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Behavior-Based Price Discrimination with Strategic Customer Targeting*

Antoine Dubus[†]

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Abstract

We analyze the impact of strategic consumer targeting on market competition in a two-period framework of behavior-based price discrimination. Strategic firms price-discriminate high-valuation customers and charge a homogeneous price to low-valuation customers, even when they have information on them.

Strategic targeting questions the main results of the literature: firms do not compete for customer information acquisition and there is no consumer poaching. However, compared with information acquired from a third-party, strategic targeting using first-party data increases competition. As firms are developing sophisticated strategies based on first-party data, we argue that competition authorities should reconsider the benefits of targeting for consumers.

Keywords: Behavior-based price discrimination; Strategic Targeting; Competition.

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1 Introduction

In the past decades, companies have increasingly adopted the services of third-party data brokers and marketing companies such as Equifax or Nielsen, specialized in consumer data collection and analytics for marketing campaigns. For instance, in 1979 Nielsen has launched its Scantrack service providing retailers with business analytics on consumer demands. The quality of these personalization services has increased rapidly with the rise of digital technologies, and Nielsen became dominant in the marketing information industry by the mid-nineties.¹

An essential factor for this success is that data brokers such as Nielsen benefit from important economies of scale, and they have developed sophisticated targeting strategies that allow firms to increase their profits using fine-grained information on consumer demand (Varian, 2018; Bounie et al., 2021). With the quality of their information and their business analytics, data brokers have managed to secure a position of information gatekeeper.

This situation has recently started to change with the rising concerns of competition authorities on the impacts of third-party data brokers on competition in product markets. In particular, the Finnish competition authority found that Nielsen’s Scantrack service led food retailers in Finland to soften competition and increase prices (Koski, 2018), leading major food retailers to terminate their agreements with Nielsen.

Moreover, with the advance of information technology, companies are increasingly developing their own sophisticated marketing strategies based on the large amounts of first-party data that they collect on their customers (DalleMule and Davenport, 2017). After terminating their agreements with Nielsen, companies such as Kesko, a major food retailer in Finland, have developed their own data analytics and personalization services based on customer data.²

Overall, firms have now their data-management functions and chief data officers, and they are increasingly using practices of behavior-based price discrimination (BBPD) to personalize offers and prices to their past customers. Practices

¹ACNielsen Corporation History, Funding Universe, last accessed October 12 2021.

²Kesko Annual Report 2015, last accessed October 12, 2021.

of BBPD are especially becoming common on the Internet (Gorodnichenko et al., 2018), where a firm such as Amazon can collect data on search behavior, GPS localization, and any type of personal information to feed machine-learning algorithms to personalize ads, products, and prices to the needs of its customers (Shiller et al., 2013). Recent studies document practices of BBPD in various industries such as newspapers (Asplund et al., 2008), credit markets (Ioannidou and Ongena, 2010) and mortgage markets (Thiel, 2019) among many others.

These practices of customer targeting by firms – using their own first-party data or using third-party data purchased from data brokers – have been analyzed by two different streams of the economic literature. On the one hand, a first stream of the literature documents practices of BBPD by firms who collect their own consumer data to target customers, even though they do not have a sophisticated data strategy (Fudenberg and Tirole, 2000; Acquisti and Varian, 2005; Fudenberg and Villas-Boas, 2006; Choe et al., 2018). This literature focuses on information acquisition practices and the competitive impact of targeting and shows that firms using BBPD will compete more fiercely to acquire consumer information, and will then engage in consumer poaching. On the other hand, recent articles analyze the selling strategies of third-party data brokers (Bergemann and Bonatti, 2015; Montes et al., 2018; Bergemann et al., 2018). Information is exogenous in these models, which focus on strategic information design by data brokers. In particular, Bounie et al. (2021) show that a monopolist data broker can internalize the business stealing effect of information by keeping a share of consumers unidentified from firms. However, to the best of our knowledge, new practices of information design by firms that have developed their own strategies based on first-party data have not yet been analyzed, and their implications for firms and consumers remain unclear.

In this article, we consider the adoption of strategic customer targeting by firms, and we analyze its implications for consumers and for market competition. We consider a two-period model of behavior-based price-discrimination à la Choe et al. (2018). Firms first compete in the information acquisition period: firms have no information but they can learn the willingness to pay of the customers who purchase their product. Then, firms compete in the second period by tar-

getting some of their past customers, in the spirit of [Bounie et al. \(2021\)](#). Using this approach, we explicitly model the strategy of information acquisition of each firm, and we allow for strategic targeting by firms using this first-party data. We characterize the optimal targeting strategies of the firms and we show that they target consumers with the highest willingness to pay for their product, and do not target a large share of low valuation consumers to soften competition.

We contribute to the literature on two main points. First, our results suggest that the competitive effects of BBPD and its benefits for consumers are becoming weaker as firms target consumers strategically. On the one hand, we show that strategic firms do not fight to acquire customer information in the information acquisition period, and they compete as in the standard Hotelling framework. As firms target only high valuation consumers in the targeting period, they do not have interest to undercut prices to acquire information on low valuation consumers who will not be targeted. In particular, this result contributes to a recent literature arguing that only asymmetric equilibria exist in models of BBPD with perfect information on past customers ([Choe et al., 2018](#)). In such asymmetric equilibria, one firm prices aggressively to limit the share of consumers served by its competitor. We show that the competitive equilibrium with strategic targeting is symmetric and no price undercutting occurs in the first period, which increases the profits of the firms and reduces consumer surplus.

On the other hand, we show that strategic firms do not poach consumers at the targeting period. As firms leave a share of consumers unidentified in the middle of the line, they can soften the competitive effect of targeting, and they will serve the same consumer demands in the two periods of competition. Hence, strategic targeting also softens the competitive effect of BBPD at the targeting period.

Secondly, we show that strategic targeting using first-party data increases market competition compared with information purchased from third-party data brokers. Data brokers can internalize the business stealing effect of information by keeping a large share of consumers unidentified from firms, and by selling information to only one of the firms, keeping the other uninformed ([Bounie et al., 2021](#)). Using the framework of BBPD developed by [Choe et al. \(2018\)](#), in which

firms acquire perfect information on their customers, we show that firms that use strategic targeting will target more consumers than a data broker, which increases competition and consumer surplus compared to third-party data.

These results have important implications for firms and for competition authorities, which depend on the level of reliance of industries on data brokers. For instance, retailers heavily rely on data brokers for their marketing and personalization campaigns (Crain, 2018), and a move of firms toward first-party data is likely to increase competition. In particular, first-party targeting would prevent exclusionary practices that are analyzed by the theoretical literature (Montes et al., 2018; Bounie et al., 2021), and which have been implemented for instance by Facebook.³ This increase of competition may not necessarily reduce the profits of the firms, as data brokers can charge high prices of information by putting firms in a prisoner’s dilemma (Montes et al., 2018), from which they can escape by building their own data strategies. On the contrary, in industries where firms traditionally manage their own first-party data and targeting campaigns, the adoption of strategic targeting is likely to increase their profits by softening market competition.

The remainder of this article is organized as follows. In Section 2 we describe the model, and we proceed to the analysis in Section 3. We discuss the welfare implications of strategic versus non-strategic targeting, and of third-party versus first-party data in Section 4. In Section 5 we analyze forward-looking consumers who anticipate targeting and may change their purchasing behavior accordingly. Section 6 discusses the main findings and concludes.

2 Description of the Model

Two horizontally differentiated firms – Firm A and Firm B – compete in a product market. We consider two competition periods $s = 1, 2$, in which firms sell non-durable goods. Both firms incur the same marginal cost of production, which is normalized to zero, and in each period consumers have unit demands.

³Facebook gave Lyft and others special access to user data; engadget, May 12th, 2018.

2.1 Consumers

Consumers are uniformly distributed on a unit line $[0, 1]$, and at each period s they can buy one product at a price p_{As} from Firm A located at 0, or p_{Bs} from Firm B located at 1.⁴ Since firms will be able to price discriminate when they have information, different consumers may pay different prices. Consumer located at $x \in [0, 1]$ derives a utility V from purchasing the product. He incurs a transportation cost $t > 0$ so that buying from Firm A (resp. from Firm B), has a total cost tx (resp. $t(1 - x)$). At each period, consumers purchase the product for which they have the highest utility.

In period $s = 1, 2$, consumer located at x has a utility function defined by:

$$u_s(x) = \begin{cases} V - p_{As} - tx, & \text{if he buys from Firm A,} \\ V - p_{Bs} - t(1 - x), & \text{if he buys from Firm B.} \end{cases} \quad (1)$$

Consumers are assumed to be myopic in the baseline model, and they maximize their utility at each consumption period.⁵ We consider forward-looking consumers in Section 5.

2.2 Firms

We describe the targeting strategies of both firms in the second period, where firms can choose the share of consumers that they target. We then describe the profits of the firms at each period of the game, and we characterize their objective functions.

Firms first compete in period 1 – the information acquisition period – in which each firm collects perfect information on its customers. Let's denote by \tilde{x}_1 the consumer indifferent between buying from Firm A and Firm B in the first period, such that Firm A serves consumers on $[0, \tilde{x}_1]$ and Firm B serves consumers on

⁴We assume that the market is covered. This assumption is common in the literature. See for instance [Bounie et al. \(2021\)](#) or [Montes et al. \(2018\)](#).

⁵This assumption is standard in a stream of the literature focusing on information acquisition by the firms and their pricing strategies ([Caillaud and De Nijs, 2014](#); [Esteves and Vasconcelos, 2015](#)).

$[\tilde{x}_1, 1]$. We follow the approach of [Choe et al. \(2018\)](#) where data allows firms to learn the location of each customer that it serves.

2.2.1 Targeting Strategies

In period 2 – the targeting period – firms choose which of their past customers they price-discriminate. Each firm can target two different types of intervals of the consumer demand ([Bounie et al., 2021](#)), corresponding respectively to first and third-degree price discrimination:

- (a) On the first type of intervals a firm charges personalized prices to all past customers.
- (b) A firm can charge a homogeneous price to all customers in the second type of intervals.

We illustrate these two types of intervals for Firm A in [Figure 1](#) when Firm B sets a homogeneous price p_B . Intervals of type (a) are displayed in [Figure 1 \(a\)](#) and Firm A charges each customer a personalized price $p_A(x)$. Firm A charges a homogeneous price p_A on intervals of type (b) illustrated in [Figure 1 \(b\)](#). We allow any combination of such intervals, as illustrated for Firm A at the bottom of [Figure 1](#), which displays from the left to the right a type (b) interval with price p_{A_i} , a type (a) interval where Firm A charges price $p_A(x)$ to a consumer located at x , then two types (b) intervals respectively with prices $p_{A_{i+1}}$ and $p_{A_{i+2}}$, and a second type (a) interval and so on. Firm B has no information on these consumers and charges homogeneous price p_B .

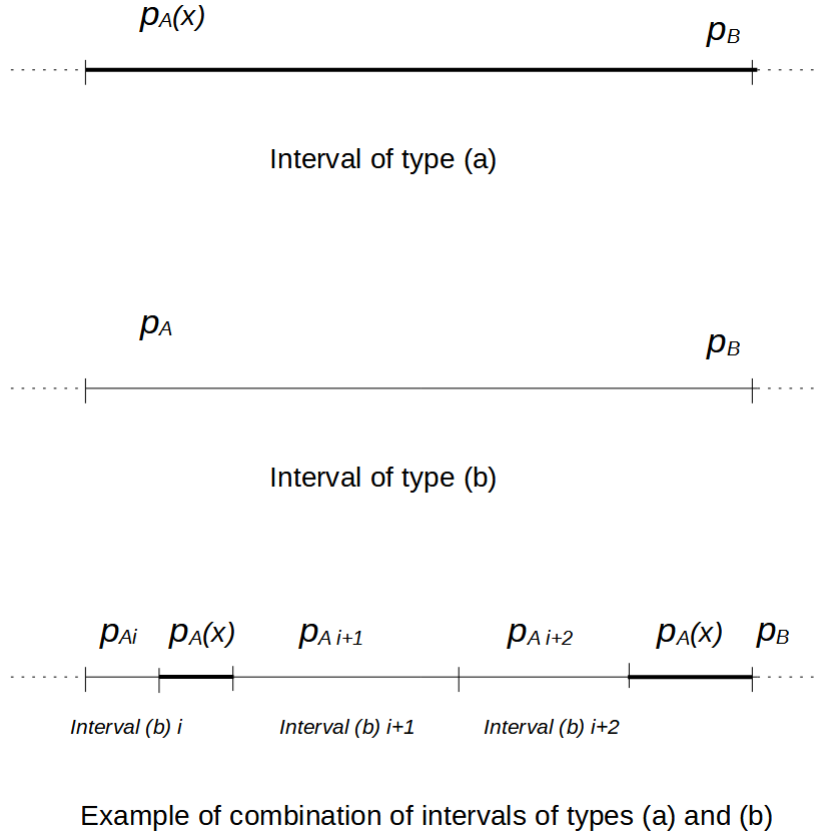


Figure 1: Possible types of intervals when Firm A targets consumers strategically.

We allow a firm to target consumers strategically: each firm can choose the combination of type (a) and type (b) intervals that yields the highest profit. While previous literature has assumed that firms price-discriminate all consumers that they have identified,⁶ we consider strategic targeting as using all available information may not be optimal for a firm. There are indeed two opposite effects of information on the profit of a firm. On the one hand, targeting consumers increases the profit of a firm through a better extraction of consumer surplus. On the other hand, information also increases competition, which reduces the profits of both firms. We characterize the optimal combination of intervals in Proposition 1.

Proposition 1

⁶Note that the situation where firms target all past customers is a special case of our model where firms only use type (a) intervals.

There exist $x_A \in [0, \tilde{x}_1]$ & $x_B \in [0, 1 - \tilde{x}_1]$ such that in equilibrium:

- Firm A targets all consumers on $[0, x_A]$ and charges a homogeneous price on consumers on $[x_A, 1]$.
- Firm B targets all consumers on $[1 - x_B, 1]$ and charges a homogeneous price on consumers on $[0, 1 - x_B]$.

Proof: see Appendix A.1.

Proposition 1 states that an information partition maximizes the profit of a firm by dividing the unit line into two intervals. Firm A charges targeted prices to consumers in the first interval on $[0, x_A]$, to which we refer as the share of targeted consumers. Firm A does not target consumers on $[x_A, 1]$, and charges a uniform price on this second interval. We refer to this interval as the share of untargeted consumers. Similarly, Firm B optimally targets consumers belonging to $[1 - x_B, 1]$ and charges a homogeneous price to consumers on $[0, 1 - x_B]$. Consumers on $[x_A, 1 - x_B]$ are not targeted in period 2. By leaving a share of consumers untargeted by firms, these optimal targeting strategies balance the rent extraction and the competition effects of information.⁷

The targeting strategies of Firm A and Firm B are characterized by their choices of x_A and x_B , which can be constrained by the number of consumers on whom firms have acquired information. In period 1, Firm A collects information on $[0, \tilde{x}_1]$ and Firm B collects information on $[\tilde{x}_1, 1]$. Therefore, the targeting strategy of each firm must verify: $x_A \leq \tilde{x}_1$ and $x_B \leq 1 - \tilde{x}_1$. Hence, competition in period 1 can have an impact on the targeting strategies of the firms. Note that the situation where each firm targets all its past customers is a special case of this approach, where $x_A = 1 - x_B = \tilde{x}_1$.

When analyzing the targeting strategies of the firms, we will focus on pure strategy Nash equilibria, and we will characterize the values of x_A and x_B in the unique Nash equilibrium of the Game. As we assume that firms choose x_A and

⁷We also generalize the results of [Bounie et al. \(2021\)](#) by characterizing the optimal targeting strategies of firms using first-party data.

x_B simultaneously, we will derive the equilibrium by finding x_A as a simultaneous best response to x_B and reciprocally.

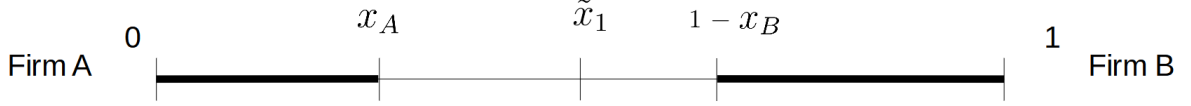


Figure 2: Targeting strategies of firms in period 2.

Figure 2 illustrates the targeting strategies of Firm A and Firm B. The thick lines represent consumers that are targeted by Firm A on $[0, x_A]$, and by Firm B on $[1 - x_B, 1]$. Consumers on segment $[x_A, 1]$ and $[0, 1 - x_B]$ are charged a homogeneous price by Firm A and Firm B respectively. Figure 2 also displays \tilde{x}_1 , the location of the indifferent consumer in period 1.

2.2.2 Profits

At the beginning of period 1, each firm maximizes the sum of its profits on both periods by discounting period 2 with factor δ .

Prices and profits in period 1 are similar to the standard Hotelling model without information. Firms only know that consumers are uniformly distributed on the unit line. Firm θ ($\theta = A, B$) sets $p_{\theta 1}$ in equilibrium, and the resulting demand is $d_{\theta 1} = \frac{p_{-\theta 1} - p_{\theta 1} + t}{2t}$, where $d_{11} = \tilde{x}_1$ and $d_{21} = 1 - \tilde{x}_1$. The profit of Firm θ is $\pi_{\theta 1} = d_{\theta 1} p_{\theta 1}$.

In period 2, Firm θ selects the share of consumers x_{θ} to price discriminate. A firm charges personalized prices $p_{\theta 2}(x)$ to targeted consumers and charges price $p_{\theta 2}$ on the rest of the unit line. Prices $p_{\theta 2}(x)$ are set as high as possible under the competitive constraint exerted by price $p_{-\theta 2}$. Hence, Firm θ sets prices in period 2 in order to maximize the following profit function:

$$\pi_{\theta 2}(p_{\theta 2}(x), p_{\theta 2}) = \int_0^{x_{\theta}} p_{\theta 2}(x) dx + p_{\theta 2} d_{\theta 2}. \quad (2)$$

We make two assumptions regarding the timing of the game. We assume that firms first choose the share of consumers that they want to target, and then charge prices. This assumption is common in the theoretical literature on targeted advertising, where firms first choose to which consumers they send an ad, and then set prices accordingly (Anderson and Renault, 2009). This assumption is also supported by managerial practices. As Du et al. (2021) emphasize, data analytics teams – in charge of the targeting strategy – and marketing decision-makers – in charge of setting prices – are frequently at arm’s length in centralized organizations.

Moreover, we assume that in period 2 Firm θ sets prices in two stages. First, she sets price $p_{\theta 2}$ on the competitive segment of untargeted consumers. Then she sets a monopoly price $p_{\theta 2}(x)$ for each targeted consumer, constrained by the homogeneous price of the competitor. Hence, the resulting demand of untargeted consumers for each firm is $d_{\theta 2} = \frac{p - \theta_2 - p_{\theta 2} + t}{2t} - x_{\theta}$.

Sequential pricing decision avoids the nonexistence of Nash equilibrium in pure strategies and is common in the literature supported by managerial practices. For instance, Jentzsch et al. (2013), Belleflamme et al. (2020) and Bounie et al. (2021) focus on sequential pricing where a higher personalized price is charged to identified consumers after a firm sets a uniform price. Sequential pricing is also common in business practices. Recently, Amazon has been accused to show higher prices for Amazon Prime subscribers, who pay an annual fee for unlimited shipping services, than for non-subscribers (Lawsuit alleges Amazon charges Prime members for "free" shipping, Consumer affairs, August 29, 2017). Thus Amazon first sets a uniform price and then increases prices for high-value consumers who are better identified when they join the Prime program.

Demands in the information acquisition period can have an impact on the targeting strategies of the firms in the targeting period. To emphasize the impact of prices in period 1 on market outcome in period 2, we write the location of the indifferent consumer as a function of prices in period 1: $\tilde{x}_1(p_{A1}, p_{B1})$. Overall the objective functions of the firms at the beginning of the game are:

$$\begin{aligned} \text{For Firm A: } & \max_{p_{A1}} \{ \pi_{A1}(p_{A1}, p_{B1}) + \delta \pi_{A2}(p_{A2}(x), p_{A2}, \tilde{x}_1(p_{A1}, p_{B1})) \} \\ & \hspace{20em} (3) \\ \text{For Firm B: } & \max_{p_{B1}} \{ \pi_{B1}(p_{B1}, p_{A1}) + \delta \pi_{B2}(p_{B2}(x), p_{B2}, \tilde{x}_1(p_{A1}, p_{B1})) \} \end{aligned}$$

2.3 Timing

We summarize the timing of the game. In period 1, firms compete and collect data on their customer. In period 2, firms choose the shares x_A and x_B of consumers that they target. Then firms set prices on the segment of untargeted consumers where they compete, and in the last stage, firms set targeted prices. The timing of the game is the following:

- Period 1:
 - Firms compete by setting prices p_{A1} and p_{B1} , and learn the location of their customers on the unit line.
- Period 2:
 - Stage 1: Each Firm θ chooses the share x_θ of consumers to price-discriminate.
 - Stage 2: Firms set prices p_{A2} and p_{B2} on the competitive segment of the unit line.
 - Stage 3: Firms set prices $p_{\theta 2}(x)$ on consumers that they price-discriminate.

3 Analysis

We start by stating the main results of the analysis in Theorem 1, which we prove in the following sections.

Theorem 1

- (a) *The dominant equilibrium of the game is symmetric.*
- (b) *Firms do not engage in consumer poaching at the targeting period.*
- (c) *Firms do not undercut prices at the information acquisition period.*

We solve the model by backward induction. We first characterize the optimal targeting strategies of firms in the second period. Then we analyze competition in period 1 and information acquisition by firms. We compute profits in the symmetric equilibrium, and we show that they dominate profits in asymmetric equilibria.

3.1 Period 2: Strategic Targeting

We characterize in this section the optimal targeting strategies of the firms in period 2 when they can first-degree price discriminate some of their past customers. Firm A price discriminates consumers on $[0, x_A]$, and charges consumers on $[x_A, 1]$ a homogeneous price. Similarly, Firm B price discriminates consumers on $[1 - x_B, 1]$, and charges a homogeneous price to consumers on $[0, 1 - x_B]$. The choices of x_A and x_B correspond to the targeting strategies of Firm A and Firm B, and we will analyze their optimal values x_A^* and x_B^* in this section.

Each firm can target in period 2 customers that it has served in period 1, and the value of \tilde{x}_1 is therefore essential for the targeting strategy of firms in period 2. Indeed, if $\tilde{x}_1 \in [x_A^*, 1 - x_B^*]$, both firms can target their optimal number of consumers in period 2. On the contrary, if $\tilde{x}_1 \in [0, x_A^*]$ or if $\tilde{x}_1 \in [1 - x_B^*, 1]$, respectively Firm A or Firm B will not be able to target their optimal number of consumers, and will be constrained on their targeting strategy.

Proposition 2 characterizes the equilibria when $\tilde{x}_1 \in [x_A^*, 1 - x_B^*]$ and firms are not constrained on their targeting strategies, and when $\tilde{x}_1 \in [0, x_A^*]$ and Firm A is constrained (the case where Firm B is constrained is identical).

Proposition 2

(a) In period 2 when $\tilde{x}_1 \in [\frac{1}{3}, \frac{2}{3}]$ the equilibrium is unconstrained and firms target symmetric shares of consumers:

$$x_A^* = x_B^* = \frac{1}{3}, \quad \tilde{x}_2 = \frac{1}{2}.$$

(b) In period 2 when $\tilde{x}_1 \in [0, \frac{1}{3}]$ the equilibrium is constrained and firms target asymmetric shares of consumers:

$$x_A^* = \tilde{x}_1, \quad x_B^* = \frac{3}{7} - \frac{2\tilde{x}_1}{7}, \quad \tilde{x}_2 = \frac{6\tilde{x}_1 + 5}{14}.$$

Proof: see Appendix A.2.

In the unconstrained equilibrium characterized by Proposition 2 (a), firms have the same optimal targeting strategies in which they target only part of their past customers. Firms have information on consumers in $[\frac{1}{3}, \frac{2}{3}]$, but they charge them a homogeneous price in period 2 to soften competition.

Proposition 2 (b) characterizes the equilibrium when Firm A is constrained on its targeting strategy and price-discriminates fewer consumers than in the unconstrained equilibrium. This relaxes the competitive pressure on Firm B, which will target more consumers and make higher profits than in the symmetric equilibrium. Hence it is profitable for a firm to face a competitor constrained on targeting. As the value of \tilde{x}_1 in period 1 depends on the prices set by the firms, we analyze in the next section whether a firm has interest to undercut prices in period 1 in order to constrain the targeting strategy of its competitor in period 2.

We will also compare the locations of the indifferent consumers \tilde{x}_1 in period 1 and \tilde{x}_2 in period 2. The literature classically finds that BBPD results in poaching practices: some consumers purchase from one firm in period 1, and then from its competitor in period 2. Poaching is considered beneficial for consumers as it results from a more competitive market in period 2 thanks to BBPD. We show in the next section that in the dominant equilibrium $\tilde{x}_1 = \tilde{x}_2$ and consumer poaching does not occur.

3.2 Period 1: Information Acquisition

We analyze competition in the information acquisition period. In the symmetric equilibrium, firms maximize profits in period 1 and market equilibrium is as in

standard Hotelling competition without data collection. We consider the profits of a firm that deviates from this symmetric equilibrium and undercuts prices in period 1 to constrain the targeting strategy of its competitor. We show in Proposition 3 that the profits of both firms are higher in the symmetric equilibrium than in the asymmetric competition with constraining strategies.

Proposition 3

- *Profits are maximized in the symmetric equilibrium.*
- *Firms do not engage in price undercutting strategies.*
- *The indifferent consumer has the same location in both periods, and poaching does not occur:*

$$\tilde{x}_1 = \tilde{x}_2 = \frac{1}{2}.$$

Proof: see Appendix A.3.

Profits in the symmetric equilibrium dominate profits in asymmetric competition when a firm engages into constraining strategies. Indeed, in order to constrain their competitor in period 2, firms must undercut prices so that the indifferent consumer \tilde{x}_1 is very close to the competitor’s location in period 1. For instance, if Firm B wants to constrain Firm A, it must be that $\tilde{x}_1 < \frac{1}{3}$. There is thus an important loss in period 1 for a firm to constrain its competitor and the increase in profits in period 2 does not cover this loss.

The literature on BBPD classically finds that competition in the first period is driven by two main forces: firms want to reach high profits in this first period, but they also anticipate the second competition period in which they are informed on their past customers. Hence, competition is fiercer than in standard Hotelling competition without information, as a firm has an additional incentive to serve a larger customer demand in period 1 to charge targeted prices to more consumers in the second period (Choe et al., 2018). We interpret this second dimension as a competition for information acquisition in period 1. When firms use strategic targeting, Proposition 3 shows that they do not charge targeted prices to consumers in the middle of the line, and thus they do not make additional benefits

from identifying these consumers in period 1: firms do not compete to acquire consumer information.

Moreover, the same consumer demands are served in both competition periods $\tilde{x}_1 = \tilde{x}_2$, and firms do not offer discounted prices to new customers. This result is a natural consequence of strategic targeting in which firms do not have interest to undercut prices and poach consumers, but soften competition by keeping a large share of consumers untargeted. Hence Proposition 3 also contributes to the literature by showing that the adoption of strategic targeting by firms allows them to avoid poaching and price undercutting in the second competition period.

Proposition 3 presents interesting connections with the results of [Choe et al. \(2018\)](#), who show in a similar setting without strategic targeting that the only equilibrium is asymmetric, and poaching occurs in period 2. Proposition 3 states that when firms target consumers strategically, the equilibrium of the game is symmetric. This has important implications for the profits of the firms and for consumer surplus, which we analyze in the next section.

4 Welfare

We compare the profits of the firms and consumer surplus in our model with those in [Choe et al. \(2018\)](#) – in which firms do not target consumers strategically – and with those in [Bounie et al. \(2021\)](#) – where strategic targeting occurs but firms acquire third-party data from a data broker. An important element of the analysis is that profits, consumer surplus, and the intensity of competition depend on the number of consumers targeted by each firm, which changes in the three scenarios.

Welfare Comparison: Strategic vs non-Strategic Targeting

We compare the profits of the firms and consumer surplus when firms use strategic targeting with those when firms target all past customers ([Choe et al., 2018](#)). This comparison allows us to understand the impact of the adoption of targeting strategies by firms using their own first-party data.

Proposition 4

Compared with competition when firms target all their past customers, strategic targeting yields higher industry profits, lower consumer surplus, and a lower intensity of competition.

Proof: see Appendix [A.4](#).

When firms target all consumers on whom they have collected information, they price aggressively new consumers that they have not served in the information acquisition period. [Choe et al. \(2018\)](#) show that a firm even charges zero prices to new consumers, which reduces the ability of their competitor to extract surplus from targeted consumers.

Hence a firm can profitably deviate from a situation where it targets all past customers by keeping some customers untargeted. By doing so, it gives incentives to its competitor to increase its price, which allows the firm to charge higher prices to the remaining targeted customers. The loss of profits from charging a homogeneous price instead of targeted prices to a share of past customers is covered by a better extraction of surplus from the remaining targeted customers. This relaxes competition, reduces consumer surplus, and increases the profits of the firms⁸

Welfare Comparison: First-party vs Third-party data

We now compare profits and surplus in the targeting period with those in [Bounie et al. \(2021\)](#), where firms acquire information from a data broker. This allows us to assess the impact of a change from third to first-party data on market competition.

Proposition 5

First-party data yield lower industry profits, higher consumer surplus, and a higher intensity of competition than third-party data acquired from a strategic data broker.

⁸This result contributes to the literature on BBPD that emphasizes the risk for consumers of an intense extraction of their surplus ([Gehrig et al., 2011](#)).

Proof: see Appendix A.5.

A data broker internalizes the business stealing effect of information by having firms target a small share of consumers and by keeping one of the firms uninformed. When firms choose their own targeting strategy using first-party data, they cannot internalize as well the business stealing effect of information: they target more consumers than a data broker, which intensifies competition, increases consumer surplus, and reduces the profits of the industry.

5 Forward-looking Consumers

Consumers may anticipate in period 1 that firms collect their information to charge targeted prices in period 2 (Li and Jain, 2016). This ability of consumers to anticipate BBPD and purchase products accordingly is a classical consideration of the literature that usually finds an intensification of competition in the information acquisition period (Fudenberg and Tirole, 2000).

In this section we consider a consumer located in $[0, \frac{1}{3}]$ who anticipates that they will be charged a targeted price in period 2. We analyze whether this consumer has interest to purchase from Firm B in period 1 in order to remain hidden from Firm A and pay a homogeneous price in period 2. When choosing which product to purchase in the first period, the consumer maximizes the sum of utilities over both periods by discounting period 2 with a factor δ_c .

Proposition 6

Strategic consumers do not hide from firms, and they purchase their preferred product at both competition periods.

Proof: see Appendix A.6.

Proposition 6 states that consumers do not have interest to hide from firms, and the equilibrium is identical to the baseline framework with myopic consumers. This result contributes to previous literature that has shown that consumers have interest to hide when they are relatively indifferent between the products of both firms (Fudenberg and Tirole, 2000). When firms are strategic, only consumers

with high valuations for a firm’s product are targeted in the second period and may have interest to purchase their least preferred product in the first period. Purchasing Firm B’s product in period 1 would induce an important opportunity cost for a consumer close to Firm A, which is not recovered in period 2, and consumers purchase their preferred product in both periods. Hence when firms use strategic targeting, consumers have no interest to hide, and strategic targeting additionally softens competition through this change in consumers’ behavior.

6 Conclusion

This model of behavior-based price discrimination with strategic customer targeting has two important implications for firms and regulators. First, our results suggest that the adoption of strategic targeting based on first-party data is likely to increase market competition compared with information acquisition from data brokers. Market competition and consumer surplus are higher when firms design their own data collection and targeting strategies than when they purchase information from third parties. Moreover, firms compete on a level playing field when they collect first-party data, while data brokers have incentives to engage into exclusionary practices and sell information to one firm only (Montes et al., 2018; Bounie et al., 2021). It is therefore important for competition authorities to assess whether the efficiency gains from having third-party data brokers specialized in data collection are not outweighed by a loss in competition and higher prices for consumers.

Secondly, with the introduction of new targeting strategies, competition authorities may have to reconsider the benefits of behavior-based price discrimination for consumer surplus. As firms become strategic in their uses of data, they can use information design to soften market competition. This result complements the report of the FTC that calls for a better understanding of the implications of Big-data analytics for markets and consumers.⁹

This simple two-period competition framework could be extended to account for positive data collection costs. Collecting, treating, and storing data is in-

⁹Big Data — A Tool for Inclusion or Exclusion?, January 6, 2016.

deed costly, and may reduce the profitability of consumer targeting for firms. In particular, asymmetric data collection costs can provide a firm with a significant competitive advantage, and could restore asymmetric competition.

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A Appendix

A.1 Proof of Proposition 1

We show that the optimal partition for a firm is composed of all segments closest to its location and no segment after a cut-off point. Firm A can choose any partition among the three types of intervals. There are three types of segments to consider:

- Segments A, where Firm A is in constrained monopoly;

- Segments B, where Firms 1 and 2 compete.
- Segments C, where Firms 1 makes zero profit.

We find the partition that maximizes the profits of Firm A. We proceed in three steps. In step 1 we analyze type A segments. We show that it is optimal to use a partition where Firm A price discriminates all consumers on these segments. In step 2, we show that all segments of type A are located closest to Firm A. In step 3 we analyze segments of type B and we show that it is always more profitable to target a union of such segments. Therefore, there is only one segment of type B, located furthest away from Firm A, and of size $1 - x_A$. Finally, we can discard segments of type C because information on consumers on these segments does not increase profits.

Step 1: We analyze segments of type A where Firm A is in constrained monopoly, and show that targeting all consumers is optimal.

Consider any segment $I = [i, i + l]$ of type A with l, i verifying $i + l \leq 1$, such that Firm A is in monopoly on this segment, constrained by firm B charging price p_B . We compare profits with first and third-degree price discrimination and we show that the former is more profitable for Firm A. We write π_A^{third} and π_A^{first} the profits of Firm A on I with third-degree and first-degree price discrimination.

To prove this claim, we establish that π_A^{first} is greater than π_A^{third} . First, profits with first-degree price discrimination is: $\pi_A^{first} = \int_i^{i+l} p_A(x)dx$. The demand is l as Firm A gets all consumers by assumption.

$$V - tx - p_A(x) = V - t(1 - x) - p_B \implies p_A(x) = t - 2tx + p_B.$$

Note that price p_B is only affected by strategic interactions on the segments where firms compete, and therefore does not depend on the pricing strategy of Firm A on type A segments. We write the profit function for any p_2 , replacing p_A :

$$\pi_A^{third} = l(t + p_B - 2(l + i)t).$$

Secondly, using a similar argument, we show that the profit with first-degree price discrimination is:

$$\pi_A^{first} = \int_i^{i+l} t - 2tx + p_B dx.$$

Comparing π_A^{third} and π_A^{first} shows that the profit of Firm A using the first-degree price discrimination is higher than under third-degree price discrimination, which establishes the claim.

Step 2: We show that all segments of type A are closest to Firm A (located at 0 on the unit line by convention).

Going from left to right on the Hotelling line, look for the first time where a type B interval, $J = [i; i+l]$ of length l , is followed by an interval $I = [i+l, i+l+\epsilon]$ of type A. Consider a reordering of the overall interval $J \cup I = [i, i+l+\epsilon]$ in two intervals $I' = [i; i+\epsilon]$ and $J' = [i+\epsilon, i+l+\epsilon]$. We show in this step that such a transformation increases the profits of Firm A.

To compare the profits of the informed firm under both partitions, we first characterize type B segments. Segment J of type B is non null, if the following restrictions imposed by the structure of the model, are met: respectively positive demand and the existence of competition on segments of type B. In order to characterize type A and type B segments, it is useful to consider the following inequality:

$$\forall i, l \in [0, 1] \text{ s.t. } 0 \leq l \leq 1 - i, i \leq \frac{\tilde{p}_B + t}{2t} \text{ and } \frac{\tilde{p}_B + t}{2t} - l \leq i + l. \quad (4)$$

In particular, we use the relation that Eq. 4 draws between price \tilde{p}_B and segments endpoint i and $i+l$ to compare the profits of Firm A with $J&I$ and with $I'&J'$. Without loss of generality, we rewrite the notation of type A and B segments. The segment of type A is of size ϵ and is located at $u_i - \epsilon$, and segments of type B, are located at s_i and are of size l_i .¹⁰ There are $n \in \mathbb{N}$ segments of type B, where prices are noted \tilde{p}_{Ai}^B . We find the demand for Firm A on these segments using the location of the indifferent consumer:

$$d_{Ai} = x - s_i = \frac{\tilde{p}_B - \tilde{p}_{Ai}^B + t}{2t} - s_i.$$

We can rewrite the profits of Firm A as the sum of two terms. The first term represents the profits on segments of type A. The second term represents the profits on segments of type B.

$$\pi_A(I, J) = \int_{i+l}^{i+l+\epsilon} \tilde{p}_A^A(x) dx + \sum_{i=1}^n \tilde{p}_{Ai}^B \left[\frac{\tilde{p}_B - \tilde{p}_{Ai}^B + t}{2t} - s_i \right].$$

Profits of Firm B are generated on segments of type B only, where the demand for Firm B is:

$$d_{Bi} = s_i + l_i - x = \frac{\tilde{p}_{Ai}^B - \tilde{p}_B - t}{2t} + s_i + l_i.$$

Profits of Firm B can be written therefore as:

$$\pi_B(I, J) = \sum_{i=1}^n \tilde{p}_B \left[\frac{\tilde{p}_{Ai}^B - \tilde{p}_B - t}{2t} + s_i + l_i \right]. \quad (5)$$

¹⁰With u_i and s_i lower than 1.

Firm A maximizes profits $\pi_A(I, J)$ with respect to $\tilde{p}_A^A(x)$ and \tilde{p}_{Ai}^B , and Firm B maximizes $\pi_B(I, J)$ with respect to \tilde{p}_B , both profits are strictly concave.

Equilibrium prices are:

$$\begin{aligned}\tilde{p}_A^A(x) &= t + \tilde{p}_B - 2xt \\ \tilde{p}_{Ai}^B &= \frac{\tilde{p}_B + t}{2} - s_i t = \frac{t}{3} + \frac{2t}{3n} \left[\sum_{i=1}^n \left[\frac{s_i}{2} + l_i \right] \right] - s_i t \\ \tilde{p}_B &= -\frac{t}{3} + \frac{4t}{3n} \sum_{i=1}^n \left[\frac{s_i}{2} + l_i \right].\end{aligned}\tag{6}$$

We can now compare profits with I, J and J', I' . When we move segments of type B from the left of segments of type A to the right of segment of type A, it is important to check that Firm A is still competing with Firm B on each segment of type B, and that Firm A is still in constrained monopoly on segments of type A. The second condition is met by the fact that price \tilde{p}_B is higher in J', I' than in I, J . The first condition is guaranteed by Eq. 4: $\frac{\tilde{p}_B + t}{2} - l_i \leq s_i + l_i$ for some segments located at s_i of size l_i . By abuse of notation, let s_i denote the segment located at $[s_i, s_i + l_i]$, which corresponds to segments of type B that satisfy these conditions. Let \tilde{s}_i denote the m segments ($m \in [0, n - 1]$) of type B with partition I, J located at $[\tilde{s}_i, \tilde{s}_i + \tilde{l}_i]$ that do not meet these conditions, and therefore are type A segments with partition J', I' .

Noting \tilde{p}'_B and $\tilde{p}_{Ai}^{B'}$ the prices with J', I' , we have:

$$\begin{aligned}\tilde{p}'_B &= \frac{4t}{3(n-m)} \left[-\frac{n}{4} + \sum_{i=1}^n \left[\frac{s_i}{2} + l_i \right] + \frac{m}{4} + \frac{1}{2} - \sum_{i=1}^m \frac{\tilde{s}_i}{2} \right] \\ &= \tilde{p}_B + \frac{4t}{3(n-m)} \left[\frac{3m\tilde{p}_B}{4t} + \frac{1}{2} + \frac{m}{4} - \sum_{i=1}^m \frac{\tilde{s}_i}{2} \right],\end{aligned}$$

for segments of type B where inequalities in Eq. 4 hold:

$$\tilde{p}_{Ai}^{B'} = \tilde{p}_{Ai} + \frac{1}{2} \frac{4t}{3(n-m)} \left[\frac{3m\tilde{p}_B}{4t} + \frac{1}{2} + \frac{m}{4} - \sum_{i=1}^m \frac{\tilde{s}_i}{2} \right],$$

for segments of type B where inequalities in Eq. 4 do not hold:

$$\tilde{p}_{Ai}^{B'} = \tilde{p}_{Ai} + \frac{1}{2} \frac{4t}{3(n-m)} \left[\frac{3m\tilde{p}_B}{4t} + \frac{1}{2} + \frac{m}{4} - \sum_{i=1}^m \frac{\tilde{s}_i}{2} \right].$$

Let us compare the profits between I, J and J', I' . To compare profits that result from moving the segment located at $i + l$ to i (A to B), we proceed in two steps. First we show that the profits of Firm A on $[i, i + l + \epsilon]$ are higher with J', I' than with I, J , and that \tilde{p}_B increases as well; and secondly we show that the profits of Firm A on type B segments are higher with J', I' than with I, J .

First we show that the profits of Firm A increase on $[i, i + l + \epsilon]$, that is, we

show that $\Delta\pi_A = \pi_A(J', I') - \pi_A(I, J) \geq 0$:

$$\begin{aligned}\Delta\pi_A &= \pi_A(J', I') - \pi_A(I, J) \\ &= \epsilon[\tilde{p}'_B - 2it - \tilde{p}_B + 2(i+l)t] \\ &\quad + \tilde{p}'_{Ai} \left[\frac{\tilde{p}'_B - \tilde{p}'_{Ai} + t}{2t} - (i + \epsilon) \right] - \tilde{p}_{Ai} \left[\frac{\tilde{p}_B - \tilde{p}_{Ai} + t}{2t} - i \right].\end{aligned}$$

By definition, \tilde{s}_i verifies the inequalities in Eq. 4, thus $\tilde{s}_i \leq \frac{\tilde{p}_B + t}{2t}$, which allows us to establish that $\frac{4t}{3(n-m)} \left[\frac{3m\tilde{p}_B}{4t} + \frac{1}{2} + \frac{m}{4} - \sum_{i=1}^m \frac{\tilde{s}_i}{2} \right] \geq \frac{2t}{3n}$. It is then immediate to show that:

$$\Delta\pi_A \geq \epsilon t \left[1 - \frac{1}{3n} \right] \left[\frac{2}{k} \frac{3nl + 1}{3n - 1} - \frac{\tilde{p}_B}{2t} - \frac{1}{2} - \frac{1}{6n} + i + \frac{1}{2} \right].$$

Also, by assumption, firms compete on $J = [i, i + l]$, which implies that inequalities in Eq. 4 hold, and in particular, $\frac{\tilde{p}_B + t}{4t} - \frac{i}{2} \leq l$.

Thus:

$$\Delta\pi_A \geq \epsilon t \left[1 - \frac{1}{3n} \right] \left[2 \frac{3nl + 1}{3n - 1} - 2l - \frac{1}{6n} + \frac{1}{2} \right] \geq 0.$$

Profits on segment $[i, i + l + \epsilon]$ are higher with J', I' than with I, J .

Second we consider the profits of Firm A on the rest of the unit line. We write the reaction functions for the profits on each type of segment, knowing that $\tilde{p}'_B \geq \tilde{p}_B$.

For segments of type A:

$$\frac{\partial}{\partial \tilde{p}_B} p_A(x) = \frac{\partial}{\partial \tilde{p}_B} ([t + \tilde{p}_B - 2u_i t]) = 1,$$

and a higher \tilde{p}_B increases profits.

For segments of type B:

$$\frac{\partial}{\partial \tilde{p}_B} \pi_{1i} = \frac{\partial}{\partial \tilde{p}_B} (p_{Ai} \left[\frac{\tilde{p}_B - \tilde{p}_{Ai}^B + t}{2t} - s_i \right]) = \frac{\partial}{\partial \tilde{p}_B} \left(\frac{1}{2t} \left[\frac{\tilde{p}_B + t}{2} - s_i t \right]^2 \right) = \frac{1}{2t} \left[\frac{\tilde{p}_B + t}{2} - s_i t \right],$$

which is greater than 0 as $\frac{\tilde{p}_B + t}{2} - s_i t$ is the expression of the demand on this segment, which is positive under Eq. 4.

Thus for any segment, the profits of Firm A increase with J', I' compared to I, J .

Intermediary result 1: *By iteration, we conclude that type A segments are always at the left of type B segments.*

Step 3: We now analyze segments of type B where firms compete. Starting from any partition with at least two segments of type B, we show that it is always more profitable to use a coarser partition.

As there are only two possible types of segments (A and B) and that we have

shown that segments of type A are the closest to the firms, segment B is therefore further away from the firm. We prove the claim of step 3 by showing that if Firm A has a partition of two segments where it competes with Firm B, a coarser partition yields higher profits. We compute the profits of the firm on all the segments where firms compete. There are three types of segments to consider:

1. segments of type A that with partition $\hat{\mathcal{P}}$ that remain of type A with partition $\hat{\mathcal{P}}'$.
2. segments of type B with partition $\hat{\mathcal{P}}$ that are of type A with partition $\hat{\mathcal{P}}'$.
3. segments of type B with partition $\hat{\mathcal{P}}$ that remain of type B with partition $\hat{\mathcal{P}}'$.

1. Profits always increase on segments that are of type A with partitions $\hat{\mathcal{P}}$ and $\hat{\mathcal{P}}'$. Indeed, we will show that \hat{p}'_B with partition $\hat{\mathcal{P}}'$ is higher than \hat{p}_B with partition $\hat{\mathcal{P}}$, and thus the profits of Firm A on type A segments increase.

2. There are m segments which were type B in partition $\hat{\mathcal{P}}$ are no longer necessarily of type B in partition $\hat{\mathcal{P}}$ (and are therefore of type A).

3. There are $n+1-m$ segments of type B with partition $\hat{\mathcal{P}}$ that remain of type B with partition $\hat{\mathcal{P}}'$. We compute prices and profits on these $n+1+m$ segments.

We proved in step 2 that prices can be written as:

$$\begin{aligned}\hat{p}_B &= -\frac{t}{3} + \frac{4t}{3(n+1)} \sum_{i=1}^{n+1} \left[\frac{s_i}{2} + l_i \right], \\ \hat{p}_{Ai}^B &= \frac{\hat{p}_B + t}{2} - s_i t \\ &= \frac{t}{3} + \frac{2t}{3(n+1)} \sum_{i=1}^{n+1} \left[\frac{s_i}{2} + l_i \right] - s_i t.\end{aligned}$$

Let \hat{p}_{1s}^B and \hat{p}_{1s+l}^B be the prices on the last two segments when the partition is $\hat{\mathcal{P}}$.

$$\begin{aligned}\hat{p}_{1s}^B &= \frac{\hat{p}_B + t}{2} - \frac{st}{k}, \\ \hat{p}_{1s+l}^B &= \frac{\hat{p}_B + t}{2} - \frac{s+l}{k}t,\end{aligned}$$

\hat{p}'_B is the price set by Firm B with partition $\hat{\mathcal{P}}'$, and $\hat{p}_{1s}^{B'}$ is the price set by Firm A on the last segment of partition $\hat{\mathcal{P}}'$.

Inequalities in Eq. 4 might not hold as price \hat{p}_B varies depending on the partition acquired by Firm A. This implies that segments which are of type B with partition $\hat{\mathcal{P}}$ are then of type A with partition $\hat{\mathcal{P}}'$. This is because the coarser the partition, the higher \hat{p}_B . We note \tilde{s}_i the m segments where it is the case. We then have:

$$\begin{aligned}
\hat{p}'_B &= \frac{4t}{3(n-m)} \left[-\frac{n-m}{4} + \sum_{i=1}^n \left[\frac{s_i}{2} + l_i \right] - \sum_{i=1}^m \frac{\tilde{s}_i}{2} \right] \\
&= \frac{4t}{3(n-m)} \left[-\frac{n+1}{4} + \sum_{i=1}^{n+1} \left[\frac{s_i}{2} + l_i \right] + \frac{m+1}{4} - \sum_{i=1}^m \frac{\tilde{s}_i}{2} - \frac{s+l}{2} \right] \\
&= \hat{p}_B + \frac{4t}{3(n-m)} \left[\frac{3(m+1)\hat{p}_B}{4t} + \frac{m+1}{4} - \sum_{i=1}^m \frac{\tilde{s}_i}{2} - \frac{s+l}{2} \right] \\
&\geq \hat{p}_B + \frac{4t}{3(n-m)} \left[\frac{3}{4t} \hat{p}_B + \frac{m\hat{p}_B}{2t} + \frac{1}{4} - \frac{s+l}{2} \right], \\
\hat{p}'_{1s} &= \frac{\hat{p}_B + t}{2} - \frac{st}{k},
\end{aligned}$$

$$\begin{aligned}
\pi_A(\hat{\mathcal{P}}) &= \sum_{i=1, s_i \neq \tilde{s}_i}^n p_{Ai} \left[\frac{\hat{p}_B + t}{4t} - \frac{s_i}{2} \right] + \sum_{i=1}^m \hat{p}_{Ai}^B \left[\frac{\hat{p}_B + t}{4t} - \frac{\tilde{s}_i}{2} \right] + \hat{p}_{1s+l}^B \left[\frac{\hat{p}_B + t}{4t} - \frac{s+l}{2} \right] \\
\pi_A(\hat{\mathcal{P}}') &= \sum_{i=1, s_i \neq \tilde{s}_i}^n \hat{p}'_{Ai} \left[\frac{\hat{p}'_B + t}{4t} - \frac{s_i}{2} \right] + \sum_{i=1}^m \frac{\tilde{l}_i}{k} \left[\hat{p}'_B + t - 2t \frac{\tilde{s}_i + \tilde{l}_i}{k} \right].
\end{aligned}$$

We compare the profits of Firm A in both cases in order to show that $\hat{\mathcal{P}}'$ induces higher profits:

$$\begin{aligned}
\Delta\pi_A &= \pi_A(\hat{\mathcal{P}}') - \pi_A(\hat{\mathcal{P}}) \\
&= \sum_{i=1, s_i \neq \tilde{s}_i}^n \hat{p}'_{Ai} \left[\frac{\hat{p}'_B + t}{4t} - \frac{s_i}{2} \right] - \sum_{i=1, s_i \neq \tilde{s}_i}^n \hat{p}_{Ai} \left[\frac{\hat{p}_B + t}{4t} - \frac{s_i}{2} \right] \\
&\quad + \sum_{i=1}^m \frac{\tilde{l}_i}{k} \left[\hat{p}'_B + t - 2t \frac{\tilde{s}_i + \tilde{l}_i}{k} \right] - \sum_{i=1}^m \hat{p}_{Ai}^B \left[\frac{\hat{p}_B + t}{4t} - \frac{\tilde{s}_i}{2} \right] - \hat{p}_{1s+l}^B \left[\frac{\hat{p}_B + t}{4t} - \frac{s+l}{2} \right] \\
&= \frac{t}{2} \sum_{i=1, s_i \neq \tilde{s}_i}^n \left[\frac{\hat{p}'_B + t}{2t} - s_i \right]^2 - \frac{t}{2} \sum_{i=1, s_i \neq \tilde{s}_i}^n \left[\frac{\hat{p}_B + t}{2t} - s_i \right]^2 \\
&\quad + \frac{t}{2} \sum_{i=1}^m \frac{\tilde{l}_i}{k} \left[2 \frac{\hat{p}'_B + t}{t} - 4 \frac{\tilde{s}_i + \tilde{l}_i}{k} \right] - \frac{t}{2} \sum_{i=1}^m \left[\frac{\hat{p}_B + t}{2t} - \frac{\tilde{s}_i}{2} \right]^2 - \frac{t}{2} \left[\frac{\hat{p}_B + t}{2t} - \frac{s+l}{k} \right]^2.
\end{aligned}$$

We consider the terms separately. First,

$$\begin{aligned}
& \frac{t}{2} \sum_{i=1, s_i \neq \tilde{s}_i}^n \left[\frac{\hat{p}'_B + t}{2t} - s_i \right]^2 - \frac{t}{2} \sum_{i=1, s_i \neq \tilde{s}_i}^n \left[\frac{\hat{p}_B + t}{2t} - s_i \right]^2 \\
&= \frac{t}{2} \sum_{i=1, s_i \neq \tilde{s}_i}^n \left[\left[\frac{2}{3(n-m)} \left[\frac{3}{4t} \hat{p}_B + \frac{m\hat{p}_B}{2t} + \frac{1}{4} - \frac{s+l}{2} \right] \right]^2 \right. \\
&\quad \left. + \left[\frac{\hat{p}_B + t}{2t} - s_i \right] \left[\frac{4}{3(n-m)} \left[\frac{3}{4t} \hat{p}_B + \frac{m\hat{p}_B}{2t} + \frac{1}{4} - \frac{s+l}{2} \right] \right] \right] \\
&\geq \frac{t}{2} \left[\frac{\hat{p}_B + t}{2t} - \frac{s+l}{k} \right] \frac{4}{3} \left[\frac{3}{4t} \hat{p}_B + \frac{m\hat{p}_B}{2t} + \frac{1}{4} - \frac{s+l}{2} \right].
\end{aligned}$$

Secondly, on segments of type B with partition $\hat{\mathcal{P}}$ that are of type A with partition $\hat{\mathcal{P}}'$:

$$\frac{t}{2} \sum_{i=1}^m \frac{\tilde{l}_i}{k} \left[2 \frac{\hat{p}'_B + t}{t} - 4 \frac{\tilde{s}_i + \tilde{l}_i}{k} \right] - \frac{t}{2} \sum_{i=1}^m \left[\frac{\hat{p}_B + t}{2t} - \frac{\tilde{s}_i}{2} \right]^2.$$

On these m segments, inequalities in Eq. 4 hold for price \hat{p}'_B but not for \hat{p}_B . Thus we can rank prices according to \tilde{s}_i and \tilde{l}_i :

$$\frac{\tilde{s}_i + \tilde{l}_i}{k} \geq \frac{\hat{p}_B + t}{2t} - \frac{\tilde{l}_i}{k} \quad \text{and} \quad \frac{\hat{p}'_B + t}{2t} - \frac{\tilde{l}_i}{k} \geq \frac{\tilde{s}_i + \tilde{l}_i}{k}.$$

thus:

$$2 \frac{\tilde{l}_i}{k} \geq \frac{\hat{p}_B + t}{2t} - \tilde{s}_i \quad \text{and} \quad \frac{\hat{p}'_B + t}{2t} - 2 \frac{\tilde{l}_i}{k} \geq \tilde{s}_i.$$

By replacing \tilde{s}_i by its upper bound value and then \tilde{l}_i by its lower bound value we obtain:

$$\frac{t}{2} \sum_{i=1}^m \frac{\tilde{l}_i}{k} \left[2 \frac{\hat{p}'_B + t}{t} - 4 \frac{\tilde{s}_i + \tilde{l}_i}{k} \right] - \frac{t}{2} \sum_{i=1}^m \left[\frac{\hat{p}_B + t}{2t} - \frac{\tilde{s}_i}{2} \right]^2 \geq 0.$$

Getting back to the profits difference, we obtain:

$$\begin{aligned}
\Delta \pi_A &\geq \frac{t}{2} \left[\frac{\hat{p}_B + t}{2t} - \frac{s+l}{k} \right] \frac{4}{3} \left[\frac{3}{4t} \hat{p}_B + \frac{m\hat{p}_B}{2t} + \frac{1}{4} - \frac{s+l}{2} \right] - \frac{t}{2} \left[\frac{\hat{p}_B + t}{2t} - \frac{s+l}{k} \right]^2 \\
&\geq \frac{t}{2} \left[\frac{\hat{p}_B + t}{2t} - \frac{s+l}{k} \right] \left[\frac{\hat{p}_B}{2t} + \frac{s+l}{3k} - \frac{1}{6} \right].
\end{aligned} \tag{7}$$

The first bracket of Equation 7 is positive given Eq. 4. The second bracket is positive if $\frac{\hat{p}_B}{2t} + \frac{s+l}{3k} \geq \frac{1}{6}$. A sufficient condition for this result to hold is $\hat{p}_B \geq \frac{t}{3}$. We prove that this inequality is always satisfied by showing that the partition that contains all segments minimizes the price and profit of Firm B, and that in this

case, $\hat{p}_B \geq \frac{t}{2}$.¹¹ And as this price is greater than $\frac{1}{6}$, the second bracket of Equation 7 is positive. This proves that $\Delta\pi_A \geq 0$.

This result allows us to establish that it is always more profitable for Firm A to use a partition with one segment of type B than to use a partition with several segments of type B.

Conclusion

These three steps prove that the optimal partition includes two intervals: Firm A first-degree price discriminates consumers on interval $[0, x_A]$, and charges a homogeneous price on the second interval located at $[x_A, 1]$. By symmetry, it is optimal for Firm B to target all consumers on interval $[1 - x_B, 1]$ and to charge a homogeneous price to consumers on $[0, 1 - x_B]$.

A.2 Proof of Proposition 2

We characterize the optimal targeting strategy of the firms in period 2. We first compute prices and demands in period 2 when firms target consumers strategically. Firm A chooses the value of x_A such that it price discriminates consumers on $[0, x_A]$, and charges consumers on $[x_A, 1]$ a homogeneous price. Similarly, Firm B price discriminates consumers on $[1 - x_B, 1]$, and charges a homogeneous price to consumers on $[0, 1 - x_B]$. The choices of x_A and x_B correspond to the targeting strategies of Firm A and Firm B. We will provide prices and profits in period 2, and we will characterize x_A and x_B .

Prices and demand.

Firm 1 sets a price $p_{12}(x)$ for consumers located at $[0, x_1]$. Similarly, Firm B sets a price $p_{22}(x)$ for consumers located at $[1 - x_B, 1]$. Firm θ then sets a unique price $p_{\theta 2}$ on the rest of the unit line. The price charged to targeted consumers by Firm A satisfies:

$$\begin{aligned} V - tx - p_{A2}(x) &= V - t(1 - x) - p_{B2} \\ \implies x &= \frac{p_{B2} - p_{A2}(x) + t}{2t} \\ \implies p_{A2}(x) &= p_{B2} + t - 2tx. \end{aligned}$$

Firm B charges homogeneous price p_{B2} on interval $[0, 1 - x_B]$, and charges targeted prices on $[1 - x_B, 1]$:

$$p_{B2}(x) = p_{A2} + t - 2tx.$$

Let denote d_{A2} the demand for Firm A (resp. d_{B2} the demand for Firm B) where firms compete. d_{A2} is determined by the indifferent consumer \tilde{x}_2 :

¹¹As shown in Liu and Serfes (2004).

$$V - t\tilde{x}_2 - p_{A2} = V - t(1 - \tilde{x}_2) - p_{B2} \implies \tilde{x}_2 = \frac{p_{B2} - p_{A2} + t}{2t} \text{ and } d_{A2} = \tilde{x}_2 - x_A = \frac{p_{B2} - p_{A2} + t}{2t} - x_A \text{ (resp. } d_{B2} = 1 - x_B - \frac{p_{B2} - p_{A2} + t}{2t}\text{)}.$$

Profits of the firms.

The profits of the firms are:

$$\begin{aligned} \pi_{A2} &= \int_0^{x_A} p_{A2}(x)dx + d_{A2}p_{A2} = \int_0^{x_A} (p_{B2} + t - 2tx)dx + \left(\frac{p_{B2} - p_{A2} + t}{2t} - x_A\right)p_{A2}, \\ \pi_{B2} &= \int_{1-x_2}^1 d_{2i}p_{2i2} + d_{B2}p_{B2} = \int_{x_B}^1 (p_{A2} + t - 2tx)dx + \left(\frac{p_{A2} - p_{B2} + t}{2t} - x_B\right)p_{B2}. \end{aligned}$$

Prices and demands in equilibrium.

We now compute the optimal prices and demands, using first-order conditions on π_θ with respect to p_θ . Prices in equilibrium are:

$$\begin{aligned} p_{A2} &= t\left[1 - \frac{2}{3}x_B - \frac{4}{3}x_A\right], \\ p_{B2} &= t\left[1 - \frac{2}{3}x_A - \frac{4}{3}x_B\right]. \end{aligned}$$

We rule out negative prices from the analysis: $p_{\theta 2}$ is taken equal to zero in case its above expression is negative.

Replacing these values in the above demands and prices gives:

$$\begin{aligned} p_{A2}(x) &= 2t - \frac{4t}{3}x_B - \frac{2t}{3}x_A - 2tx, \\ p_{B2}(x) &= 2t - \frac{4t}{3}x_A - \frac{2t}{3}x_B - 2tx \end{aligned}$$

Demands in equilibrium are as follows:

$$\begin{aligned} d_{A2} &= \frac{1}{2} - \frac{2}{3}x_A - \frac{1}{3}x_B, \\ d_{B2} &= \frac{4}{3}x_B - \frac{1}{2} - \frac{1}{3}x_A. \end{aligned}$$

Profits in equilibrium.

We compute profits by replacing prices and demands by their equilibrium values:

$$\pi_{\theta 2} = \frac{t}{2} - \frac{7}{9}x_\theta^2t + \frac{2}{9}x_{-\theta}^2t - \frac{4}{9}x_\theta x_{-\theta}t + \frac{2}{3}x_\theta t - \frac{2}{3}x_{-\theta}t.$$

Profits are strictly concave functions with respect to x_A and x_B , and they have a unique maximum.

Optimal targeting strategies: unconstrained.

We derive the optimal targeting strategies x_A^* and x_B^* of Firm A and Firm B. The targeting strategies x_A^* and x_B^* are chosen as simultaneous best responses. We apply first-order condition on π_{A2} with respect to x_A and to π_{B2} with respect to x_B , and we find:

$$x_A^* = x_B^* = \frac{1}{3}.$$

As $p_{A2}^* = p_{B2}$, the indifferent consumer in period 2 is located at $\tilde{x}_2 = \frac{1}{2}$. By replacing x_A^* and x_B^* into π_{A2} and π_{B2} we obtain:

$$\pi_{\theta 2}^* = \frac{7t}{18}.$$

Optimal targeting strategies: constrained.

We derive the optimal targeting strategy x_B^* of Firm B when Firm A is constrained and $x_A^* = \tilde{x}_1$.

x_B^* is chosen as a best response to $x_A^* = \tilde{x}_1$. The profits of the firms are the following:

$$\pi_{A2} = \frac{t}{2} - \frac{7}{9}\tilde{x}_1^2 t + \frac{2}{9}x_B^2 t - \frac{4}{9}\tilde{x}_1 x_B t + \frac{2}{3}\tilde{x}_1 t - \frac{2}{3}x_B t.$$

$$\pi_{B2} = \frac{t}{2} - \frac{7}{9}x_B^2 t + \frac{2}{9}\tilde{x}_1^2 t - \frac{4}{9}x_B \tilde{x}_1 t + \frac{2}{3}x_B t - \frac{2}{3}\tilde{x}_1 t.$$

We apply first-order conditions on π_{B2} with respect to x_B :

$$x_B^* = \frac{3}{7} - \frac{2\tilde{x}_1}{7}.$$

Replacing x_A^* and x_B^* into p_{A2}^* and p_{B2}^* , we find that the indifferent consumer in period 2 is located at $\tilde{x}_2 = \frac{6\tilde{x}_1 + 5}{14}$.

By replacing x_A^* and x_B^* by their expressions into π_{A2} and π_{B2} we obtain:

$$\pi_{A2}^* = \frac{25t}{98} + \frac{30t}{49}\tilde{x}_1 - \frac{31t}{49}\tilde{x}_1^2,$$

$$\pi_{B2}^* = \frac{9t}{14} - \frac{6t}{7}\tilde{x}_1 + \frac{2t}{7}\tilde{x}_1^2.$$

A.3 Proof of Proposition 3

We show that profits in the symmetric equilibrium are always higher than profits in the constrained equilibrium when Firm B undercuts prices.

We focus on the case where $\delta = 1$, and asymmetric equilibria are the most profitable.

Profits in the symmetric equilibrium are equal to $\frac{7t}{18}$ in period 2 and $\frac{t}{2}$ in period 1 and overall to $\frac{7t}{18} + \frac{t}{2} = \frac{8t}{9}$.

The maximal profit in period 2 in the constrained equilibrium is reached when $\tilde{x}_1 = 0$ (when Firm A is constrained) and is equal to $\frac{9t}{14}$.

For Firm B to constrain Firm A in period 1, it must be the case that $\tilde{x}_1 \leq \frac{1}{3}$. Let us consider the least constraining case where $\tilde{x}_1 = \frac{1}{3}$, which leads to the highest profits of Firm B among the set of constraining equilibrium in period 1.

Necessarily, it is easy to show that Firm B must charge $p_{B1} = \frac{t}{3}$, yielding profits in period 1 equal to $\frac{t}{9}$.

Thus the sum of profits over both periods in the constraining equilibrium is equal to $\frac{95t}{126} < \frac{8t}{9}$, and profits are higher in the symmetric equilibrium.

A.4 Proof of Proposition 4

we show that the profits of the firms are greater, and consumer surplus lower in our model with strategic targeting than when firms target all consumers, as in the model of [Choe et al. \(2018\)](#). We cannot directly compare the values of profits and surplus between both models, as they consider a Hotelling competition framework with quadratic transportation costs while we consider linear transportation costs.

Hence we compare profits in both models with those in the standard Hotelling competition framework without information. In our model, profits in period 1 are those in the standard Hotelling model, while profits in period 1 in the model of [Choe et al. \(2018\)](#) are lower than in Hotelling.

Moreover, the profits of the firms are also lower in the targeting period as firms target more consumers in the model of [Choe et al. \(2018\)](#) than with strategic targeting. The resulting consumer surplus is lower with strategic targeting.

A.5 Proof of Proposition 5

Our model is directly comparable with market outcomes in [Bounie et al. \(2021\)](#), in which the data broker sells information to Firm A only, who can identify $x_{DB} = \frac{3}{7}$ consumers on $[0, \frac{3}{7}]$. Moreover, Firm B makes profits equal to $\frac{25t}{98}$ and Firm A makes profits equal to $\frac{9t}{14}$.

In our model with first-party data, profits in the second stage are equal to $\pi_{\theta 2}^* = \frac{7t}{18} < \frac{9t}{14}$.

Moreover, consumer surplus is greater with first-party data where both firms target consumers and compete on a level playing field, and the total share of targeted consumers is equal to $\frac{2}{3} > \frac{3}{7}$.

A.6 Proof of Proposition 6

We compare the utility of a consumer located at $x \in [0, \frac{1}{3}]$ when purchasing its preferred product with its utility from purchasing Firm B's product in period 1 and paying the homogeneous price in period 2.

The utility when purchasing from Firm A is $u_1(x) = V - tx - t$ in period 1 and $u_2(x) = V - tx - \frac{4t}{3} + 2tx$ in period 2.

The utility when purchasing from Firm B in period 1 is $u_{1B}(x) = V - t(2 - x)$ and $u_{2A}(x) = V - tx - \frac{t}{3}$ when paying the homogeneous price in period 2.

For all $\delta_c \leq 1$, $u_1(x) + \delta_c u_2(x) \geq u_{1B}(x) + \delta_c u_{2A}(x)$ and consumers do not hide.