International Journal of Industrial Organization 32 (2014) 46–56

Contents lists available at ScienceDirect

International Journal of Industrial Organization

journal homepage: www.elsevier.com/locate/ijio

Elasticity of demand and behaviour-based price discrimination ☆

Rosa-Branca Esteves [a,*], Carlo Reggiani [b]

[a] Universidade do Minho and NIPE, Braga, Portugal
[b] School of Social Sciences — Economics, University of Manchester, United Kingdom

ARTICLE INFO

Article history:
Received 2 April 2013
Received in revised form 22 October 2013
Accepted 29 October 2013
Available online 7 November 2013

JEL classification:
D43
L13

Keywords:
Price discrimination based on purchase history
Elasticity of demand
Welfare

ABSTRACT

Behaviour-based price discrimination (BBPD) is typically analysed in a framework characterised by perfectly inelastic demand. This paper provides a first assessment of the role of demand elasticity on the profit, consumer and welfare effects of BBPD. We show that the demand expansion effect, that is obviously overlooked by the standard framework with unit demand, plays a relevant role. In comparison to uniform pricing, we show that firms are worse off under BBPD, however, as demand elasticity increases the negative impact of BBPD on profits gets smaller. Despite a possible slight increase in the average prices charged over the two periods in comparison to uniform pricing, we show that BBPD boosts consumer surplus and that this benefit is independent of elasticity. In contrast to the welfare results derived under the unit demand assumption, where BBPD is always bad for welfare, the paper shows that BBPD can be welfare enhancing if demand elasticity is sufficiently high.

1. Introduction

The increasing diffusion of the internet as a marketplace and the unprecedented capability of firms to gather and store information on the past shopping behaviour of consumers are enhancing their ability to make use of this information and price differently their own previous customers with respect to the rivals' consumers. This form of price discrimination, termed behaviour-based price discrimination (BBPD) or price discrimination by purchase history or dynamic pricing, is now widely observed in many markets. Examples of firms that adopt BBPD include supermarkets, web retailers, telecom companies, banks, restaurants and many others.

As this business practice is becoming increasingly prevalent, a good economic understanding of its profit, consumer surplus and welfare implications needs to be founded on a good understanding of the market in which it is implemented. Although this type of price discrimination has recently received much attention in economics,[1] the literature has hitherto focused on the assumption that consumers have perfectly inelastic (or unit) demand. Because price discrimination has no role to increase aggregate output, one must be careful when interpreting the welfare results obtained in these models (Stole, 2007).

In real markets, however, the consumers' decision does not only involve choosing a firm but also the amount of good(s) purchased. Therefore, an important issue remains to be explored. What happens if the restrictive assumption of unit demand is relaxed? What are the welfare implications of price discrimination when aggregate output can vary with prices?

The main contribution of this paper is to offer a first assessment of the profit and welfare effects of BBPD when firms face a demand that can vary with the price level. With this goal in mind, we relax the perfectly inelastic demand assumption, in a BBPD model where purchase history discloses information about consumers' exogenous preferences for brands. Based on the CES (constant elasticity of substitution) representative consumer model we allow demand elasticity to vary between zero and unity, i.e., $\varepsilon \in [0,1)$. Our basic model follows the brand preference approach proposed in Fudenberg and Tirole (2000) by considering a two-period model with two horizontally differentiated firms competing for consumers with stable exogenous preferences across periods. These preferences are specified in the Hotelling-style linear market of unit length with firms positioned at the endpoints. Firms cannot commit to future prices. As firms have no information about consumers' brand preferences in period 1, they quote a uniform price. In period 2, firms use the consumers' first period purchase history to draw inferences about consumers' preferences and price accordingly. Unlike their assumption of perfectly inelastic demand, we maintain that consumers' demand can respond to price changes.

☆ We are grateful to the Editor, Yongmin Chen, and to two anonymous referees for their thorough and thoughtful reports. Thanks for comments are also due to Yiqian Gu. This work is funded by FEDER funds through the Operational Program for Competitiveness Factors – COMPETE and National Funds through FCT – Foundation for Science and Technology within the project PTDC/EGE-ECO/108784/2008. Financial support from the DERS Super Pump Priming, University of York is also gratefully acknowledged. The usual disclaimer applies.

* Corresponding author at: Universidade do Minho, Braga, Portugal.
E-mail addresses: rbranca@eeg.uminho.pt (R.-B. Esteves), carlo.reggiani@manchester.ac.uk (C. Reggiani).

[1] Chen (2005), Fudenberg and Villas-Boas (2007) and Esteves (2009) present comprehensive literature surveys on BBPD.

0167-7187/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.ijindorg.2013.10.010

The assumption that firms are competing in a unit demand framework *à la Hotelling* is widely adopted by the literature on BBPD, implying that the role of demand elasticity on the effects of competitive BBPD has been mostly overlooked. The assumption may be justified by the challenge posed by introducing demand elasticity in a Hotelling framework. Nero (1999) and Rath and Zhao (2001) seem to be the first to tackle the issue. They use quadratic utility preferences to show that a Hotelling game with not perfectly inelastic demand has a unique price-location equilibrium. Both papers emphasize the role of the transport cost to reservation price ratio as a determinant of the optimal location of firms. Anderson and De Palma (2000) introduce the CES representative consumer model in a spatial framework to analyse issues related to localised and global competition. In so doing they allow the elasticity of demand to vary between zero and unity. Gu and Wenzel (2009, 2011) use the same system of preferences to address the optimality of firms' entry in a spatial model.

In this paper we also adopt the CES formulation to introduce the elasticity of demand in the analysis of competitive BBPD. This approach has the advantage of tractability which allows us to provide a closed form solution to a two periods BBPD model.

The economics literature on price discrimination based on purchase history has followed two main approaches. In the switching costs approach, consumers initially view the two firms as perfect substitutes; but in the second period they face a switching cost if they change supplier. In this setting, purchase history discloses information about exogenous switching costs (e.g. Chen, 1997; Taylor, 2003). In the brand preferences approach (e.g. Fudenberg and Tirole, 2000; Villas-Boas, 1999), purchase history discloses information about a consumer's exogenous brand preference for a firm. Although the framework of competition differs in the two approaches their predictions have some common features. First, when price discrimination is permitted, firms offer better deals to the competitor's consumers than to its previous customers. Second, because both firms have symmetric information for price discrimination purposes and the market exhibits best-response asymmetry,[2] industry profits fall with price discrimination (e.g., Chen, 1997; Esteves, 2010; Fudenberg and Tirole, 2000; Gehrig et al., 2011, 2012; Taylor, 2003; Villas-Boas, 1999).[3] Third, when consumers have perfectly inelastic demand, there is no welfare benefit when prices fall due to discrimination. The exclusive effect of BBPD is to give rise to a deadweight loss to society due to the mismatch of preferences caused by excessive switching (Chen, 1997; Fudenberg and Tirole, 2000; Gehrig et al., 2011, 2012). Nonetheless, important differences arise in both approaches when taking into account the effects of poaching on initial prices. While in the brand preferences' approach when BBPD is permitted initial prices are high and then decrease, in the switching costs approach the reverse happens.

Some authors have recently explored new avenues in the literature on BBPD. Chen and Pearcy (2010), for instance, look at BBPD under the assumption of correlated preferences across time. They show that if there is sufficiently strong dependence between preferences, BBPD reduces industry profits and increases consumer surplus. In contrast, under weak dependence they show that BBPD increases industry profits and reduces consumer surplus.[4]

This paper enriches the literature on BBPD following the avenue of relaxing the assumption of perfectly inelastic demand. As said, following the brand preference approach proposed in Fudenberg and Tirole (2000), the main goal is to investigate whether the results derived with perfectly inelastic demand hold or are rather contradicted when demand elasticity is allowed to vary between zero (perfectly inelastic) and unity. We show that the model yields the same results as in Fudenberg and Tirole when demand elasticity is low. New results are nonetheless obtained when demand elasticity is sufficiently high. When demand is perfectly inelastic BBPD reduces average prices in comparison to uniform pricing. The paper shows that this result holds for low levels of the elasticity. In contrast, the average price with BBPD can be above its non discrimination counterpart when the elasticity of demand is sufficiently high. Additionally, when demand elasticity is high both loyal and poached consumers can face a higher present value of total payment for the two periods of consumption. This reverses the results obtained under perfectly inelastic demand.

This paper highlights that a complete picture of the welfare effects of price discrimination based on purchase history should be drawn under the assumption that consumers' demand do respond to price changes. Although average prices can increase with BBPD (for high ε) in comparison to uniform pricing, we show that, in aggregate, BBPD always increases overall consumption. The model confirms that regardless of the elasticity of demand, BBPD by competing firms often intensifies competition and benefits consumers. The CES formulation implies that the benefit of BBPD on consumer surplus does not depend on the elasticity of demand.

Our results confirm that BBPD reduces overall social surplus in the special case of $\varepsilon = 0$ and when demand elasticity is low enough ($0 < \varepsilon < 0.5$). In contrast, if the elasticity of demand is high enough, the welfare result derived in models with unit demand no longer applies. Specifically, when $0.5 < \varepsilon < 1$, *price discrimination can actually boost overall welfare* in comparison to uniform pricing. The inefficiency created by sub-optimal consumption is more than compensated by the increase in the overall quantity consumed. Additionally, we show that if consumers are myopic, which tends to be the case in many markets, the positive impact of BBPD on overall welfare is expected to be positive for a wider range of the elasticity of demand ($0.125 < \varepsilon < 1$).

The rest of the paper is structured as follows. Section 2 introduces the model. Section 3 sets the benchmark case with no discrimination. Section 4 solves the model when firms practice BBPD. Section 5 discusses the effects of BBPD on prices, quantities and profits and Section 5 provides the welfare analysis. Section 7 concludes.

2. The model

Two firms, *A* and *B*, produce at zero marginal cost[5] a nondurable good and compete over two periods, 1 and 2. On the demand side, there is a large number of consumers whose mass is normalised to one. In each period a consumer can either decide to buy the good from firm *A* or from firm *B*, but not from both. We assume that the two firms are located at the extremes of a unit interval [0,1], and consumers are uniformly distributed along this interval. A consumer located at $x \in [0,1]$ is at a distance $d_A(x) = x$ from firm *A* and at distance $d_B(x) = 1-x$ from firm *B* and *t* is the unit transport cost. Transport cost is linear in distance and does not depend on the quantity purchased. Note that the location of a consumer *x* represents his relative preference for firm *B* over *A* while $t > 0$ measures how much a consumer dislikes buying a less preferred brand. A consumer's brand preference *x* remains fixed for both periods. In contrast to Fudenberg and Tirole (2000) consumers are not restricted to buy a single unit of the differentiated good. Thus, the amount bought depends on the price charged. Following Anderson and de Palma (2000) and Gu and Wenzel (2009, 2011) the (indirect) utility for a consumer located at *x* conditional on buying from firm *i*, $i = A,B$ is:

$$V_i = Y + v(p_i) - td_i(x).$$

[2] In the terminology of Corts (1998) there is best response asymmetry when each firm's strong market is the rival's weak market.

[3] On the Pros and Cons of Price Discrimination, Chen (2005) argues also that firms tend to be worse off being able to recognise consumers and price discriminate. Targeted pricing is also bad for profits in Shaffer and Zhang (1995) and Bester and Petrakis (1996).

[4] Esteves (2013) extends the literature on BBPD allowing firms to employ retention strategies to avoid losing part of the old customers willing to switch. Esteves and Vasconcelos (2013) look at mergers when BBPD is permitted.

[5] The assumption of zero marginal costs can be relaxed without altering the basic nature of the results derived throughout the model.