhang 2011).

A model is developed in the next section. Section 3 derives the equilibrium with and without customer recognition and discusses their properties and the profit and welfare effects of BPD. Section 4 compares with an inspection good duopoly and points out the role of consumers' ex ante valuation uncertainty in moderating dynamic competition. Section 5 concludes. The appendix and online technical appendix (available as supplemental material at http://dx.doi.org/10.1287/mnsc.2014.2114) contain the proofs and technical material.

2. Model

We consider a two-period model of an experience good duopoly. Two firms, 0 and 1, are located at the end points 0 and 1, respectively, of a unit Hotelling line. Below, we also refer to their respective products as 0 and 1 without confusion. Ex ante, a consumer does not observe her value of either product, which reflects her idiosyncratic match with the product's experience attribute. Instead, we assume that such valuation can only be revealed via consumption. The firms have zero fixed costs and a (common) constant marginal production cost, which is normalized to zero. A consumer population with unit mass is uniformly distributed along the unit interval. Each consumer lives for both periods and demands at most one unit of the product per period. Each consumer observes her location and both firms' locations prior to purchase. When purchasing a product at distance x away, a consumer incurs a disutility tx, where t is the unit transportation cost. The transportation cost is incurred with each purchase. Here, one may view the unit interval as a geographical space and tx as the cost of visiting a store. Alternatively, the unit interval may represent a product attribute whose values are ex ante observable to consumers. In the latter interpretation, each product essentially has two attributes, with the other attribute being an experience attribute.

Each consumer's valuations of products 0 and 1 are assumed to be identically and independently distributed. Let v denote a consumer's value of each product. For simplicity, we adopt a discrete value distribution: $v = H$ with probability λ $(0 < \lambda < 1)$, and $v = L$ $(0 < L < H)$ with probability $1 - \lambda$. A consumer at x on the unit interval receives surplus $v - tx - p_0$ from purchasing one unit of product 0 at price p_0 and surplus $v - t(1 - x) - p_1$ from purchasing one unit of product 1 at price p_1. Let $\bar{v} = \lambda H + (1 - \lambda)L$ denote the mean value of each good. For simplicity and benchmarking purposes, we assume that a consumer's location (x) and valuation (v) of a product do not change over time, as in Villas-Boas (1999) and Fudenberg and Tirole (2000). Therefore, if a consumer purchases product i $(i = 0, 1)$ in period 1, then at the beginning of period 2, she discovers her true value of i but remains uninformed about the value of the other product. Both firms and the consumers are risk neutral. We ignore time discounting. Each firm maximizes its total expected profits, and each consumer maximizes her total expected surplus over both periods. Incorporating discounting does not alter the spirit of the results.

We assume that L is sufficiently high relative to t so that the market is covered in each period.[4] At the beginning of period 1, firms 0 and 1 simultaneously announce prices a_0 and a_1, respectively, and consumers decide which product to purchase. By period 2, each firm recognizes its period 1 customers and thus can potentially price discriminate based on purchase history. The firms simultaneously announce prices for their repeat and new customers. Let b_i^R and b_i^S denote firm i's $(i = 0, 1)$ period 2 prices for its repeat and switching customers, respectively. Each consumer observes her value of the product she previously purchased and the period 2 prices, and she decides whether to repeat buy the same product or to switch to the other product. For simplicity, we focus on pure-strategy equilibrium.

We have just developed a model of an experience good duopoly. In §4, we also consider an inspection

[4] In §5, we discuss the market-not-covered case.

good duopoly in the same setting, where ex ante each consumer observes her valuation of both products before purchase.

3. The Experience Good Duopoly

3.1. Competition Without Customer Recognition

As a benchmark, we examine the case in which BPD is infeasible or banned. First, we observe that in period 2 some of the consumers who realize a low value from the first purchase switch brands. Furthermore, the extent of brand switching depends on the period 2 price difference between the products. Therefore, competition is truly dynamic. This contrasts with the two-period duopoly of inspection goods, where, without BPD, brand switching never arises, and competition reduces to repetitions of the static Hotelling game. Proposition 1 summarizes the equilibrium.

Proposition 1. *Suppose $t \geq \lambda(H-L)$. Without BPD, the two-stage game has a unique subgame perfect equilibrium (SPE): each firm charges price $a^N = 2(1+\lambda)t/3$ in period 1 and $b^N = t/(2(1-\lambda))$ in period 2, making total profits $\pi^N = (1+\lambda)t/3 + t/(4(1-\lambda))$. Upon realizing a low value in period 1, consumers in $[x_0 = \frac{1}{2} - \lambda(H-L)/(2t), x_1 = \frac{1}{2} + \lambda(H-L)/(2t)]$ switch brands in period 2.*

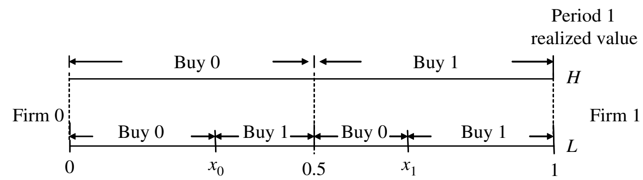
When $t \geq \lambda(H-L)$, some (but not all) consumers realizing a low value switch brands. Two features of the equilibrium are noteworthy. First, without BPD, our experience good duopoly demonstrates socially efficient switching. Switching is driven by consumer learning in period 1: a consumer realizing a low value switches if and only if the expected gain in product value ($\lambda(H-L)$) covers the additional transportation cost. Figure 1 depicts consumer choice in period 2. Second, firm profits monotonically increase in λ. A partial intuition is as follows. Provided that firm 0's period 1 market share is not too extreme, in period 2 the firms compete only for the consumers who have realized a low value (with population $1-\lambda$). When λ increases, the population of L consumers decreases, weakening the period 2 price rivalry.

3.2. Competition with Customer Recognition

The equilibrium configuration when the firms practice BPD is summarized below and is depicted in Figure 2.

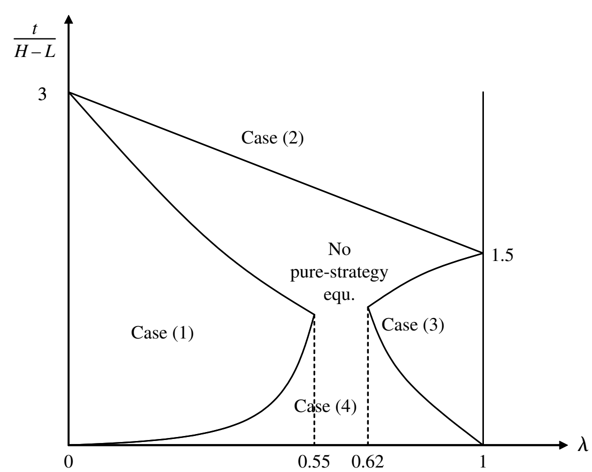
Proposition 2. (1) *When $0 \leq \lambda \leq 1 - \sqrt{5}/5$ and $\lambda(1-\lambda)/(2-3\lambda) \leq t/(H-L) \leq (1-\lambda)(6-5\lambda)/2$, the unique SPE is each firm charging $a^D = 2(2-\lambda^2)t/(3(1-\lambda)) + 2\lambda(H-L)/3$ in period 1 and $b^R = \frac{1}{3}[2t/(1-\lambda) - \lambda(H-L)]$ and $b^S = \frac{1}{3}[t/(1-\lambda) + \lambda(H-L)]$ to repeat buyers and switchers, respectively, in period 2, where only some of the consumers realizing a low value from the first purchase switch brands.* (2) *When $t/(H-L) > 3(2-\lambda)/2$, the unique SPE is $a^D = 4t/3$, $b^R = 2t/3$, and $b^S = t/3$, where some consumers realizing a low or high value from the first purchase switch brands.* (3) *When $\lambda > (\sqrt{5}-1)/2$ and $\lambda[(1+2\lambda)\sqrt{1-\lambda} + 2(1-\lambda)\sqrt{\lambda}]/(2(2-\lambda)\sqrt{\lambda} - (1+\lambda)\sqrt{1-\lambda}) \leq t/(H-L) \leq \lambda(2+\lambda)/(1+\lambda)$, the unique SPE is $a^D = 2(3-\lambda)t/3\lambda - 2(1-\lambda)(H-L)/3$, $b^R = ((1+\lambda)t + \lambda(1-\lambda)(H-L))/(3\lambda)$ and $b^S = ((2-\lambda)t - \lambda(1-\lambda)(H-L))/(3\lambda)$, where all consumers realizing a low value and some consumers realizing a high value from the first purchase switch brands.* (4) *Otherwise, there is no pure-strategy price equilibrium (i.e., any potential equilibrium is in mixed strategies).*

Figure 1 Period 2 Consumer Choice Without BPD



The intuition behind Proposition 2 is as follows. In cases (1) and (3), the unit transportation cost is relatively low, and the consumers realizing a low value are prone to switch. In case (1), the segment of consumers who realized H in period 1 (called the H segment, without confusion) is small, and the high–low value difference $(H-L)$ is large enough relative to t. In period 2, the firms will only compete for the segment of consumers who realized L previously (called the L segment), and the limited discount for switchers does not appeal to the H consumers ($H - b^R \geq \bar{v} - b^S$ or, equivalently, $b^R - b^S \leq (1-\lambda)(H-L)$). In case (3), $(H-L)$ is still large enough relative to t, but the H segment is sufficiently large. In period 2, the firms will actively compete for each other's H consumers with sufficiently deep discounts ($b^R - b^S \geq (1-\lambda)(H-L)$). Meanwhile, the transportation cost is low enough so that all L consumers switch. In case (2), the high–low

Figure 2 Equilibrium with BPD



value difference ($H - L$) is small relative to the unit transportation cost (t), and after realizing a low value, consumers lack a strong incentive to switch brands. Here, the rationale for BPD resembles that in inspection good markets (Villas-Boas 1999, Fudenberg and Tirole 2000): the firms engage in poaching and attract each other's previous customers in both the L and H segments. However, because of the high transportation cost, not all L consumers switch brands.

In case (4), when ($H - L$) is low relative to t, the only possible pure-strategy equilibrium involves all consumers (L or H) switching brands in period 2, where either firm would benefit from unilaterally and sufficiently lowering its period 2 price for repeat buyers. When ($H - L$) is high enough relative to t, the only possible pure-strategy equilibrium involves all L consumers and no H consumer switching brands in period 2, where either firm would benefit from unilaterally raising its period 2 price for switchers or for repeat buyers. Therefore, there is no pure-strategy equilibrium in case (4); any equilibrium (if it exists) must be in mixed strategies.[5] Proposition 3 directly follows from Proposition 2.

Proposition 3. *In case* (1) *of Proposition* 2, *the firms reward repeat purchase* ($b^R < b^S$) *when* $t/(H - L) < 2\lambda(1 - \lambda)$ *and reward switching* ($b^R > b^S$) *otherwise. In cases* (2) *and* (3), *the firms reward switching*.

Recall that in the two-period duopoly without valuation uncertainty, poaching prevails; i.e., switchers pay lower prices than repeat customers. The rationale behind this is as follows. *Without valuation uncertainty, a consumer's period* 1 *choice reveals her relative product preference*. At equal period 2 prices, each consumer prefers the product she purchased previously, and BPD then entails extending a lower price to the rival's previous customers than to one's own.

In our experience good duopoly, Proposition 3 shows that the firms may charge lower prices to repeat customers. Here, *a consumer's period* 1 *choice is based on her expected product valuation and may not indicate her period* 2 *product preference*. The consumers realizing a high value prefer the products purchased previously, but those realizing a low value may prefer to switch, especially if they are located near the center of the unit interval. In case (1) of Proposition 2, the H segment is relatively small ($\lambda < 1 - \sqrt{5}/5 \approx 0.553$), and in period 2, the firms only compete for the L segment. The direction of BPD depends on the unit transportation cost (t), which measures the cost of brand switching. *When* t *is relatively low* ($t \le 2\lambda(1 - \lambda)(H - L)$), *without BPD, more than half of the total consumer population prefers to switch, which will potentially intensify price rivalry*.[6] BPD then induces the firms to contain switching by rewarding repeat patronage. *When* t *is relatively high* ($t > 2\lambda(1 - \lambda)(H - L)$), *without BPD, less than half of the total consumer population switches, which limits the amount of surplus that can be extracted*. BPD then requires each firm to encourage switching through a lower price for switchers.

The driver behind Proposition 3 is that consumers' period 2 product preference depends on their realized values in period 1. In particular, some of the L consumers still prefer to switch even when the firms reward repeat buying, and all H consumers still prefer to repeat purchase even when the firms practice poaching with a limited discount ($b^R - b^S \le (1 - \lambda)(H - L)$).[7] This creates extra space for BPD.

Alternatively, Proposition 3 says that the firms should reward repeat customers when λ is relatively low and when the high–low value difference is high ($H - L > t/(2\lambda(1 - \lambda))$) and reward switchers otherwise. This prediction seems largely consistent with empirical observations. For example, firms reward repeat buying in packaged foods (breakfast cereals, peanuts, instant coffee, and tea), hair salons, and restaurants, but they reward switching in credit cards and wireless services. Although it is hard to measure the specific parameters, the perceived value difference ($H - L$) in the former types of markets is markedly higher than in the latter, partly because consumers demonstrate more heterogeneous horizontal preference over the products in the former categories.

Proposition 4. (1) *In case* (1) *of Proposition* 2, *BPD always increases firm profits*. (2) *In case* (2), *BPD increases firm profits when* $\lambda < (17 - \sqrt{133})/12 \approx 0.46$ *and decreases firm profits otherwise*.

Surprisingly, BPD often increases each firm's total profits in the experience good duopoly. This again contrasts with the conventional wisdom that without valuation uncertainty, BPD unambiguously lowers firm profits (Villas-Boas 1999, Fudenberg and Tirole 2000). In case (1) of Proposition 2, BPD relaxes overall price rivalry by reducing the firms' demand elasticities in both periods. To see this, without BPD, each firm's period 2 and period 1 demand elasticities equal

[5] There are only five possible equilibrium outcomes: (1) only some of the L consumers switch, (2) some of the L and H consumers switch, (3) some of the H consumers and all L consumers switch, (4) all L consumers switch but no H consumer switches, and (5) all consumers (L or H) switch. In the proof of Proposition 2 (in the online technical appendix), we show that only the first three cases hold under the respective conditions. Cases (4) and (5) never arise in any pure-strategy equilibrium.

[6] At equal period 2 prices, the consumers in $[\frac{1}{2} - \lambda(H - L)/2t, \frac{1}{2} + \lambda(H - L)/2t]$ who realize a low value in period 1 would switch. The number of potential switchers, $(\lambda(1 - \lambda)(H - L))/t$, exceeds $\frac{1}{2}$ when $t \le 2\lambda(1 - \lambda)(H - L)$.

[7] These patterns never emerge when consumers face no ex ante valuation uncertainty.

$|\partial D_0/\partial b_0| = (1-\lambda)/t$ and $|\partial\theta/\partial a_0| = 3(1-\lambda)/(2(1+2\lambda-2\lambda^2)t)$, respectively. Under BPD, let D_i^R and D_i^S denote firm i's period 2 demand from repeat buyers and switchers, respectively. We then have (from the proof of Lemma TA1 in the online technical appendix) that $|\partial D_i^R/\partial b_i^R| = |\partial D_i^S/\partial b_i^S| = (1-\lambda)/(2t) < (1-\lambda)/t$ and $|\partial\theta^D/\partial a_0| = 3(1-\lambda)/(4(1+\lambda)(2-\lambda)t) < 3(1-\lambda)/(2(1+2\lambda-2\lambda^2)t)$. The intuition behind this is as follows. Without BPD, in period 2, each firm uses a single price to retain its previous customers *and* to attract the rival's previous customers who have realized a low value. With BPD, each firm employs separate prices for these two tasks, and consequently, the marginal demand effect of varying each price is lower. In period 2, the firm with a smaller period 1 market share is more appealing to the rival's L customers because they can economize on transportation costs. This prompts the former to raise its price for switchers.[8] BPD thus lowers the value of having a larger period 1 market share and relaxes period 1 price competition.

Intriguingly, although poaching prevails in case (2) of Proposition 2, BPD still increases firms' profits when λ is relatively low ($\lambda < 0.46$). Again, this is because BPD decreases the firms' demand elasticities when λ is low.[9] Assessing the profit effects of BPD in case (3) of Proposition 2 is less tractable. However, numerical analysis indicates that BPD may increase firm profits for low values of λ and decrease firm profits otherwise.[10]

Proposition 5. *BPD always reduces social welfare and also reduces consumer surplus when it increases firm profits.*

Recall that the market demonstrates an efficient amount of switching in the absence of BPD. BPD lowers social welfare by inducing too little or excessive switching. Consumer surplus then must decrease when BPD increases firm profits.

4. Comparison with an Inspection Good Duopoly

In the inspection goods version of our model, consumers observe their product values before purchase: $\lambda^2 + (1-\lambda)^2$ consumers value both goods equally, $\lambda(1-\lambda)$ consumers value good 0 at H and good 1 at L, and $\lambda(1-\lambda)$ consumers value good 0 at L and good 1 at H. Fudenberg and Tirole (2000) essentially analyze a variant of this model with consumers only holding equal valuation of both goods. As Lemma TA5 in the online technical appendix shows, including the remaining consumers does not alter the market outcome, with or without BPD. When consumers observe their values of both products, the game without BPD reduces to repetitions of the static Hotelling game, and each firm charges price t and makes total profits t. BPD leads to a higher period 1 price $4t/3$ and lower period 2 prices ($2t/3$ for repeat buyers and $t/3$ for switchers) than the static case (or without BPD). Each firm makes total profits $17t/18$.

Proposition 6. (1) *Suppose $t \geq \lambda(H-L)$. Without BPD, each firm makes higher total profits when consumers face (ex ante) valuation uncertainty if $\lambda \geq \frac{1}{2}$ and makes higher total profits without such uncertainty if $\lambda < \frac{1}{2}$.* (2) *Suppose $0 \leq \lambda \leq 1-\sqrt{5}/5$ and $\lambda(1-\lambda)/(2-3\lambda) \leq t/(H-L) \leq (1-\lambda)(6-5\lambda)/2$. With BPD, each firm makes higher total profits when consumers face valuation uncertainty than without such uncertainty.* (3) *Suppose $t/(H-L) > 3(2-\lambda)/2$. With BPD, each firm makes the same profits whether or not consumers face valuation uncertainty.*

Proposition 6 sheds light on the role of consumers' (ex ante) valuation uncertainty in dynamic price competition. Without BPD, consumers' valuation uncertainty causes each firm's profits to increase when $\lambda \geq \frac{1}{2}$ and to decrease otherwise. With BPD, consumers' valuation uncertainty yields equal or higher firm profits.

With or without BPD, consumers' (ex ante) valuation uncertainty may increase the firms' profits through decreasing their demand elasticities. Here, we illustrate this by focusing on the scenario without BPD. When consumers observe their values of the products, they purchase their preferred products in each period and never switch brands. Each firm's per-period demand elasticity equals $1/(2t)$ (see the proof of Lemma TA5 in the online technical appendix). When consumers face valuation uncertainty, their period 2 choice depends on the realized value of the first purchase, and competition becomes truly dynamic. Each firm's period 2 and period 1 demand elasticities equal $|\partial D_0/\partial b_0| = (1-\lambda)/t$ and $|\partial\theta/\partial a_0| = 3(1-\lambda)/(2(1+2\lambda-2\lambda^2)t)$, respectively. It is easy to check that $(1-\lambda)/t \leq 1/(2t) \Leftrightarrow 3(1-\lambda)/(2(1+2\lambda-2\lambda^2)t) \leq 1/(2t) \Leftrightarrow \lambda \geq \frac{1}{2}$. When $\lambda \geq \frac{1}{2}$, consumers'

[8] When consumers in $[0,\theta]$ ($(\theta,1]$) purchase product 0 (1) in period 1, from the proof of Lemma TA1, the period 2 prices for switchers are $b_0^S = \frac{1}{3}[2(1-(2-\lambda)\theta)t/(1-\lambda)+t+\lambda(H-L)]$ (which decreases in θ) and $b_1^S = \frac{1}{3}[2(2-\lambda)\theta t/(1-\lambda)-t+\lambda(H-L)]$ (which increases in θ).

[9] For example, in case (2) of Proposition 2, each firm's period 2 demand elasticity satisfies (see the proof of Lemma TA2) $|\partial D_i^R/\partial b_i^R| = |\partial D_i^S/\partial b_i^S| = 1/(2t) < (1-\lambda)/t$ when $\lambda < \frac{1}{2}$, and its period 1 demand elasticity satisfies $|\partial\theta^D/\partial a_0| = 3/(8t) < 3(1-\lambda)/(2(1+2\lambda-2\lambda^2)t)$ when $\lambda < (3-\sqrt{3})/2 \approx 0.634$.

[10] We provide one illustrative example. Let $L(\lambda) \equiv \lambda[(1+2\lambda)\cdot\sqrt{1-\lambda}+2(1-\lambda)\sqrt{\lambda}]/(2(2-\lambda)\sqrt{\lambda}-(1+\lambda)\sqrt{1-\lambda})$, and let $R(\lambda) \equiv \lambda(2+\lambda)/(1+\lambda)$. When $H-L=1$, $t=1.043$, and $\lambda=0.65$, we have $L(\lambda)=1.04221$, $t/(H-L)=1.043$, and $R(\lambda)=1.04394$. The condition for case (3) is thus satisfied. We can easily verify that $\pi^D = 1.565596 > \pi^N = 1.31865$.

valuation uncertainty decreases the firms' demand elasticities and leads to higher prices, causing profits to rise. Otherwise, it intensifies price rivalry and lowers each firm's total profits.

5. Discussions and Conclusion

Our main model assumes that the low value (L) is sufficiently high so that the market is covered in both periods. We also examined two alternative settings where the market is not fully covered. First, consider the scenario where L is low so that the market is covered in period 1 but not in period 2. As expected, BPD has a market-expansion effect in that it increases market coverage and the firms' period 2 profits. Surprisingly, BPD decreases each firm's total profits. The intuition is that BPD allows each firm to better protect the period 2 margin from its own various customers who have realized a high value. This increases the value of the period 1 market share and hence intensifies the period 1 competition. The period 1 profit reduction turns out to dominate the period 2 profit gain, lowering each firm's total profits.

Second, consider the scenario where without BPD the firms act as local monopolies in each period and where with BPD the market is not covered in period 1 but the firms actively compete in period 2. In period 2, each firm charges the same price for the consumers who did not buy in period 1 and the rival's previous customers, as it can not tell them apart. We find that in period 2 each firm charges a lower price to its new buyers than to its repeat buyers. Here, BPD frequently increases each firm's total profits through expanding its period 2 market coverage.

As a robustness check, we have also investigated the scenario in which both long- and short-term contracts are deployed: in period 1, each firm sets a spot price and also offers a long-term contract to provide the good in both periods. In equilibrium, the consumers who most prefer each brand purchase long-term contracts, and the remaining ones pay spot prices. We find that the use of long-term contracts lowers the period 2 spot prices for both repeat customers and switchers, as the lock-in of its most captive customers enables each firm to price more aggressively. Consistent with Proposition 3, the firms reward repeat purchase when the high–low value difference is relatively high and reward switching otherwise.

We conclude by highlighting two distinguishing features of the experience good duopoly. First, when the probability of a high value is low and the high–low value difference is high, the firms reward repeat purchase. In this case, without price discrimination, more than half of the consumers would switch brands for a potentially higher product value, and with BPD, the firms counter such a tendency by rewarding repeat purchase. Otherwise, they reward switchers. Second, BPD always increases firm profits when they reward repeat buying. Remarkably, BPD may still increase firm profits when they engage in poaching. We thus reveal the counterintuitive insight that poaching need not imply intensified competition and lower firm profits. These features contrast with those of an inspection good duopoly (Villas-Boas 1999, Fudenberg and Tirole 2000), where BPD always leads to poaching and erodes firm profits. The driver behind this is consumers' valuation uncertainty and learning through the first purchase in an experience good market. With inspection goods, the first purchase reveals a consumer's relative product preference. That her only motive to switch is a lower price leads to poaching. With experience goods, the first purchase may not indicate a consumer's period 2 preference, as those realizing a low value may prefer to switch. The direction of BPD then depends on the strength of consumers' intrinsic tendency to switch.

Our model has its limitations. First, for tractability, we utilized a discrete value distribution. A direction for future work is to examine the case of a continuous value distribution. The same driver will persist: those realizing a value above the mean prefer repeat purchase, but the others may wish to switch. These two forces jointly determine the direction of BPD. In addition, efficiency is always achieved without customer recognition when the market is covered. BPD thus reduces social welfare. Second, for benchmarking, we have focused on consumer learning through the first purchase in a two-period setting. When consumers have a longer life span, however, the second purchase also serves a learning purpose to brand switchers. Therefore, future research may examine a setting where each consumer lives for three or more periods. Finally, our model has considered only dynamic price competition. One may also investigate the case where each firm can precommit to future prices at the beginning of the first period.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/mnsc.2014.2114.

Acknowledgments

The author thanks the department editor, an associate editor, and two anonymous reviewers for very helpful comments. Useful feedback was also received from the seminar participants at Renmin University of China and the attendants at the 2014 Five-School Marketing Conference (Cheung Kong Graduate School of Business (CKGSB), Fudan University, New York University, Peking University, and Tsinghua University). The author also thanks the China Business Research Institute at CKGSB for financial support. All errors are the author's.

Appendix

The appendix contains the proofs of Propositions 1, 4, 5, and 6. The proofs of Proposition 2 and Lemma TA5 are given in the online technical appendix.

Proof of Proposition 1. We first derive the period 2 price equilibrium. For any period 1 prices, if a consumer at x $(0 < x < 1)$ prefers to buy product i in period 1, then any consumer between x and product i also strictly prefers product i. Therefore, without loss of generality, suppose that in period 1 consumers in $[0, \theta]$ ($(\theta, 1]$) have purchased product 0 (1). In period 2, each firm i sets price b_i to maximize its current profits.

Let x_i denote the consumer who purchased product i previously, realized a low value, and is now indifferent to making a repeat purchase and switching to the other product. That $L - b_0 - tx_0 = \bar{v} - b_1 - t(1 - x_0)$ and $L - b_1 - t(1 - x_1) = \bar{v} - b_0 - tx_1$ leads to $x_0 = (b_1 - b_0 + t - \lambda(H - L))/(2t)$ and $x_1 = (b_1 - b_0 + t + \lambda(H - L))/(2t)$. When the consumers realizing a high value from their first purchase do not switch (we will verify that this holds in equilibrium), firm 0's and firm 1's period 2 demand functions are $D_0 = \lambda\theta + (1 - \lambda)x_0 + (1 - \lambda)\cdot(x_1 - \theta)$ and $D_1 = \lambda(1 - \theta) + (1 - \lambda)(1 - x_1) + (1 - \lambda)(\theta - x_0)$, respectively.

Firm i's period 2 profit function is $R_i = D_i b_i$. Since $d^2R_i/db_i^2 < 0$, from the first-order conditions (FOCs), we readily obtain the period 2 equilibrium,

$$b_0 = \frac{[2 - \lambda - (1 - 2\lambda)\theta]t}{3(1 - \lambda)} \quad \text{and} \quad b_1 = \frac{[1 + \lambda + (1 - 2\lambda)\theta]t}{3(1 - \lambda)},$$

and firm i's $(i = 0, 1)$ period 2 profits, $R_i = ((1 - \lambda)(b_i)^2)/t$.

To solve the period 1 game, we need to identify the boundary between the firms' period 1 turfs, θ, for given period 1 prices a_0 and a_1. Each consumer is forward looking and maximizes her total expected surplus over both periods. Consumer θ's total expected surplus conditional on buying product 0 in period 1 is $V_0(\theta) = (\bar{v} - a_0 - t\theta) + \lambda(H - b_0 - t\theta) + (1 - \lambda)[\bar{v} - b_1 - t(1 - \theta)]$. After buying product 0, with probability λ she will realize a high value (H) and make a repeat purchase. Otherwise, she will switch to product 1. Similarly, her total expected surplus conditional on buying product 1 in period 1 is $V_1(\theta) = [\bar{v} - a_1 - t(1 - \theta)] + \lambda[H - b_1 - t(1 - \theta)] + (1 - \lambda)[\bar{v} - b_0 - t\theta]$. Setting $V_0(\theta) = V_1(\theta)$ and substituting in b_0 and b_1 yield θ as a function of a_0 and a_1: $\theta = \frac{1}{2} - 3(1 - \lambda)(a_0 - a_1)/(2(1 + 2\lambda - 2\lambda^2)t)$.

In period 1, firms 1 and 2 simultaneously set prices a_0 and a_1 to maximize their respective total expected profits over both periods, anticipating the resulting period 1 consumer choice behavior (i.e., θ) and their period 2 profits, R_0 and R_1. Their period 1 objective functions are therefore $\pi_0 = \theta a_0 + ([2 - \lambda - (1 - 2\lambda)\theta]^2 t)/(9(1 - \lambda))$ and $\pi_1 = (1 - \theta)a_1 + ([1 + \lambda + (1 - 2\lambda)\theta]^2 t)/(9(1 - \lambda))$, respectively, where θ is as given above. Since $d^2\pi_i/da_i^2 = -3(1 - \lambda)[5 + 16\lambda(1 - \lambda)]/(6t[1 + 2\lambda(1 - \lambda)]^2) < 0$, the FOCs lead to a unique SPE, $a_0 = a_1 = a^N$ and $b_0 = b_1 = b^N$, where

$$a^N = \frac{2(1 + \lambda)t}{3} \quad \text{and} \quad b^N = \frac{t}{2(1 - \lambda)}.$$

It is easy to verify that $x_0 \geq 0 \Leftrightarrow x_1 \leq 1 \Leftrightarrow t \geq \lambda(H - L)$; that is, when $t \geq \lambda(H - L)$, only some consumers realizing a low value from the first purchase switch brands. When $t < \lambda(H - L)$, there is no pure-strategy price equilibrium.[11] Q.E.D.

Proof of Proposition 4. Without BPD, each firm makes total profits $\pi^N = (1 + \lambda)t/3 + t/(4(1 - \lambda))$ (from Proposition 1).

(1) In case (1) of Proposition 2, each firm makes total profits $\pi^D = (2 - \lambda^2)t/(3(1 - \lambda)) + \lambda(H - L)/3 + R^D$, where $R^D > 0$ (from the proof of Lemma TA1). We have $\pi^D > (2 - \lambda^2)t/(3(1 - \lambda)) = (1 + \lambda)t/3 + t/(3(1 - \lambda)) > (1 + \lambda)t/3 + t/(4(1 - \lambda)) = \pi^N$.

(2) In case (2) of Proposition 2, each firm makes total profits $\pi^D = 17t/18$ (from the proof of Lemma TA2). We can verify that $\pi^D > \pi^N \Leftrightarrow 12\lambda^2 - 34\lambda + 13 > 0 \Leftrightarrow 0 < \lambda < (17 - \sqrt{133})/12$. Q.E.D.

Proof of Proposition 5. Subsection 3.1 has shown that without BPD, the amount of switching is efficient. From Proposition 2, it is clear that BPD reduces social welfare by inducing too little (when the firms reward repeat purchase) or too much (when they engage in poaching) switching. The rest of the statement clearly holds. Q.E.D.

Proof of Proposition 6. (1) Under the condition of part (1), without BPD, there exists a unique symmetric equilibrium whether or not consumers face valuation uncertainty (from Proposition 1 and Lemma TA5). Each firm makes total profits $(1 + \lambda)t/3 + t/(4(1 - \lambda))$ when consumers face ex ante valuation uncertainty (from Proposition 1) and makes total profits t without such uncertainty (from Lemma TA5). It is easy to verify that $(1 + \lambda)t/3 + t/(4(1 - \lambda)) \geq t \Leftrightarrow (1 - 2\lambda)(5 - 2\lambda) \leq 0 \Leftrightarrow \lambda \geq \frac{1}{2}$.

(2) When $0 \leq \lambda \leq 1 - \sqrt{5}/5$ and $\lambda(1 - \lambda)/(2 - 3\lambda) \leq t/(H - L) \leq (1 - \lambda)(6 - 5\lambda)/2$, under BPD, there exists a unique symmetric SPE whether or not consumers face valuation uncertainty (from Proposition 2 and Lemma TA5). When consumers face valuation uncertainty, each firm makes total profits $\pi^D = (2 - \lambda^2)t/(3(1 - \lambda)) + \lambda(H - L)/3 + R^D$, where

$$R^D = \frac{1}{18(1 - \lambda)t}\{[2t - \lambda(1 - \lambda)(H - L)]^2 + [t + \lambda(1 - \lambda)(H - L)]^2\}$$
$$= \frac{1}{18(1 - \lambda)t}\{5t^2 - 2t\lambda(1 - \lambda)(H - L) + 2[\lambda(1 - \lambda)(H - L)]^2\}.$$

[11] When $t < \lambda(H - L)$, the only possible equilibrium involves all consumers realizing L switching brands and no consumer realizing H switching brands. Suppose there is a pure-strategy SPE where consumers in $[0, \theta]$ ($[\theta, 1]$) purchase product 0 (product 1) in period 1 and where firms 0 and 1 charge b_0 and b_1, respectively, in period 2. After realizing L with product 0, consumer 0 switches to product 1 iff $L - b_0 \leq \bar{v} - b_1 - t$. After realizing H with product 0, consumer θ will repeat buy product 0 iff $H - b_0 - t\theta \geq \bar{v} - b_1 - t(1 - \theta)$. These two inequalities jointly imply $-t(1 - 2\theta) - (1 - \lambda)(H - L) \leq b_1 - b_0 \leq \lambda(H - L) - t$. Similarly, after realizing L with product 1, consumer 1 switches to product 0 iff $L - b_1 \leq \bar{v} - b_0 - t$. After realizing H with product 1, consumer θ will repeat buy product 1 iff $H - b_1 - t(1 - \theta) \geq \bar{v} - b_0 - t\theta$. These two inequalities jointly imply $t(1 - 2\theta) - (1 - \lambda)(H - L) \leq b_0 - b_1 \leq \lambda(H - L) - t$. Therefore, if $b_0 \neq b_1$, the firm with a lower period 2 price benefits from slightly increasing its price. If $b_0 = b_1$, either firm benefits from slightly raising its price—a contradiction.

Without such uncertainty, each firm makes total profits $17t/18$ (from Lemma TA5). It is straightforward to verify that $(2-\lambda^2)t/(3(1-\lambda))+\lambda(H-L)/3+R^D > 17t/18 \Leftrightarrow -\lambda(17-6\lambda)t^2 < 2\lambda(1-\lambda)(H-L)[2t+\lambda(1-\lambda)(H-L)]$, where the latter inequality clearly holds because its left-hand side is negative and its right-hand side is positive.

(3) When $t/(H-L) > 3(2-\lambda)/2$, under BPD, there exists a unique SPE where each firm makes total profits of $17t/18$, whether or not consumers face valuation uncertainty (from Proposition 2 and Lemma TA5). Q.E.D.

References

Acquisti A, Varian H (2005) Conditioning prices on purchase history. *Marketing Sci.* 24(3):367–381.

Bergemann D, Valimaki J (2006) Dynamic pricing of new experience goods. *J. Political Econom.* 114(4):713–743.

Caminal R, Matutes C (1990) Endogenous switching costs in a duopoly model. *Internat. J. Indust. Organ.* 8(3):353–373.

Chen Y (1997) Paying customers to switch. *J. Econom. Management Strategy* 6(4):877–897.

Chen Y, Pearcy J (2010) Dynamic pricing: When to entice brand switching and when to reward consumer loyalty. *RAND J. Econom.* 41(4):674–685.

Fong YF, Liu Q (2011) Loyalty rewards facilitate tacit collusion. *J. Econom. Management Strategy* 20(3):739–775.

Fudenberg D, Tirole J (2000) Customer poaching and brand switching. *RAND J. Econom.* 31(4):634–657.

Jing B (2011) Pricing experience goods: The effects of customer recognition and price commitment. *J. Econom. Management Strategy* 20(2):451–473.

Kim B, Choi JP (2010) Strategic incentives to share customer information: Substitutes or complements? *J. Econom. Management Strategy* 19(2):403–433.

Kim BD, Shi M, Srinivasan K (2001) Reward programs and tacit collusion. *Marketing Sci.* 20(2):99–120.

Kim BD, Shi M, Srinivasan K (2004) Managing capacity through reward programs. *Management Sci.* 50(4):503–520.

Musalem A, Joshi YV (2009) How much should you invest in each customer relationship? A competitive strategic approach. *Marketing Sci.* 28(3):555–565.

Pancras J, Sudhir K (2007) Optimal marketing strategies for a customer data intermediary. *J. Marketing Res.* 44(4):560–578.

Pazgal A, Soberman D (2008) Behavior-based discrimination: Is it a winning play, and if so, when? *Marketing Sci.* 27(6):977–994.

Rossi P, McCulloch R, Allenby G (1996) The value of purchase history data in target marketing. *Marketing Sci.* 15(4):321–340.

Shaffer G, Zhang ZJ (2000) Pay to switch or pay to stay: Preference-based price discrimination in markets with switching costs. *J. Econom. Management Strategy* 9(3):397–424.

Shin J, Sudhir K (2010) A customer management dilemma: When is it profitable to reward one's own customers? *Marketing Sci.* 29(4):671–689.

Shin J, Sudhir K, Yoon D-H (2012) When to "fire" customers: Customer cost-based pricing. *Management Sci.* 58(5):932–947.

Singh S, Jain DC, Krishnan TV (2008) Customer loyalty programs: Are they profitable? *Management Sci.* 54(6):1205–1211.

Syam N, Hess J (2006) Acquisition versus retention: Competitive customer relationship management. Working paper, University of Houston, Houston.

Taylor CR (2003) Supplier surfing: Competition and consumer behavior in subscription markets. *RAND J. Econom.* 34(2):223–246.

Taylor CR (2004) Consumer privacy and the market for customer information. *RAND J. Econom.* 35(4):631–650.

Villas-Boas JM (1999) Dynamic competition with customer recognition. *RAND J. Econom.* 30(4):604–631.

Villas-Boas JM (2004a) Consumer learning, brand loyalty, and competition. *Marketing Sci.* 23(1):134–145.

Villas-Boas JM (2004b) Price cycles in markets with customer recognition. *RAND J. Econom.* 35(3):486–501.

Villas-Boas JM (2006) Dynamic competition with experience goods. *J. Econom. Management Strategy* 15(1):37–66.

Zhang J (2011) The perils of behavior-based personalization. *Marketing Sci.* 30(1):170–186.