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Experimenting with purchase history based price discrimination

Zuzana Brokesova [a,*], Cary Deck [b,c], Jana Peliova [a]

[a] Faculty of National Economy, University of Economics in Bratislava, Dolnozemska cesta 1, 852 35 Bratislava, Slovak Republic
[b] Sam M. Walton College of Business, University of Arkansas, Fayetteville, AR 72701, United States
[c] Economic Science Institute, Chapman University, One University Drive, Orange, CA 92866, United States

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ABSTRACT

Many purchases of differentiated goods are repeated, giving sellers the opportunity to engage in price discrimination based upon the shopper's previous behavior by either offering loyalty discounts to repeat buyers or introductory rates to new customers. Recent theoretical work suggests that loyalty discounts can be profitable to sellers when customer preferences are not stationary and sellers can pre-commit to prices for repeat buyers, but otherwise returning customers can be expected to pay the same or more than new buyers. This paper reports behavior in controlled laboratory experiments designed to empirically test the impact of these factors on pricing strategies. The results generally support the comparative static predictions of the theoretical model. When customer preferences are fixed over time, sellers attempt to lure customers from their rival. Price pre-commitment for repeat shoppers when buyer preferences vary over time resulted in modest loyalty pricing, but the discounts are not as prevalent as predicted as sellers rarely price below cost. Behaviorally, price pre-commitment to loyal customers is found to reduce prices overall.

1. Introduction

Sellers have long engaged in various forms of price discrimination (see Stole, 2007; Varian, 1989). Recent technological advances give sellers even more information about their customers including the ability to track people across shopping episodes. This enables sellers, both online and in bricks and mortar stores, to identify which customers are making a repeat visit and which are new. With such information sellers can either attempt to reward loyalty by offering lower prices to their own returning customers or poach from rivals by offering lower prices to rivals' customers.[1] Indeed, both practices are now commonly observed. Many airlines and retailers offer perks to loyal customers, while credit cards and insurance companies commonly advertise low introductory rates to new customers. In each of these cases sellers are basing prices on the shopper's previous behavior.

Caillaud and De Nijs (2011, p. 1) define the practice of "*offering different prices to different customers according to their past purchase history*" as *behavior based pricing*. This practice, which does not fit any of the traditional categories of price discrimination, has also been referred to as customer relationship management based pricing (Shih and Sudhir, 2007), pricing with customer recognition (Esteves, 2010a, 2010b; Fudenberg and Tirole, 2000; Villas-Boas, 1999; Villas-Boas, 2004) or one-to-one pricing (Rossi et al., 1996; Shaffer and Zhang, 1997). Given the popularity of both practices, there have been several recent theoretical papers that attempted to understand the market conditions that determine when loyalty rewards are optimal and when poaching is optimal (e.g. Caminal and Clarici, 2007; Caminal and Matutes, 1990; Chen, 1997; Chen and Pearcy, 2010; Fudenberg and Tirole, 2000; Pazgal and Soberman, 2008; Shin and Sudhir, 2007, 2010; Villas-Boas, 1999).[2]

While the optimality of poaching or loyalty discounts depends on the assumptions of the specific model, generally poaching is found to be optimal. The general reasoning is that initial purchases help sellers to identify the customers who value their product most and thus can be exploited later; that is the first period which is used to segment the market. For example, Fudenberg and Tirole (2000) use a simple two

* Corresponding author. Tel.: +421 2 672 91 562.
E-mail addresses: zuzana.brokesova@euba.sk (Z. Brokesova), cdeck@walton.uark.edu (C. Deck), jana.peliova@euba.sk (J. Peliova).

[1] Fudenberg and Tirole (2000, pp. 634) explain poaching as an effort by a "*firm to "poach" the current customers of their competitors by offering them special discounts or other inducements to switch.*"

[2] Based on the empirical analysis of Swedish newspaper subscriptions, Asplund et al. (2008) report that in competitive markets, the use of discounts to poach is inversely related to the seller's market share. There has also been work in monopoly settings considering pricing to new and repeat customers (e.g. Acquisti and Varian, 2005; Bikhchandani and McCardle, 2012; Villas-Boas, 2004).

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firm, two period Hotelling model, where there is a continuum of relative brand preferences by customers. When customers' preferences do not change over time, the second period is essentially competition over two distinct markets; one for customers who prefer the seller and one for customers who prefer the rival ceteris paribus. The seller can charge a high price to shoppers who prefer it, but to capture the rival's customers, the seller must offer a low poaching price. However, Caminal and Matutes (1990) find that under the conditions of independent customer preferences and price pre-commitment for loyal customers, it can be more profitable for sellers to reward their own high-valued customers.[3] Similar results are obtained by Shin and Sudhir (2007, 2010), who studied a market with high and low volume customers.

In a recent paper, Chen and Pearcy (2010) develop a model that captures several key pieces of the behavior based pricing problem. They also consider a basic two period duopoly Hotelling model and show that the optimality of rewarding loyalty versus poaching depends on 1) the ability to pre-commit to future prices for repeat customers and 2) the degree to which buyer preferences vary between periods. In particular, Chen and Pearcy (2010) show that regardless of the ability to pre-commit to future prices, a lack of heterogeneity across time should lead to poaching. However, when there is heterogeneity in preferences over time and sellers can guarantee a future price to repeat buyers then loyalty is rewarded. The logic is that the low future price induces people to visit the seller initially and attract back those who may ultimately find themselves preferring the competitor in the future without having to offer low prices to those who do not visit initially but change to preferring that seller in the future. If there is sufficient heterogeneity and an inability to commit to future prices then the market essentially becomes a repeated single period Hotelling game as in Fudenberg and Tirole (2000).

While sellers routinely have to make the decision to poach or offer loyalty discounts, it can be difficult to study such markets empirically because customer preferences and "distance costs" are inherently unobservable. Therefore, we turn to controlled laboratory experiments to explore how the factors identified by Caminal and Matutes (1990), Chen and Pearcy (2010), and Fudenberg and Tirole (2000) among others impact behavior based pricing. Our paper reports the results of a set of market experiments, which vary the degree of heterogeneity in shopper's preferences between periods and the ability of sellers to pre-commit to prices for loyal customers. Of course, naturally occurring markets have a myriad of other complicating factors such as more than two sellers being in operation, buyers making decisions over more than two periods, and people entering and exiting the market asynchronously. The goal in developing a theoretical model or an experiment is to focus on the interplay of the key elements. Thus, controlled laboratory experiments are an ideal tool for cleanly examining seller reactions to factors the model has identified as strategically important.

Despite the recent theoretical work on behavior based pricing, the only related laboratory experiments of which we are aware are by Mahmood (in press) and Mahmood and Vulkan (2012), both of which are in the vein of Shin and Sudhir (2010) and in settings where loyalty discounts are not expected. Mahmood (in press) considers a discrete market with high and low volume customers and allows for probabilistic preference mobility.[4] Behaviorally, Mahmood (in press) does not observe loyalty discounts in any treatment and does observe poaching with customer recognition as anticipated. Mahmood and Vulkan (2012) conduct an experiment with professionals from a variety of industries. These experiments also involved high and low volume customers, various market structures (two firms on a Hotelling line or four firms on a Salop circle) and the ability to price discriminate based on type of customer. Their results suggest that greater competition reduces the magnitude of poaching and can encourage loyalty discounts. The main difference between our approach and these previous studies is our focus on price pre-commitment.[5]

The remainder of the paper is organized as follows. The next section lays out the theoretical framework for the markets examined in the laboratory. The experimental design and the experimental results are then presented in separate sections. A final section offers concluding remarks.

2. Market structure

Our market structure follows that of Chen and Pearcy (2010). There are two firms $f \in [A, B]$ selling differentiated products a la a linear Hotelling model. For simplicity, we use the notation $-f$ to denote f's rival. Firms sell their products in two periods, $n = 1, 2$. Customers demand one unit in the first period and one unit in the second period. Each period, customers are distributed uniformly over an interval of length $\bar{\theta}$. Firm A is located at 0 while Firm B is located at $\bar{\theta}$. In period n, a customer located at $\hat{\theta}$ receives a utility of $v - p_A - \hat{\theta}$ for purchasing from A at price p_A and receives a utility of $v - p_B - (\bar{\theta} - \hat{\theta})$ from buying from B at price p_B. v is assumed to be sufficiently high that all buyers will purchase a unit in both periods. Total consumer costs in period n are denoted by C_n and include the price paid to a seller plus travel costs. In period 2, Firm f can identify customers who visited Firm f in period 1. Therefore, each firm sets three prices: P_1^f is Firm f's price in period 1, $\tilde{P}_2^f$ is Firm f's price in period 2 for repeat (loyal) customers, and P_2^f is Firm f's price in period 2 for new customers. Sellers incur a constant marginal cost, c, for each unit sold. Firm profit denotes as π_n^f, where n represents a period and f a firm.

With this basic framework, we consider the implications of two factors. The first is the relationship between buyer preferences in period 1 and period 2. Although Chen and Pearcy (2010) allow for a continuum of relationships, we focus on the two extreme cases: buyer preferences are independently determined each period and buyer preferences are fixed over time.[6] The second is the timing of when $\tilde{P}_2^f$ is set: before or after buyers make their period 1 decisions. That is, whether or not sellers pre-commit to loyalty prices. Other prices are always set at the start of the period for which the price is in effect. The combinations of the two factors yield four distinct cases. A firm is said to poach if $\tilde{P}_2^f > P_2^f$ and offer a loyalty discount if the inequality is reversed. Given the sequential nature of the market, the appropriate solution concept is that of subgame perfection. While Chen and Pearcy (2010) characterize the equilibrium, for our purposes it is also critical to identify the best response functions for both sellers in period 2 and buyers in period 1 in case observed first period seller behavior is off the equilibrium path. Buyers in period 2 will simply choose to purchase from the seller offering the lower total cost at that point.

Case 1. Independent preferences and no price pre-commitment

In this case, buyers are randomly relocated after the first period. Therefore, in period 2 the sellers are essentially competing on two independent Hotelling lines of length $\bar{\theta}$. The line for people who purchased from A in period 1 accounts for a fraction $\frac{\theta^*}{\bar{\theta}}$ of the total market and the

[3] See also von Weizsäcker (1984) who did pioneering work on consumer preference instability over time.

[4] In Mahmood (in press), mobility in buyer preferences is implemented as a 50% chance that a buyer's location will change between the two discrete possibilities.

[5] There are several other important design differences that may have an impact on pricing. One is the way how the mobility of preferences is implemented in the two mentioned studies. In Mahmood's work, each person's preference changes with a 50% chance whereas in ours each buyer receives a new preference location with certainty. Another difference is that Mahmood has only a small number of human buyers at specified locations so that demand is discrete whereas our study has a continuous demand with automated buyers meaning the effect of small changes in prices has more predictable effects on profits in our experiment.

[6] Chen and Pearcy (2010) model the preference relationship between periods using a copula function with a continuous parameter α. Our cases correspond to theirs for $\alpha = 0$ and $\alpha = 1$.