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Selling customer information to competing firms

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HIGHLIGHTS

- A big data broker holds precise information about customer preferences and can sell this data to competing differentiated firms.
- The first-best allocation is achieved when data are sold non exclusively, but this never arises in equilibrium.
- The data broker instead sells the data set exclusively to only one firm. This leads to inefficient allocations.

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ABSTRACT

We consider a data broker that holds precise information about customer preferences. The data broker can sell this data set either exclusively to one of two differentiated competing firms, or to both of them. If a downstream firm obtains the data set, it can practice personalized pricing, else it has to offer a uniform price to customers. The first-best allocation can be achieved when data are sold non exclusively, but this never arises in equilibrium. The data broker instead sells the data set exclusively either to the high quality firm or to the low quality firm rival, according to their quality-adjusted cost differential. This leads to inefficient allocations.

1. Introduction

Recent developments in digital markets have led to the emergence of firms that achieve large turnovers based on business models which involve the collection of personal data. The Google search engine and the Facebook social network are the most known examples. Data are also said to facilitate personalized pricing. Indeed, by using data about their clients, a company receives better information about their purchasing habits and is able to assess their willingness to pay for a given good or service. Provided that it has market power, the company that holds customer data would be able to set different prices for the different customer groups it has identified thanks to the data collected.

An extensive literature in economics has analyzed the impact of price discrimination in competitive settings (see, e.g., Thisse and Vives, 1988; Liu and Serfes, 2009; Chen and Zhang, 2011; Shy and Stenbacka, forthcoming). Personal information about consumers can intensify competition among retailers since they compete market-by-market instead of at higher levels of aggregation. In related works, studies on behavior-based price discrimination consider the case where past behavior about customers is used to make targeted offers in future periods (see, e.g., Fudenberg and Tirole, 2000; Fudenberg and Villas-Boas, 2012). The literature has mostly tackled cases where detailed customer information is either available or not available symmetrically among competing firms (see Taylor and Wagman, 2014 for a survey).

In this paper we take a different point of departure, assuming that the ability of retail firms to directly collect and process customer information is limited. Instead, they have to make recourse to the information collected by an intermediary, a data broker, that then sells it to the downstream firms. Indeed, recent

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years have seen a surge in the emergence of data intermediaries, such as Acxiom or Teradata, which collect and analyze data for third parties. Some data brokers have entered into partnerships with Facebook or Google, in order to help them improve the targeting of their advertising offers.

This brings the question of the extent to which a data broker that has collected a unique data set will want to sell the data set to all competing downstream firms, or exclusively to some of them. In the former case, the fee is earned more than once, but in the second case it is likely that the data set is more valuable to the firm that gets it. This idea is studied by Montes et al. (2016) who, among other things, show an exclusivity result under various settings. While they model retail competition in a Hotelling fashion, the purpose of this paper is to see if the exclusivity result holds also with another workhorse in Industrial Organization, vertical product differentiation. This model has the added advantage, in case exclusivity is offered, to identify precisely which firm should be granted it: either the low-quality firm or the high-quality firm.

In order to solve the model, we must consider asymmetric cases where one retail firm does not have information (and thus offers uniform prices) while the rival firm can target individual customers by practicing first-degree price discrimination. These asymmetric analyses are instrumental to derive all possible payoffs and determine the fee that competing firms would be willing to pay when the data set is put on offer. To the best of our knowledge, this interim analysis of mixed pricing between informed and uniformed vertically-differentiated firms is also new in the literature.

2. The model

There are three types of agents: consumers, two competing retailers supplying goods of different quality, and a data broker that holds information about consumer preferences.

We describe consumer preferences first. Consumers buy one unit of a product at most, and their preferences follow a standard model of vertical product differentiation. A type θ buying a product of quality q_i at a price p_i enjoys a net utility of $U(q_i, p_i; \theta) = \theta q_i - p_i$, where θ is uniformly distributed between $\underline{\theta}$ and $\bar{\theta}$ with unit density.

Two differentiated retailers, denoted as $i = L, H$, compete in the downstream market, with $q_L < q_H$. The firms also have different marginal costs of production, with $c_L < c_H$. It will be useful at times to use the notation $q_H - q_L = \Delta_q$ and $c_H - c_L = \Delta_c$.

In order to focus on a more interesting welfare analysis, we posit that

$$\underline{\theta} \leq \theta^W \equiv \frac{\Delta_c}{\Delta_q} \leq \bar{\theta}. \tag{1}$$

This assumption on the quality-adjusted cost differential implies that it is efficient to serve the top end of the market ($\theta^W \leq \theta \leq \bar{\theta}$) with the high-quality product and the bottom end of the market ($\underline{\theta} \leq \theta < \theta^W$) with the low-quality product.

Finally, the data broker holds a data set with precise information about consumers. If a downstream firm is given the data set, then it knows the precise type of each customer in the data set and can practice first-degree price discrimination. Else it just knows the distribution of types, and can offer a uniform price.

The game proceeds in sequential stages. First the data broker allocates the data to one or both downstream firms (more on this in Section 3). Then retail firms, given the data in their possession, compete for consumers in the final market: firms set basic prices if they do not have information; otherwise, in a subsequent stage, they offer a tailored price. This sequence has relevance in the asymmetric case and is further discussed below. Finally, consumers buy the product and consume it. We look for the subgame perfect Nash equilibrium of this game.

2.1. No firm has information

Imagine no retailer has precise customer information. Then competition is in uniform prices. This is standard, with the exception that we consider firms with different marginal costs, whereas the canonical model involves firms with identical costs, often normalized to zero (Tirole, 1988). Following standard procedures, the indifferent consumer is defined as

$$\theta^* q_H - p_H = \theta^* q_L - p_L \Longrightarrow \theta^* = \frac{p_H - p_L}{q_H - q_L}.$$

Firms' profits are $\pi_L = \left(\theta^* - \underline{\theta}\right)(p_L - c_L)$ and $\pi_H = \left(\bar{\theta} - \theta^*\right)(p_H - c_H)$. Taking the first-order conditions, the equilibrium in prices is given by

$$p_H = c_H + \frac{1}{3}\left(\Delta_q(2\bar{\theta} - \underline{\theta}) - \Delta_c\right),$$

$$p_L = c_L + \frac{1}{3}\left(\Delta_q(\bar{\theta} - 2\underline{\theta}) + \Delta_c\right).$$

The indifferent consumer then simplifies to

$$\theta^* = \frac{\bar{\theta} + \underline{\theta}}{3} + \frac{\Delta_c}{3\Delta_q}. \tag{2}$$

It is straightforward to confirm that (1) guarantees that there is an interior solution with $\underline{\theta} \leq \theta^* \leq \bar{\theta}$.

Finally, we report the expressions for the profits

$$\pi_H^{N,N} = \frac{\left(\Delta_q(2\bar{\theta} - \underline{\theta}) - \Delta_c\right)^2}{9\Delta_q}, \qquad \pi_L^{N,N} = \frac{\left(\Delta_q(\bar{\theta} - 2\underline{\theta}) + \Delta_c\right)^2}{9\Delta_q},$$

where the superscripts (N, N) refer to the case where no firm has information.

Consumer surplus is equal to

$$\begin{aligned} CS_H &= \int_{\theta^*}^{\bar{\theta}} (\theta q_H - p_H) d\theta \\ &= \left(\frac{\Delta_q(2\bar{\theta} - \underline{\theta}) - \Delta_c}{18\Delta_q}\right) \\ &\quad \times \left(\left(3\underline{\theta} + \frac{\Delta_c}{\Delta_q}\right) q_H + 2((2\bar{\theta} - \underline{\theta}) q_L - 2c_H - c_L)\right), \\ CS_L &= \int_{\underline{\theta}}^{\theta^*} (\theta q_L - p_L) d\theta \\ &= \left(\frac{\Delta_q(\bar{\theta} - 2\underline{\theta}) + \Delta_c}{18\Delta_q}\right) \\ &\quad \times \left(\left(3\bar{\theta} + \frac{\Delta_c}{\Delta_q}\right) q_L - 2((\bar{\theta} - 2\underline{\theta}) q_H + 2c_L + c_H)\right). \end{aligned}$$

It follows that total surplus is given by

$$\begin{aligned} CS &= \frac{q_L(\bar{\theta}^2 - \underline{\theta}^2)}{2} - c_L(\bar{\theta} - \underline{\theta}) \\ &\quad + \frac{1}{18}\left(\frac{\Delta_c^2}{\Delta_q} - \Delta_c(10\bar{\theta} - 8\underline{\theta}) - \Delta_q(2\bar{\theta}^2 - 14\bar{\theta}\underline{\theta} + 11\underline{\theta}^2)\right). \end{aligned}$$

2.2. Both firms have information

In this scenario firms are able to compete for every consumer on an individual basis, making targeted offers $p_H(\theta)$ and $p_L(\theta)$ to type θ. We concentrate on equilibria where firms cannot make offers below their costs. Then each firm serves consumers efficiently, that is, firm L serves types $\underline{\theta} \leq \theta < \theta^W$ offering a price that just matches the best offer that firm H can make ($p_H(\theta) = c_H$), hence

$$p_L(\theta) = c_H - \theta\Delta_q.$$