Competition Under Informational Head Starts

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-PRELIMINARY AND INCOMPLETE-

This model analyses the effects of informational asymmetries on competition and market structure. In a simple Hotelling framework, it examines how a former monopolist can use information gathered about consumers as a competitive tool. The incumbent holds an informational advantage over a potential entrant and is able to set behaviour-based prices.

It demonstrates that informational head-starts affect market structure and repercussions on entry can arise. A monopolistic firm may strategically gather more information by setting low prices in order to deter entry and secure its position in the future. If such informational advantages are not sufficient to keep other firms out of the market, prices are instead used as a commitment device: the incumbent sets high prices in order to learn about fewer consumers and signal to the entrant that she will not behave aggressively. This weakens price competition and allows both firms to earn higher profits.

Different policy could be adopted to promote welfare in such a setting. I show under what conditions a ban of price discrimination increases welfare. Motivated by antitrust policies, I investigate the effect of an information sharing requirement where the incumbent has to share its private information. If not anticipated this policy promotes entry and increases welfare.

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1. Introduction

The rise of online commerce has dramatically expanded firms' ability to track and store consumers' purchase behaviour, yielding increasingly precise information about preferences. Firms can deploy this information to personalise prices and, when access is asymmetric, to create competitive advantages. More informed firms can make targeted offers to consumers who purchase from a rival, with repercussions for market shares, entry, and welfare.

Informational head starts are therefore a central concern for competition policy. In many digital markets, access to consumer data is heavily skewed toward towards some big players (Newman, 2014; Englehardt and Narayanan, 2016). Building customer databases is itself a dimension of competition: by interacting with more consumers today—potentially via lower prices—an incumbent can learn more, establish an informational lead, and entrench future dominance.

Policy makers have voiced similar concerns. In a speech a former Vice President of the European Commission responsible for Competition Policy- pointed out that *"a company [...] that would have exclusive access to personal data in a given market could give rise to concentration concerns"* (Alumina, 2012). Concrete antitrust cases have also emerged. In the French gas market, ENGIE—formerly the regulated monopoly—used its subscriber database to target switching consumers after liberalisation; the French Competition Authority fined ENGIE for abuse of dominance and required information sharing with competitors. More recently, the European Commission opened an investigation into whether Facebook leverages advertising data from competing firms to advantage Facebook Marketplace. These cases differ in details, but share a theme: data advantages can distort competitive dynamics.(Autorité de la concurrence, 2017a,b).

More recently, the European Commission found an abuse of dominance regarding Facebook Marketplace and, on 14 November 2024, fined Meta €797.72 million for tying Marketplace to Facebook and for unfair conditions toward rival classifieds services; Meta has said it will appeal while complying (European Commission, 2024). The case speaks directly to informational advantage: by operating both the social network and a competing marketplace, Meta could cross-use advertising and user interaction data gathered from rivals that depend on Facebook for distribution, reinforcing its informational lead over them. By contrast, in the UK the CMA accepted commitments that let advertisers who compete with Marketplace opt out of such data use (Competition and Markets Authority, 2023). The underlying theme is the same: when a dominant platform is both supplier and competitor, privileged access to (and cross-use of) data can skew competition.

As highlighted by these examples and a plethora of policy papers on the topic (Schweitzer and Welker, 2019; Scott Morton et al., 2019), the issue has been recognized by policymakers in the past. This paper develops a framework for these questions in a two-period Hotelling model. The incumbent is a monopolist in period 1 and learns the locations of the consumers it serves. In period 2, a potential entrant may enter by paying a fixed cost. The incumbent then sets behaviour-based prices for its previously served consumers and a uniform price for others, while the entrant—lacking consumer-specific information—sets a uniform price. Consumers are non-strategic with respect to future prices, and the discount factor is one. This non-strategic assumption fits environments where firms meet new consumers each period, yet the incumbent can infer willingness to pay from observable characteristics correlated with those of its past customers.

Two sets of results follow. First, informational head starts can be a bottleneck to entry. When fixed entry costs are sufficiently high, the incumbent has incentives to set lower prices in period 1 to learn about more consumers and thereby deter entry in period 2. When fixed costs are low enough that entry must be accommodated, incentives flip: the incumbent prefers to serve fewer consumers in period 1, using a higher initial price as a commitment device to limit the scope for later discrimination, soften period-2 price competition, and raise joint profits. Thus, being first can enable either aggressive data accumulation (to exclude) or self-imposed restraint (to collude tacitly on softer competition), depending on entry costs. Since there are potential repercussion on entry and welfare, it is natural to ask what effect of policy interventions would be. I study a ban on behaviour-based pricing and an information-sharing requirement that compels the incumbent to share consumer information with entrants. A ban can raise welfare, but when anticipated, the effects depend on whether entry is blockaded, deterred or accommodated absent the ban. Similarly, when not anticipated, an information sharing requirement promotes entry and is welfare enhancing, but when anticipated, the incumbent may react to still deter entry.

The remainder of this paper is structured as follows: In Section 2 I give a brief overview of the literature related to my thesis. Section 3 introduces the model. Results of the model are presented in Section 4and Section 5 provides an analysis of different potential policies that could be adopted. I conclude with a brief summary of my findings and an outlook for future work in Section 6.

2. Literature Review

In this paper, I build upon the work of Thisse and Vives (1988). They show that in a Hotelling model, in which two firms first decide between price discriminating against all consumers or setting uniform prices and then compete accordingly, price discrimination is a dominant strategy. Profits are lower than under uniform prices, so the authors show that price discrimination is a prisoners dilemma. While my analysis will follow their model structure, it is different in some important respects. Instead of a binary specification where either there is price discrimination against all or no consumer, the model I suggest makes this variable continuous. The mass of consumers the incumbent sets discriminatory prices for, is determined endogenously through first-period pricing. Thus the ability to price discriminate may be costly in terms of foregone profits in period 1. In a similar vein Choe et al. (2018) consider a model of dynamic competition where two competing firms learn about customers they served in the past and can price discriminate accordingly in the future. However, both models consider a setup where firms have a symmetric ability to gather information on consumers. In contrast, I consider a model of an incumbent that faces potential entry by an uninformed competitor. This allows me to study strategic effects such as entry deterrence as well as using first period prices as a commitment device to behave less aggressively when entry cannot be prevented.

Armstrong (2006) and Stole (2007) give a concise overview of the literature on price discrimination. Some papers have previously considered the effects of price discrimination on competition and entry. Corts (1998) discusses the effects of third-degree price discrimination in a model of elastic demand. Armstrong and Vickers (1993) consider a model of two markets, one of them captive to the incumbent. They show that entry may be hindered if the incumbents is allowed to charge different prices in both markets. My model is different in two important respects. I consider first-degree price discrimination instead of third-degree price discrimination. While this is extreme, it is important to understand the dynamics of this benchmark. Today some firms may have a very good understanding of consumers preferences. More importantly in my model, the ability to price discriminate arises endogenously: the incumbent will be able to price discriminate only against those consumers she has served in the past.

This issue of behaviour-based price discrimination has been vastly discussed in the literature in the case of monopoly as well as duopoly (Fudenberg and Tirole, 2000; Acquisti and Varian, 2005). A concise survey of this literature is provided by Fudenberg and Villas-Boas (2006). The literature on oligopolies documents the potential of consumer poaching: Competitors may charge lower prices to those who bought from rivals in order to win them over. This literature, however, does not consider the effects of an asymmetric ability of one firm to price discriminate on market structure.

This paper also ties in more broadly with a growing literature on information, privacy and data markets. This strand of the literature focuses on the sale and purchase of information through markets (Bergemann et al., 2018, 2019). Bonatti and Cisternas (2020) provide a model where consumers' purchase history is aggregated into scores and provides uncertain signals of their preferences to firms. In this model, I abstract from the possibility of data intermediation, since I am interested in understandings the effects of asymmetric access to such data. Nageeb Ali et al. (2021) instead, analyse a model of voluntary disclosure by consumers: They consider a setup in which consumer preferences are private information, but consumers can send firm-specific signals about their preferences in both competitive and non-competitive settings. Allowing for such signalling in my model might be an interesting extension to understand consumer incentives better.

In short, this paper contributes to a growing literature on the importance of data. I focus on the effects that informational head-starts can have on market structure through behaviour-based price discrimination.

3. Model

The situation will be analysed through a two-period Hotelling model. The structure of the game will be as follows: in period one the incumbent is a monopolist in the market and sets prices accordingly. She serves the subset of consumers willing to purchase at those prices. In the second period, another firm has the possibility to enter into the market at a fixed cost F. Then all active firms set prices and the market equilibrium realises. Throughout the analysis, it will be assumed that both firms have the same marginal cost of production c. For convenience, this marginal cost will be normalised to 0.

Consumers are uniformly distributed across the unit interval. They have inelastic unit demand and purchase the good whenever the payoff of purchasing is weakly greater than 0. The utility function of a consumer located at $x \in [0,1]$ is given by:

$$1 - p_{i,\tau}(x) - td_i(x) \tag{1}$$

where the consumers' valuation is normalised to 1- $p_{i,\tau}(x)$ is the price charged by firm i in period τ to a consumer located at x. The distance of a consumer located at x to firm i is denoted by $d_i(x)$ and t are the transport costs. Transports costs are assumed to be linear in the distance to the firm consumers purchase from. In this model, I will assume that the location of both firms is fixed. They will be located at the extreme points of the unit interval. The incumbent I will be located at 0 while the entrant E can only locate at 1. All of the former is commonly known by both firms.

As an equilibrium concept, I will rely on subgame perfection. Thus the game will be analysed backwards. However, for an easier exposition of the game structure, I will start by describing the game chronologically.

In the first period, consumers will purchase from the incumbent whenever

$$1 - p_1 - tx \geq 0 \tag{2}$$

where the firm subscript is omitted since I is the only price-setting firm in period 1. Thus the incumbent serves consumers up to $\tilde{x}$, where:

$$\tilde{x} = \min\left\{\frac{1-p_1}{t}, 1\right\} \tag{3}$$

Since the incumbent is supplying the product to all consumers in $[0, \tilde{x}]$ it will learn their location and hence in the future will be able to price discriminate against them. She can of course not price discriminate against specific consumers in $[\tilde{x}, 1]$ since she has not served those in the past. However the fact that they did not purchase in the first period provides some knowledge about their location. Now in order to make the analysis more tractable, I will assume that this ability to price-discriminate is not anticipated by consumers.

Assumption 1 *Consumers are non-strategic: When making their purchase decisions in period 1, they don't take the effect on future prices into account.*

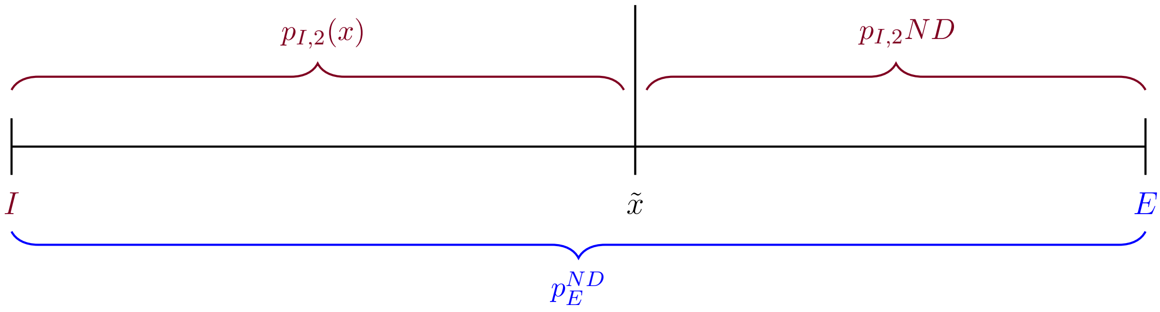

Figure 1: Prices charged to different consumers

This assumption can be interpreted as follows: Each period new arrive, yet the incumbent can infer willingness to pay from observable characteristics that are correlated with those of its past customers. Consumers therefore do not shade first-period demand to avoid future targeting, while in period 2 the incumbent leverages these observables to tailor prices to its previously served consumers.

In addition, I will impose the following assumption:

Assumption 2 *Throughout the analysis, it is assumed that* $t \leq 1$.

This assumption imposes that the potential market area of a firm is the entire market: At prices equal to marginal costs all consumers would find it optimal to buy from a monopolistic seller even if located at an extremal point. This assumption also ensures that the market under competition is fully covered.

In the second period, the entrant has the possibility to enter into the market at some fixed cost F. It knows the general distribution of consumers, how many consumers were served in $\tau = 1$ and thus also how many consumers will receive personalized offers from the incumbent. Since the entrant has not previously interacted with consumers, it will charge the same price $p_{E,2}$ to all consumers upon entry. The incumbent on the other hand will set two types of prices: It will set discriminatory prices $p_{I,2}(x)$ to those consumers it previously served and non-discriminatory prices $p_{I,2}^{ND}$ to the remaining ones. Figure 1 illustrates what prices are charged to different consumers in the second period. As pointed out by Thisse and Vives (1988) if discriminatory and non-discriminatory prices are set simultaneously in the second period, a pure strategy Nash equilibrium may not exist. In order to make the analysis tractable, I will follow their timing assumption on price setting that has become standard in the literature (Choe et al., 2018; Choudhary et al., 2005; Garella et al., 2021): First, both firms simultaneously set non-discriminatory prices. Thus the incumbent announces a uniform price to those consumers in $[\tilde{x}, 1]$ and the entrant announces a price to all consumers. Then upon observing the entrant's price the incumbent announces her discriminatory prices to those consumers in $[0, \tilde{x}]$.[1] This assumption is reasonable since list prices are often set at a managerial level and changed less frequently. Personalized discounts on the set list prices are then offered to certain consumers. Those can change very frequently.

To summarize the structure of the game will be as follows: In the first period the incumbent acts as a monopolist and sets prices. In the second period, the entrant first makes her entry decision. Afterwards, both firms set non-discriminatory prices. Then the incumbent announces individual prices to those consumers she has served in the first period.

Now in order to keep the analysis more tractable, I will assume that the incumbent does not discount profits in the second period when setting prices in the first period.

Assumption 3 *The discount factor* δ *is* 1*.*

4. Results

Having introduced the general structure of the model, I will now turn to a discussion of the results. First I discuss the case of *accommodated* entry, so when entry occurs will be discussed. Having established this, I will next turn to the cases of *blockaded* and *deterred* entry. *Blockaded* entry is understood as the case where the incumbent prices optimally as a two-period monopolist and this suffices to hinder entry. Entry is *deterred* if the incumbent prices suboptimally in $\tau = 1$ in order to hinder entry in the second period. If the incumbent is unable to deter entry profitably, it will be accommodated. Throughout the analysis I will solve by backward induction.

4.1. Accommodated Entry

I now turn to the case where the entry occurs in the second period. The last move in this period is the discriminatory price setting of the incumbent to consumers in $[0, \tilde{x}]$. Whenever possible the incumbent will match the delivered price of the entrant.[2] This

[1] As pointed out by Aguirre et al. (2001) reversing this assumption and letting discriminatory prices be set first, affects the findings by Thisse and Vives (1988).Instead of price discrimination by both firms being the unique equilibrium, they establish multiplicity of equilibria. Thus, I cannot rule out that the subsequent analysis is also sensitive towards this assumption.

[2] For tractability I assume that ties are broken in favour of the incumbent. The analysis would work equally when assuming that the incumbent undercuts the entrants delivered prices by ϵ.

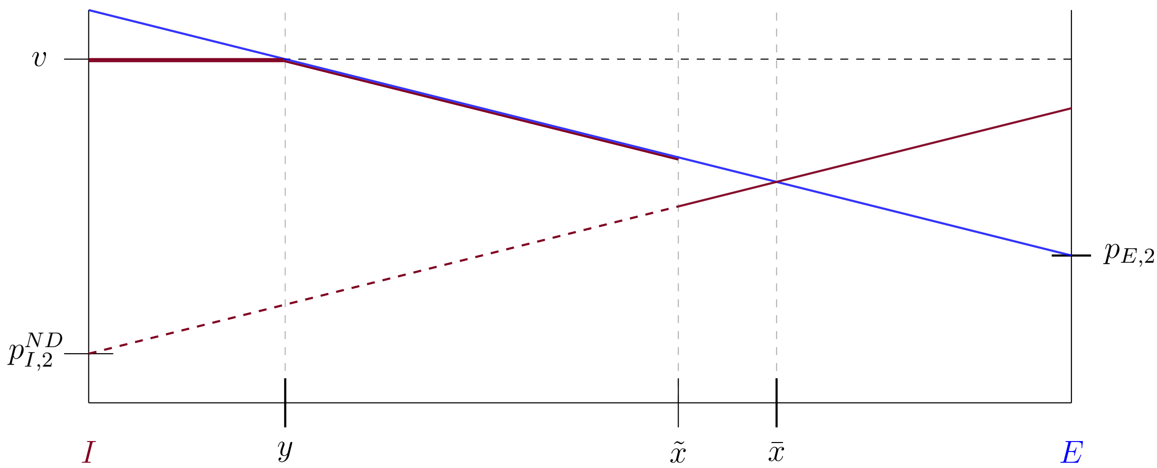

Figure 2: Example of Delivered Price Schedule

price is given by the price charged at the entrant's location $p_{E,2}$ plus the transport cost $(1-x)t$. Consumers incur a transport cost tx when purchasing from the incumbent. Thus I matches the entrant's delivered prices by charging $p_E+(1-x)t-tx$. Whenever this price exceeds the consumer valuation, the incumbent sets a price that extracts all surplus from consumers. The discriminatory price schedule of the incumbent is therefore given by:

$$p_{I,2}(x) = min\{1-tx, p_{E,2}+(1-x)t-tx\} \tag{4}$$

Next, I derive optimal uniform prices set by the two competitors. There are two potential indifference conditions that could determine the market areas. The consumer located at $\bar{x} = \frac{p_{E,2}-p_{I,2}^{ND}+t}{2t}$ is indifferent between purchasing from the incumbent at its uniform price and buying from the entrant. Now if the indifferent consumer is located to the right of $\tilde{x}$ then all consumers in $[0,\bar{x}]$ purchase from the incumbent. Otherwise the market boundary is given by the consumer indifferent between minimal discriminatory prices $p_{I,2}(x)=0$ and the entrant's uniform price $\hat{x} = \frac{p_{E,2}+t}{2t}$. If $\tilde{x} > \hat{x}$ those consumers in $[0,\hat{x}]$ purchase from the incumbent. The remaining consumers purchase from the entrant. Therefore the profit function of the entrant is given by:

$$\pi_E = \left(1 - \mathbb{1}_{\{\tilde{x}<\hat{x}\}}\bar{x} - \mathbb{1}_{\{\tilde{x}\geq\hat{x}\}}\hat{x}\right) p_{E,2} - F \tag{5}$$

In order to understand the profit function of the incumbent better, it is useful to understand the different delivered prices through Figure 2. The entrant sets uniform prices for all consumers. Thus delivered prices displayed in blue increase linearly in the distance to the entrant. Potentially the incumbent cannot sell to all consumers by matching the entrant's price if such a price exceeds their valuation. As delivered prices are increasing in distance, this must be true for consumers in a connected interval $[0, y]$. The flat part of the red line represents such consumers. Now to consumers located in $[y, \tilde{x}]$ the incumbent charges a delivered price that matches the entrant's delivered price. To consumers located in $[\tilde{x}, 1]$ she charges a uniform price $p_{I,2}^{ND}$.

The incumbents profit function is given by the following expression:

$$\pi_{I,2}^{A} = \int_{0}^{y} 1 - txdx + \int_{y}^{\min\{\hat{x},\tilde{x}\}} p_{E,2} + t - 2txdx + \mathbb{1}_{\{\tilde{x}<\hat{x}\}} \left(\bar{x} - \tilde{x}\right) p_{I,2}^{ND} \qquad (6)$$

where y is the last consumer s.t. the incumbent charges discriminatory delivered prices equal to the consumers valuation.[3] If consumers' valuation is high enough then for prices matching the entrant's delivered price all consumers are willing to buy and $y = 0$. In addition we must always have that $y \leq \tilde{x}$ since she can only prices discriminate against consumers in $[0, \tilde{x}]$. Otherwise the first consumer the incumbent sets matching delivered prices for is located at the point where both discriminatory prices are equal. Now optimal prices in the second period will be given by:

$$p_{I,2}^{*ND} \begin{cases} = (1 - \frac{4}{3}\tilde{x})t & \text{if } \tilde{x} \leq \frac{3}{4} \\ \geq 0 & \text{otherwise} \end{cases} \qquad p_{E,2}^{*} = \begin{cases} (1 - \frac{2}{3}\tilde{x})t & \text{if } \tilde{x} \leq \frac{3}{4} \\ \frac{t}{2} & \text{otherwise} \end{cases} \qquad (7)$$

(For a derivation of optimal prices refer to Appendix B.2.)

Notice that technically for $\tilde{x} > \frac{3}{4}$, any pricing schedule of the incumbent such that $p_{I}^{2,ND} \geq 0$ and no one in $[\tilde{x}, 1]$ buys from the incumbent is an equilibrium. Since this multiplicity does not change the results, I will focus on the equilibrium in which $p_{I}^{2,ND} = 0$.

From these price schedules, it is already apparent that uniform prices depend negatively on $\tilde{x}$. To put it differently, if the incumbent can price-discriminate against more consumers this intensifies price competition in the non-discriminatory segment. The entrant has to price more aggressively in order to capture at least some part of the market. Therefore the effects of increasing $\tilde{x}$ on the entrant's profits are clear. As

[3]For an exact expression of y refer to Appendix B.2

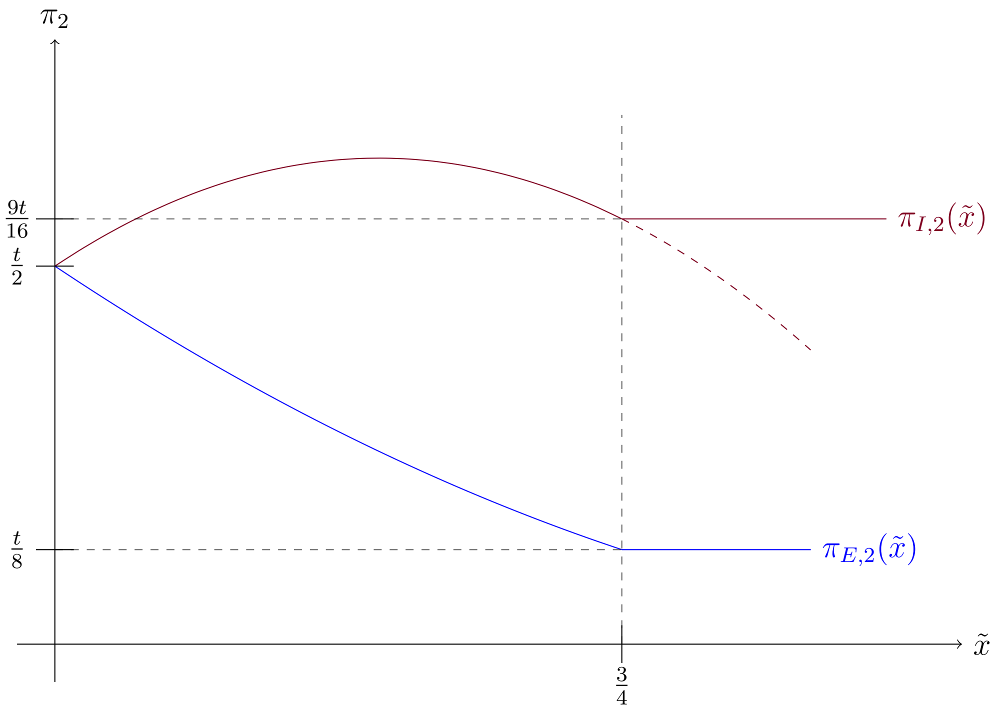

Figure 3: Second period profits as a function of $\tilde{x}$ for $F = 0$

illustrated in Figure 3 the entrant's profits are decreasing in $\tilde{x}$. However the entrant will always be able to serve consumers in $[\frac{3}{4}, 1]$ and secure a minimal profit level of $\frac{t}{8}$. This corresponds to the case where the indifferent consumer is determined through $\hat{x}$ and coincides with findings of Thisse and Vives (1988) full price discrimination.

For the incumbent's profits, the dynamics are less obvious. When entry must be accommodated the incumbent faces a trade-off. Being able to price-discriminate against more consumers allows her to sell larger quantities. However, if $\tilde{x}$ is high the entrant sets lower prices in order to serve at least some consumers. This in turn lowers the prices the incumbent can charge to consumers in its discriminatory turf. As visible from Figure 2 the incumbent does not find it optimal to price- discriminate against as many consumers as possible. Instead from the perspective of second-period profits an intermediate value of $\tilde{x}$ is optimal.

In the first period, the incumbent maximizes total profits. As discussed in the following proposition this trade-off induces the incumbent to charge higher prices in period 1 than would be optimal in terms of first period profits.

Proposition 1 (Accommodated Entry) *For $t \in [0, \frac{5}{6})$ the incumbent serves strictly less consumers than would be optimal from the perspective of first period*

profits: $p^A_{I,1} > p_M$
Prices will be given by:

$$p^A_1 = \begin{cases} 1-t & \textit{if } t \leq \frac{1}{2} \\ \frac{1}{2} & \textit{if } t \in (\frac{1}{2}, \frac{52-3\sqrt{6}}{75}] \\ \frac{23}{32} - \frac{3}{16}t & \textit{if } t \in [\frac{52-3\sqrt{6}}{75}, \frac{19}{30}] \\ \frac{11}{12} - \frac{1}{2}t & \textit{if } t \in [\frac{19}{30}, 1] \end{cases} \tag{8}$$

Proof. Appendix B. ■
Thus the incumbent uses first period prices as a costly commitment device: In order to lessen competition in the second period, she forgoes part of her profits in $\tau = 1$. This signals to the entrant that the incumbent will not poach as many consumers located closer to the entrant in period 2 and triggers a less aggressive pricing response by the entrant. Both firms can charge higher prices and earn higher profits.

This partially qualifies the findings by Thisse and Vives (1988). Price discrimination is not a dominant strategy: The incumbent only prefers to price discriminate against consumers which are close to her, but commits to not price discriminate against those further away. It is also in contrast to the findings of Liu and Serfes (2004). They analyse a model of third-degree price discrimination and find that when only one firm is informed this firm's profits are increasing in the consumer segments that can be distinguished after a certain threshold. The main difference in the model at hand is that here the firm can decide to only price discriminate against the consumers most valuable to her instead of learning about all consumers equally as in Liu and Serfes (2004).

4.2. Blockaded Entry

In order to understand when entry is blockaded it is necessary to analyse the behaviour of a two period monopolist. In the second period the monopolist optimizes the following profit function:

$$\pi^M_{I,2}(p_{I,2}(x), p^{ND}_I) = \int_0^{\tilde{x}} \max\{1 - tx, 0\}dx + (\bar{x} - \tilde{x})p^{ND}_2 \tag{9}$$

The integral corresponds to those consumers served in the first period that the incumbent can now price-discriminate against. Due to the assumption that $v \geq t$ it follows that she sets a price of $p_{I,2}(x) = v - tx$ to all those consumers. The second term of the profit function stems from those consumers served at non-discriminatory prices. Similarly to the first period, the consumer indifferent between purchasing and not purchasing is located at:

$$\bar{x} = \min\left\{\frac{1 - p_2^{ND}}{t}, 1\right\} \tag{10}$$

Profit maximization gives us the following expression of optimal second period prices as a function of $\tilde{x}$:

$$p_{I,2}^{ND} = \begin{cases} \frac{1-t\tilde{x}}{2} & \text{if } t(2 - \tilde{x} \geq 1) \\ 1 - t & \text{otherwise} \end{cases} \tag{11}$$

(For derivations of this result refer to Appendix A.1.)
Non-discriminatory prices in the second period are decreasing in $\tilde{x}$. Higher values of $\tilde{x}$ indicate that more consumers bought in the first period and consumers who did not purchase are located further away from the incumbent. Since they face higher transport costs when purchasing, they are only willing to buy at lower prices. Second-period profits depend positively on $\tilde{x}$ in a monopolistic model: For all consumers whose location is known, the monopolist can extract all surplus. Now $\tilde{x}$ is determined through prices set in the first period. At lower first period prices more consumers will buy and reveal their preferences. When setting prices in the first period the incumbent maximizes total profits taking the effects of p_1 on second-period profits into account:

$$\pi^M = \begin{cases} \left(\frac{1-p_1}{t}\right) p_1 + \int_0^{\frac{1-p_1}{t}} (1 - tx)\, dx + \left(\frac{p_1}{2t}\right) \frac{p_1}{2} & \text{if } 1 \leq t + \frac{p_1}{2} \\ \left(\frac{1-p_1}{t}\right) p_1 + \int_0^{\frac{1-p_1}{t}} (1 - tx)\, dx + \left(1 - \frac{1-p_1}{t}\right)(1 - t) & \text{otherwise} \end{cases} \tag{12}$$

where the first term gives profits in period one. The profit function is split into two cases since price-setting in the second period depends on the parameter specifications. This translates into two cases for total profits as a function of first period prices. Optimizing this function and using the expression derived before for second-period prices gives the following:

$$p_1 = \begin{cases} \frac{2}{5} & \text{if } t \geq \frac{4}{5} \\ \frac{2-t}{3} & \text{if } t \in (\frac{1}{2}, \frac{4}{5}) \\ 1-t & \text{otherwise} \end{cases} \qquad p_2 = \begin{cases} \frac{1}{5} & \text{if } t \geq \frac{4}{5} \\ 1-t & \text{if } t \in (\frac{1}{2}, \frac{4}{5}) \\ NA & \text{otherwise} \end{cases} \tag{13}$$

(For derivations of this result refer Appendix A.2.)
So if $v < \frac{5}{4}t$ only a subset of consumers is served in both periods. When $v \in [\frac{5}{4}t, 2t]$ only a subset purchases in the first, but everyone buys in the second period. Otherwise the entire market is covered in both periods. Whenever $v < 2t$ it is not optimal to serve all consumers from a perspective of first period profits. In this case the monopolist faces a trade-off: Serving more consumers reduces profits today but allows full surplus extraction tomorrow. The next proposition establishes how the monopolists resolve this trade-off under the maintained assumption that $\delta = 1$.

Proposition 2 (Monopoly pricing) *For any admissible value of v in a two-period monopoly, the incumbent serves weakly more consumers than in a one-period monopoly.*

Proof. In order to establish this I will show that first period prices in a two-period monopoly are weakly lower than prices in a one-period monopoly: $p_{I,1}^M \leq p_M$. In a one period monopoly the optimal prices are given by (Derivations in Appendix A.3):

$$p_M = \begin{cases} \frac{1}{2} & \text{if } t \leq \frac{1}{2} \\ 1-t & \text{otherwise} \end{cases}$$

Now if $t \leq \frac{1}{2}$ the monopolist sets the same first period price in both cases and serves all consumers in $\tau = 1$. If $t \in [\frac{4}{5}, 1]$ clearly $p_{I,1} = \frac{2}{5} < \frac{1}{2} = p_M$. Whenever $t \in (\frac{1}{2}, \frac{5}{4})$, we have that:

$$\frac{2-t}{3} < \frac{1}{2} \iff \frac{1}{6} < \frac{t}{3} \iff 1 < 2t \iff p_{I,1} < p_M \tag{14}$$

This establishes that the monopolist sets weakly lower prices in a two-period monopoly and thus serves weakly more consumers in period 1. ■

The intuition of this result is straightforward: In a price-discriminating monopoly, all surplus can be extracted from the consumers. Thus whenever the incumbent finds it optimal not to serve all consumers in terms of first period profits, it forgoes some profit in $\tau = 1$ in order to be able to price-discriminate against more consumers in the second period and earn higher profits.

Having uncovered the dynamics both when entry does and does not occur, the entry decision itself can be analysed. If fixed costs are too high in order for it to be profitable to enter given optimal first-period prices derived in 13, entry is blockaded. Since the entrant's profits are increasing in first period prices, entry is blockaded for lower fixed cost values if the incumbent finds it optimal to serve more consumers in $\tau = 1$. This is the case when v is high. Throughout the analysis, I will assume the following tie-breaking rule: if $F = \pi_E$, the entrant enters into the market. Apart from establishing parameter specification such that entry occurs it is also relevant to compare to a benchmark of entry under uniform pricing. The following proposition characterizes the exact fixed costs for which entry is blockaded and compares them to those that blockade entry under uniform pricing.

Proposition 3 (Blockaded Entry) *Under asymmetric price discrimination, entry is blockaded for strictly lower fixed cost than under uniform pricing of both firms. More precisely entry is blocked for the following parameter values:*

$$t \leq \frac{4}{5} \qquad \textit{and} \qquad F > \frac{t}{8} \tag{15}$$

$$t \in \left[\frac{4}{5}, 1\right) \qquad \textit{and} \qquad F > \frac{t}{2} - \frac{2}{5} + \frac{2}{25t} \tag{16}$$

Proof. Under non-discriminatory the profits of both firms are given by $\frac{t}{2}$ (Derivation in Appendix C). This is strictly lower than those fixed costs given in 15 or 16 since for all $t \in \left[\frac{4}{5}t, 1\right)$ we have that $\frac{2v}{5} > \frac{2v^2}{25t}$. The exact expression for F is derived as follows: Whenever $t \leq \frac{4}{5}$, $\tilde{x} \geq \frac{3}{4}$ in a two-period monopoly and the entrants profits are reduced to their minimal level $\frac{t}{8}$. To see this, recall that when $t < \frac{1}{2}$ are $p_1 = v - t$ and $\tilde{x} = 1$. Now when $t \in [\frac{1}{2}, \frac{4}{5}]$ $p_1 = \frac{2-t}{3}$ the market boundary $\tilde{x}$ is greater than $\frac{3}{4}$ for all values in that range:

$$\tilde{x} = \frac{1}{3t} + \frac{1}{3} \geq \frac{3}{4} \quad \Longleftrightarrow \quad t \geq \frac{4}{5} \tag{17}$$

The second condition just states that for $v \in [t, \frac{5}{4})$ entry is blockaded whenever the entrant's profit under optimal first-period monopoly prices are below the fixed costs (Derivation in Appendix C). ■

This proposition already establishes that under an asymmetric ability to price discriminate of one firm entry appears for fewer parameter values. Thus there is a region of fixed costs for which entry would occur under uniform pricing, but is blockaded under behaviour-based second-period pricing. Up to now, the incumbent did not behave strategically. Next, I open the possibility of strategic first-period pricing.

4.3. Deterred Entry

In addition to entry being simply blockaded, the incumbent may set first period prices strategically to reduce the entrant's profits below the fixed cost associated with entry. As previously discussed and illustrated in Figure 3 the entrant's profits are weakly decreasing in the incumbent's ability to price discriminate. Therefore increasing $\tilde{x}$ by charging lower first period prices potentially hampers entry. However this is only feasible for $\tilde{x} \in [0, \frac{3}{4})$. For $\tilde{x} \in [\frac{3}{4}, 1]$ the entrants profits are constant in $\tilde{x}$. For higher values of $\tilde{x}$, the incumbent is unable to set second-period discriminatory prices that are competitive. Even at zero prices consumers in $[\frac{3}{4}, \tilde{x}]$ are better off when purchasing from the entrant in equilibrium. Therefore those consumers will switch supplier in the second period. The entrant can serve $\frac{1}{4}$ of consumers and insure her minimal profit level. Thus whenever $F \leq \frac{t}{8}$ entry can never be deterred. There is only scope for entry deterrence when $\tilde{x}^* < \frac{3}{4}$ and entry is not already blockaded. This corresponds to parameter values $t \in (\frac{4}{5}, 1]$.

Even if the entrant's profits can be reduced by setting lower first period prices, the incumbent may not find it optimal to do so. It is only optimal to deter entry if profits earned in a two-period monopoly under deterrence prices are higher than profits under optimally accommodated entry. In order to deter entry, the incumbent must set lower prices than would be optimal in a two-period monopoly. Profits of a two-period monopolist are a quadratic function of $\tilde{x}$. Thus the lower the price necessary to deter entry, the lower the profits in a two-period monopoly. To establish for what values of $F > \frac{t}{8}$ entry will be deterred it is therefore sufficient to find the maximal reduction in p_1 the incumbent is willing to undertake to keep the entrant out of the market. The maximal reduction that may ever be profitable pushes $\tilde{x}$ to $\frac{3}{4}$ and reduces the entrant's profits to its minimal level. The price corresponding to such a reduction is given by:

$$p_1 = 1 - \frac{3}{4}t \tag{18}$$

If for such a price the incumbent still finds it optimal to deter entry, deterrence will occur whenever there is scope for it. The following proposition establishes that this is indeed the case and gives an expression for the price p_1 necessary to deter entry.

Proposition 4 (Deterred Entry) *For $t \in (\frac{4}{5}, 1]$ there is scope for entry deterrence. Whenever $F > \frac{t}{8}$ and $t \leq 0.98$ the incumbent will engage in aggressive pricing in the first period in order to deter entry in the second. Under deterrence prices in the first period are given by:*

$$p_1 = 1 - \frac{3}{2}t + \frac{3}{4}t\sqrt{\frac{8F}{t}} \tag{19}$$

Second-period prices correspond to those optimal in monopoly derived in Equation 13. For $t \leq \frac{4}{5}$ entry cannot be deterred. Optimal non-strategic pricing as a two-period monopolist already reduces the entrant's profits to their minimal level.

Proof. Appendix D. ■

Now Propositions 3 and 4 establish for what values of F entry will be accommodated in equilibrium. Whenever entry is not already blockaded it will be deterred. Therefore in equilibrium entry only occurs when $F \leq \frac{t}{8}$. Thus entry only happens for lower fixed costs than under uniform pricing. Therefore an asymmetric ability to price discriminate due to an informational advantage does have an effect on market structure. The incumbent strategically exploits her ability to keep potential entrants out of the market.

Table 1 summarizes the results. For all parameter specifications, it gives an overview of when entry is accommodated, blockaded or deterred. In addition prices and market shares are displayed.

Upon entry, the incumbent loses part of her customers to the entrant only if t is sufficiently low ($t < \frac{1}{2}$). For all remaining admissible values of t the incumbent enlarges her turf in the second period and the entrant is unable to capture all of the uncovered market. Under accommodated entry, all customers are served in the second period. Whenever t is intermediate ($t \in [\frac{1}{2}, \frac{4}{5})$) this is also true in a two-period monopoly. If t is high ($t \in [\frac{4}{5}, 1]$)) however and entry does not occur not all consumers will be served in period two. The mass of consumers served in period one varies with entry. Depending on whether entry can be deterred or must be accommodated, first-period pricing may be lower or higher than optimal from a perspective of first period profits. Whenever entry is blockaded the incumbent finds it

t	F	Entry	p_1	$\tilde{x}$	$p^I_{2,ND}$	p^E_2	$\bar{x}$
$\leq \frac{1}{2}$	$\leq \frac{t}{8}$	A	$\frac{1}{2}$	1	> 0	$\frac{t}{2}$	$\frac{3}{4}$
	$> \frac{t}{8}$	B	$1-t$	1			1
$\in [\frac{1}{2}, \frac{4}{5})$	$\leq \frac{t}{8}$	A	$\frac{23}{32} - \frac{3}{16}t$	$\in [\frac{69}{128}, \frac{3}{4}]$	$\frac{26t-9}{32}$	$\frac{14t-3}{16}$	$\in [\frac{87}{128}, \frac{3}{4}]$
	$> \frac{t}{8}$	B	$\frac{2-t}{3}$	$\in [\frac{3}{4}, 1]$	$1-t$		1
$\in [\frac{4}{5}, 1)$	$\leq \frac{t}{8}$	A	$\frac{23}{32} - \frac{3}{16}t$	$\in [\frac{15}{32}, \frac{69}{128}]$	$\frac{26t-9}{32}$	$\frac{28t-6}{32}$	$\in [\frac{21}{32}, \frac{87}{128}]$
	$> \frac{25t^2-20t+4}{50t}$	B	$\frac{2}{5}$	$\in [\frac{3}{5}, \frac{3}{4}]$	$\frac{1}{5}$		$\in [\frac{4}{5}, 1]$
	$> \frac{t}{8}$	D	$1 - \frac{3}{2}t + \frac{3}{4}t\sqrt{\frac{8F}{t}}$	$\leq \frac{3}{4}$	$\min\{\frac{1}{5}, 1-t\}$		$\in [\frac{4}{5}, 1]$

Table 1: Overview over market structure and prices for different parameter values

$\tilde{x}$ gives the share of the market that is covered in period 1, $\bar{x}$ is the market share of the incumbent both when entry occurs and when it does not occur. For a table giving exact expressions for market shares refer to Appendix F.

optimal to set lower prices in period 1 in order to learn about more consumers in the second period. Now if entry is not blockaded but can be deterred, the incumbent sets even lower prices in order to prevent entry. If instead entry must be accommodated, the incumbent serves fewer consumers in period one. It uses higher first period prices as a commitment device to price discriminate against fewer consumers. The incumbent suggests to the entrant to split the market and keep prices high. Under accommodated entry, the market share of the entrant may go up to 34,38%.

These findings can be relevant from a policy perspective. Weakly fewer consumers are served if entry does not occur in the second period and prices are higher in both periods for at least some consumers. Entry is hampered by the incumbent's asymmetric ability to price discriminate. When compared to a uniform pricing benchmark entry only occurs for lower fixed costs. Policy-makers may want to implement policies that promote entry, induce competition and increase consumer welfare.

5. Implications of Potential Market Interventions

Having established the price-setting behaviour of both firms in the baseline model, I will now turn to a welfare analysis of potential interventions. The welfare measure employed across this section wil be the sum of consumers surplus (CS) and producer surplus(PS) across periods.

$$\mathcal{W}_T = CS_1 + PS_1 + \delta(CS_2 + PS_2) \tag{20}$$

While many different policies could be considered I will focus on two: a ban of price discrimination and an information-sharing requirement that obliges the incumbent to give the entrant access to the information on consumers it collected. At the end of this section, I will quickly discuss what other policies could be interesting to consider.

Ban of Price Discrimination If price discrimination is banned, both firms have to compete in uniform prices. In order to ensure existence of an equilibrium in the uniform pricing games the assumption on t must be strengthened to $t \leq \frac{2}{3}$. Notice that under this restriction there is no scope for entry deterrence, since when the incumbent behaves as a two-period monopolist, profits of the entrant are already reduced to their minimal level. As previously discussed and established in Appendix A.3 both firms set a price of t and share the market equally. Thus the profits of the entrant are $\pi_E = \frac{t}{2}$, which is higher than under asymmetric price discrimination. Since there is no scope for entry deterrence if price discrimination is banned, entry will occurs whenever $F \leq \frac{t}{2}$. So when compared to the baseline model three different cases could potentially arise. For low enough fixed cost ($F \leq \frac{t}{8}$) entry happens independent of the ban. For intermediate values ($F \in (\frac{t}{8}, \frac{t}{2}]$) the policy facilitates entry and for high values of the fixed cost($F > \frac{t}{2}$) the policy has no effect on the entry decision. Now if such a policy is anticipated by the incumbent in the first period than there are welfare effects across both periods. The reason for negative welfare effects whenever $F > \frac{t}{2}$ is simple. In this case entry does not occur independent of the policy. A monopoly that can perfectly price discriminate against consumers serves more consumers in both periods. Since prices are just a transfer from consumers to the monopolist this implies increased welfare. The result is also standard in the sense that in monopoly, non-discriminatory pricing results in a dead weight loss, while first degree price discrimination does not induce the same problem. For low values of F, entry happens independent of the policy. In the second period all consumers will be served in both setups. The entire welfare difference is thus captured by the difference in transport costs. Under the policy consumers buy from the closest firm, which is not true without the policy. Thus in the second period the welfare effects are positive. However if the incumbent anticipates the policy in the first period, it no

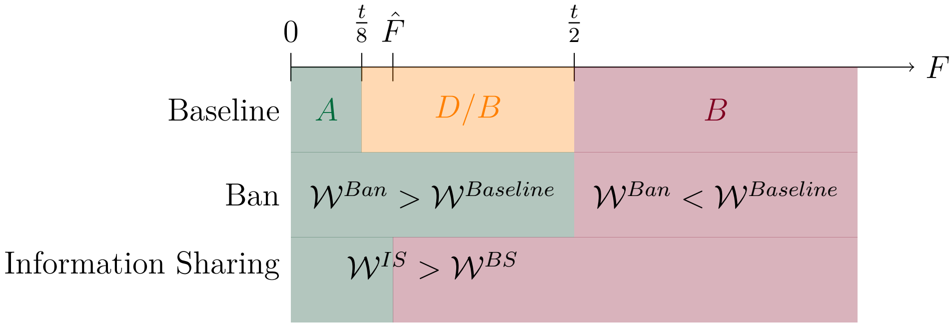

Figure 4: Comparison of the Baseline Model to Policy Interventions.

Notice that for the orange region whether entry is bloackaded or deterred depends on the level of the transport cost.

longer finds it optimal to serve more consumers than under a one period monopoly. Thus first period welfare effects are negative. Overall the second period positive effects outweigh negative second period effects. When F is intermediate the policy facilitates entry. Due to the parameter restriction $t \leq \frac{2}{3}$ the market is fully covered in the baseline as well as under the policy. Similarly to before welfare in period 2 will be higher due to the lower transport costs paid by some consumers. Since this effect is more pronounced if entry only happens under the policy, clearly overall welfare effects are the same than for low fixed cost.

Information Sharing Requirement An alternative policy that could be considered is an information-sharing requirement. This would oblige the incumbent to share the information she holds about consumers with the entrant. Understanding the effects of such a policy seems especially relevant since they already have been adopted by antitrust agencies as in the case of the energy supplier ENGIE. Here, I will focus on the case where such a requirement is not anticipated by the incumbent in $\tau = 1$.[4] Under such a policy the market can be viewed as being split into two segments in the second period: One in which the two firms compete in discriminatory prices and one in which they compete in non-discriminatory prices. The segment where both firms set non-discriminatory prices is located closer to the incumbent, while the other segment is closer to the entrant. Whether a firm is able to set prices that allow her to attract at least some consumer will depend on the relative size of the segments.

Again, I proceed backwards. First I will analyse the price-setting behaviour in the discriminatory region. As also established in Thisse and Vives (1988) firms compete

[4]I am planning to analyse the case where information sharing is anticipated as well.

prices down until consumers are indifferent between purchasing from either firm:

$$p_{I,2}(x) = p_{E,2}(x) + (1-2x)t \tag{21}$$

$$p_{E,2}(x) = p_{I,2}(x) - (1-2x)t \tag{22}$$

I assume that ties are broken in favour of the firm located closer to the consumer. Thus we get that consumers in $[0, \frac{1}{2}]$ buy from the incumbent at prices $p_{I,2}(x) = (1-2x)t$ and consumers in $[\frac{1}{2}, \tilde{x}]$ buy from the entrant at prices $p_{E,2}(x) = (2x-1)t$ if $\tilde{x} \geq \frac{1}{2}$. Otherwise the entrant is not able to set competitive discriminatory prices and there are no effects on entry. I will therefore focus on the case when $\tilde{x} \geq \frac{1}{2}$.

Before firms set discriminatory prices simultaneously, they compete in the uniform segment. Competition in non-discriminatory prices is the same as in Section 4.1. As derived there, when $\tilde{x} \geq \frac{3}{4}$ the incumbent cannot set competitive prices in the uniform-pricing segment. Profits of the entrant, given the price setting behaviour derived in Section 4.1 are given by:

$$\pi_E^{IS} = \begin{cases} (1-\bar{x})\left(1-\frac{2}{3}\tilde{x}\right)t & \tilde{x} < \frac{1}{} \\ \int_{\frac{1}{2}}^{\tilde{x}} 2xt - t dx + (1-\bar{x})\left(1-\frac{2}{3}\tilde{x}\right)t & \text{if } \tilde{x} \leq \frac{3}{4} \\ \int_{\frac{1}{2}}^{\tilde{x}} 2xt - t dx + (1-\tilde{x})\frac{t}{2} & \text{otherwise} \end{cases} \tag{23}$$

Proposition 5 (Unanticipated Information Sharing) *Under an information sharing requirement that is not anticipated the policy promotes entry: The entrants profits are weakly higher and entry thus occurs for higher fixed costs.*
In addition, the policy is welfare enhancing: $\mathcal{W}^{IS} > \mathcal{W}^{Baseline}$

Notice that the entrants profits are weakly higher under the policy. More importantly the minimal profits of the entrant are higher and if the policy is not anticipated there is no scope for deterrence. Thus entry will happens for a larger range of fixed costs. In Figure 4 $\hat{F}$ denotes the minimal profit level of the entrant under information sharing.

Welfare effects are purely concentrated on the second period since the policy is not anticipated. Notice that the policy will have positive effects for two reasons: It reduces transport costs since now consumers closer to the entrant buy from it. In addition if entry occurs due to the policy than (weakly) more consumers are served. If the policy is anticipated however this result may not hold.

Proposition 6 (Anticipated Information Sharing) *Under an anticipated infor-*

mation sharing agreement, maximal deterrence becomes again optimal. Thus entry does not occur whenever $F > \frac{2}{11}t$. When compared to the baseline, entry occurs for lower fixed costs.

There are other potential policies that could be considered. One of them could be to allow for voluntary disclosure: In addition to the incumbent learning the consumers' location through serving them, consumers are able to reveal their location in the second period. Since for those consumers in the discriminatory segment prices under symmetric price discrimination are lower than if only the incumbent price-discriminates, I expect that all consumers in the discriminatory turf would reveal their location. The incentives for consumers that face uniform prices are less clear and depend on the size of the non-discriminatory segment. Consumers located sufficiently close to $\frac{1}{2}$ should also have incentives to reveal their location. In a sense this analysis is also related to the idea of data portability: In order to credibly reveal their location, the consumers may need to be able to access data the incumbent stored about them and transfer them to the entrant.

6. Conclusion

The analysis demonstrates the dynamics of a market characterized by informational asymmetries concerning consumers' preferences. I show that an asymmetric ability to price discriminate has non-trivial strategic effects. If entry must be accommodated the incumbent uses prices as a commitment device to split the market and keep prices high. For high enough fixed costs, on the other hand, the incumbent strategically builds up an informational advantage over potential competitors through low prices that allow her to keep them out of the market. Thus entry may be hampered. This can provide an alternative explanation for the observation of concentrated markets with nonetheless aggressive pricing strategies and supports the idea that measuring welfare purely in terms of short-run price effects may be insufficient. Developing new policies that are capable of dealing with the dynamics of such markets seems like one of the most important challenges antitrust authorities face today. Even if immediate price-effects may point to a different direction, a ban of price discrimination can have positive welfare effects. An information sharing requirement may be another effective tool to increase competition and welfare.

In the future, I would like to generalize this model in multiple respects. First, I want to consider more general correlation structures of valuations not permitted by the Hotelling framework. This would allow me to explore how the correlation of valuations interacts with an incumbents incentive to influence competitiveness through the acquisition of information. Second, I aim to relax the assumption of perfect recognition and consider different intensities of learning when the incumbent interacts with consumers, to test the robustness of the main mechanisms to partial or noisy information.

Extensions and future work. Future work could generalise the model along several dimensions. First, I plan to move beyond the Hotelling structure and allow for richer correlation patterns in valuations. This would permit an explicit analysis of how the *structure* of correlation—rather than simple spatial proximity—interacts with the incumbent's incentive to acquire information in order to shape subsequent competitiveness. Second, I aim to relax the assumption of perfect recognition and consider different intensities of learning when the incumbent interacts with consumers, to test the robustness of the main mechanisms to partial or noisy information.

A more technical extension concerns the timing of second-period prices. As discussed above, Aguirre et al. (2001) show in the model of Thisse and Vives (1988) that letting discriminatory prices be set first can overturn standard findings. While the timing adopted here is conventional in the literature, re-deriving the results under this alternative rule would provide a useful robustness check.

It is also natural to introduce cost asymmetries. In particular, if the entrant is more efficient than the incumbent ($c_E < c_I$), it is interesting to characterise for which cost differentials an information advantage can still deny entry to the superior-cost competitor. Finally, allowing the entrant to choose its location would clarify how positioning interacts with informational asymmetries in established markets and when entry is profitable. Together, these extensions would help assess the external validity of the head-start mechanism and refine the policy conclusions.

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Appendices

All Appendices are formulated in terms of a general v.

A. Monopoly Profit Maximization

A.1. Second period profit maximization

The second period profit function of the incumbent is given by:

$$\pi_{I,2}^M(p_I^D(x), p_I^{ND}) = \int_0^{\tilde{x}} \max\{1 - tx, 0\} dx + (\bar{x} - \tilde{x})p_I^{ND}$$

$$\pi_{I,2}^M(p_I^D(x), p_I^{ND}) = \tilde{x} - \frac{t\tilde{x}^2}{2} + (\bar{x} - \tilde{x})p_I^{ND} \tag{24}$$

Notice that for all $\tilde{x} \in [0, 1]$ monopoly profits are increasing in $\tilde{x}$.

Now $\bar{x} = \frac{1-p_I^{ND}}{t}$ and the optimal non-discriminatory price under monopoly can be calculated. Profit Maximization gives us the following expression of optimal second period prices as a function of $\tilde{x}$:

$$p_{I,2}^{ND} = \begin{cases} \frac{1-t\tilde{x}}{2} & \text{if } 1 \leq t(2 - \tilde{x}) \\ 1 - t & \text{otherwise} \end{cases} \tag{25}$$

Therefore $\bar{x} = \frac{\tilde{x}}{2} + \frac{1}{2t}$. Thus unsurprisingly the non-discriminatory prices correspond to prices in a monopoly where the monopolist only serves customers in $[\tilde{x}, 1]$.

Second period equilibrium monopoly profits are given by:

$$\pi_{I,2}^M(p_{I,2}^*(x), p_{I,2}^{ND,*}) = \begin{cases} \frac{\tilde{x}}{2} - \frac{t\tilde{x}^2}{4} + \frac{1}{t} & \text{if } 1 \leq t(2 - \tilde{x}) \\ t\tilde{x} - \frac{t\tilde{x}^2}{2} + (1 - t) & \text{otherwise} \end{cases} \tag{26}$$

A.2. First period: Total profit maximization

The total profits are given by:

$$\pi^T = \begin{cases} \frac{1-p_1}{t} p_1 + \frac{1}{2}\frac{1-p_1}{t} - \frac{t}{4}\left(\frac{1-p_1}{t}\right)^2 + \frac{1}{t} & \text{if } 1 \leq t + \frac{p_1}{2} \\ \frac{1-p_1}{t} p_1 + t\frac{1-p_1}{t} - \frac{t}{2}\left(\frac{1-p_1}{t}\right)^2 & \text{otherwise} \end{cases} \tag{27}$$

Now I derive first order conditions for both cases. If $1 \leq t(2 - \tilde{x})$ the the first order conditions are given by:

$$0 = \frac{1 - 2p_1}{t} - \frac{1}{2t} + \frac{t}{4t^2} 2(1 - p_1)$$

$$\frac{2p_1}{4t} = \frac{1}{t} + \frac{2p_1}{t} \tag{28}$$

Otherwise they will be given by:

$$0 = \frac{1-2p_1}{t} - 1 + \frac{1-p_1}{t} \tag{29}$$

This gives us the following expression for prices in equilibrium:

$$p_1 = \begin{cases} \frac{2}{5} & \text{if } v \leq \frac{5}{4}t \\ \frac{2-t}{3} & \text{if } v \in [\frac{5}{4}t, 2t] \\ 1-t & \text{otherwise} \end{cases} \qquad p_2 = \begin{cases} \frac{1}{5} & \text{if } v < \frac{5}{4}t \\ 1-t & \text{if } v \in [\frac{5}{4}t, 2t] \\ NA & \text{otherwise} \end{cases} \tag{30}$$

Using these prices givces the following for the two cut-off $\tilde{x}$ and $\bar{x}$:

$$\tilde{x} = \begin{cases} \frac{3}{5t} & \text{if } t \geq \frac{4}{5} \\ \frac{1}{3} + \frac{1}{3t} & \text{if } t \in [\frac{1}{2}, \frac{4}{5}] \\ 1 & \text{otherwise} \end{cases} \qquad \bar{x} = \begin{cases} \frac{4}{5t} & \text{if } t \geq \frac{4}{5} \\ 1 & \text{otherwise} \end{cases} \tag{31}$$

A.3. Profit maximization in a one period monopoly

The profit function of and the corresponding optimal prices a one period monopolist is given by:

$$\pi_M(p_M =) \max\left\{1, \left(\frac{1-p_m}{t}\right)\right\} p_M \qquad p_M^* = \begin{cases} \frac{1}{2} & \text{if } t \geq \frac{1}{2} \\ 1-t & \text{otherwise} \end{cases} \tag{32}$$

The first case corresponds to the case when optimal prices are in the interior and only a subset of the market is served. The second case corresponds to the whole market being covered.

B. Accomodated Entry

B.1. Second period profit maximization under accommodated entry

The profit functions are given by:

$$\pi_{I,2}^A = \int_0^{\min\{\hat{x},\tilde{x}\}} min\{1-tx, p_{E,2}+t-2tx\}dx + \max\{0, \bar{x}-\tilde{x}\}p_{I,2}^{ND} \tag{33}$$

$$\pi_E = (1 - \max\{\min\{\bar{x}, \hat{x}\}, \tilde{x}\})\, p_{E,2} \tag{34}$$

Now two cases may arise that affect optimal second period prices. Either the indifference condition is determined by $\tilde{x}$ or it is pinned down by $\hat{x}$. First I analyse the case when the indifference condition is determined by $\tilde{x}$. In that case profit functions will be given by:

$$\pi^A_{I,2} = \int_0^{\tilde{x}} min\{1-tx, p_{E,2}+t-2tx\}dx + \left(\frac{p_{E,2}-p^{ND}_{I,2}+t}{2t} - \tilde{x}\right) p^{ND}_{I,2} \tag{35}$$

$$\pi_E = \left(1 - \frac{p_{E,2}-p^{2,ND}_I + t}{2t}\right) p_{E,2} \tag{36}$$

First order conditions and optimal prices are given by:

$$\frac{\delta \pi I,2}{\delta p^{ND}_{I,2}} = (\frac{1}{2} + \frac{p_{E,2} - 2p^{ND}_{I,2}}{2t} - \tilde{x}) = 0 \qquad p^{ND}_{I,2} = (1 - \frac{4}{3}\tilde{x})t \tag{37}$$

$$\frac{\delta \pi_E}{\delta p_{E,2}} = \frac{1}{2} - \frac{2p_{E,2} + p^{ND}_{I,2}}{2t} = 0 \qquad p_{E,2} = (1 - \frac{2}{3}\tilde{x})t \tag{38}$$

The indifferent consumer is located at $\bar{x}$, whenever the indifference condition is determined by the non-discriminatory prices, so whenever $\hat{x} < \tilde{x}$ and $\tilde{x} < \bar{x}$

$$\bar{x} = \frac{1}{2} + \frac{1}{3}\tilde{x} \tag{39}$$

This will be true whenever $\tilde{x} \leq \frac{3}{4}$. Otherwise, the incumbent will not be able to set competitive non-discriminatory prices. At any price $p^{2,ND}_I$ no consumer will buy from the incumbent. Thus if $\tilde{x} > \hat{x}$ only the entrant's optimal profits need to be derived since the incumbent sets discriminatory prices to all consumers it serves In this case, the entrant's profit function is given by:

$$\pi_E = \left(1 - \frac{p_{E,2}+t}{2t}\right) p_{E,2} \qquad p_{E,2} = \frac{t}{2} \tag{40}$$

This leads to the following overall price schedules:

$$p^{*ND}_{I,2} = \begin{cases} (1-\frac{4}{3}\tilde{x})t & \text{if } \tilde{x} \leq \frac{3}{4} \\ 0 & \text{otherwise} \end{cases} \qquad p^*_{E,2} = \begin{cases} (1-\frac{2}{3}\tilde{x})t & \text{if } \tilde{x} \leq \frac{3}{4} \\ \frac{t}{2} & \text{otherwise} \end{cases} \tag{41}$$

And the following profit functions:

$$\pi^*_E = \begin{cases} (\frac{1}{2} - \frac{1}{3}\tilde{x}) \left(1 - \frac{2}{3}\tilde{x}\right) t & \text{if } \tilde{x} \leq \frac{3}{4} \\ \frac{t}{8} & \text{otherwise} \end{cases} \tag{42}$$

$$\pi^{*A} = \begin{cases} \int_0^{\max\{0,y\}} v - txdx + \int_{\max\{0,y\}}^{\tilde{x}} \left(1 - \frac{2}{3}\tilde{x}\right) t + t - 2txdx + (\frac{1}{2} - \frac{2}{3}\tilde{x}) \left(1 - \frac{4}{3}\tilde{x}\right) t & \text{if } \tilde{x} \leq \frac{3}{4} \\ \int_0^{\max\{0,y\}} v - txdx + \int_{\max\{0,y\}}^{\frac{3}{4}} \frac{3t}{2} - 2txdx & \text{otherwise} \end{cases} \tag{43}$$

B.2. Total profit maximization under accommodated entry

Next, I turn to the profit maximization of the entrant in period one. In order to derive the optimal prices, it is necessary to derive an expression of y. y is is defined to be the last consumer such that the incumbent charges a price equal to the consumers' valuation. So if consumers valuation are sufficiently high then y should be 0. If the consumers' valuations are sufficiently low then at most the incumbent charges everyone she can price discriminate against a price according to her valuation. So the maximal value of y is given by the maximal value of consumers served at discriminatory prices: $\max(y) = \bar{x}$. If y is in the interior of these two extreme values then it is determined by

$$1 - (1 - ty^{int}) - ty = 1 - (p_E + (1 - y^{int})t - ty^{int}) - ty^{int} \tag{44}$$

$$y^{int} = \frac{t - 1 + p_{E,2}}{t}$$

$$y^{int} = \begin{cases} \frac{2t - 1 - \frac{2}{3}\tilde{x}t}{t} & \text{if } \tilde{x} < \frac{3}{4} \\ \frac{\frac{3}{2}t - 1}{t} & \text{otherwise} \end{cases}$$

This gives the following definition of y

$$y = \max\left\{0, y^{int}\right\} \tag{45}$$

Now, second period profits are given by:

$$\pi^A_{I,2} = \begin{cases} y - \frac{t}{2}y^2 + 2t\tilde{x} - \frac{2t}{3}\tilde{x}^2 - t\tilde{x}^2 - 2ty + \frac{2t}{3}\tilde{x}y + ty^2 + \frac{t}{2} - \frac{2t}{3}\tilde{x} - \frac{2t}{3}\tilde{x} + \frac{8t}{9}\tilde{x}^2 & \tilde{x} \leq \frac{3}{4} \\ \max\{0, \frac{3}{2} - \frac{1}{t}\}y + \frac{t}{2}\left(\max\{0, \frac{3}{2} - \frac{1}{t}\}\right)^2 - \frac{3t}{2}\max\{0, \frac{3}{2} - \frac{1}{t}\} + \frac{9t}{16} & \text{otherwise} \end{cases} \tag{46}$$

$$\pi^A_{I,2} = \begin{cases} (1 - 2t)y + \frac{t}{2}y^2 + \frac{2}{3}\tilde{x}yt + \frac{2}{3}\tilde{x}t - \frac{7}{9}t\tilde{x}^2 + \frac{t}{2} & x \leq \frac{3}{4} \\ \max\{0, \frac{3}{2} - \frac{1}{t}\} + \frac{t}{2}\left(\max\{0, \frac{3}{2}) - \frac{1}{t}\}\right)^2 - \frac{3t}{2}\max\{0, \frac{3}{2} - \frac{1}{t}\} + \frac{9t}{16} & \text{otherwise} \end{cases} \tag{47}$$

Therefore total profits are given by:

$$\pi^T_I = \begin{cases} \left(\frac{1-p_1}{t}\right)p_1 - (1 - 2t)y + \frac{t}{2}y^2 + \frac{2}{3}\left(\frac{1-p_1}{t}\right)yt + \frac{2}{3}\left(\frac{1-p_1}{t}\right)t - \frac{7}{9}t\left(\frac{1-p_1}{t}\right)^2 + \frac{t}{2} & \text{if } \frac{1-p_1}{t} \leq \frac{3}{4} \\ \left(\frac{1-p_1}{t}\right)p_1 + 1\max\{0, \frac{3}{2} - \frac{1}{t}\} + \frac{t}{2}\max\{0, \frac{3}{2} - \frac{1}{t}\}^2 - \frac{3t}{2} + \max\{0, \frac{3}{2} - \frac{1}{t}\}\frac{9t}{16} & \text{otherwise} \end{cases} \tag{48}$$

Now different four different cases may ariser The first case is that $\tilde{x} \leq \frac{3}{4}$ as well as $0 \leq y \leq \tilde{x}$. In this case the second period profit function is given by:

$$\pi_{I,2}^A = (1-2t)y + \frac{t}{2}y^2 + \frac{2}{3}\tilde{x}yt + \frac{2}{3}\tilde{x}t - \frac{7}{9}t\tilde{x}^2 + \frac{t}{2} \tag{49}$$

$$= (1-2t)\left(\frac{2t-1-\frac{2}{3}\tilde{x}t}{t}\right) + \frac{t}{2}\left(\frac{2t-1-\frac{2}{3}\tilde{x}t}{t}\right) + \frac{2}{3}\tilde{x}\left(\frac{2t-1-\frac{2}{3}\tilde{x}t}{t}\right)t + \frac{2}{3}\tilde{x}t - \frac{7}{9}t\tilde{x}^2 + \frac{t}{2} \tag{50}$$

$$= -\tilde{x}^2 t + \left(2t - \frac{2}{3}\right)\tilde{x} - \frac{(2t-1)^2}{2t} + \frac{t}{2} \tag{51}$$

$$= \frac{-6t^2\tilde{x}^2 + 12t^2\tilde{x} - 9t^2 + 12t - 4t\tilde{x} - 3}{6t} \tag{52}$$

Total proftis are given by:

$$\pi_I^A = \left(\frac{1-p_1}{t}\right)p_1 + \frac{-6t^2\left(\frac{1-p_1}{t}\right)^2 + 12t^2\left(\frac{1-p_1}{t}\right) - 9t^2 + 12t - 4t\left(\frac{1-p_1}{t}\right) - 3}{6t}$$

$$\pi_I^A = \frac{-12p_1^2 - 12tp_1 + 22p_1 - 9t^2 - 13 + 24t}{6t} \tag{53}$$

Optimal prices are given by:

$$p_1 = \frac{11}{12} - \frac{1}{2}t \tag{54}$$

The cutoffs $\tilde{x}$ and y are given by:

$$\tilde{x} = \frac{1}{2} + \frac{1}{12t} \qquad y = \frac{5}{3} - \frac{19}{18t} \tag{55}$$

Now I establish for what values of the valuation and transport costs such an equilibrium may arise. Thus we need to check the following two conditions: $\tilde{x} < \frac{3}{4}$ and $y \in (0, \tilde{x})$. In order for $\tilde{x} < \frac{3}{4}$ it is sufficient that $t \geq \frac{1}{3}$. To obtain that $y \geq 0$ it is is necessary that $t \geq \frac{19}{30}$ Notice that we always have that $y \leq \tilde{x}$

Therefore this case can only ever arise when $t \in [\frac{19}{30}, 1]$

Now, I analyse the case in which $y = 0$ and $\tilde{x} \leq \frac{3}{4}$. The profit function will be given by:

$$\pi_I^T = \frac{v-p_1}{t}p_1 - \frac{7}{9}\left(\frac{v-p_1}{t}\right)^2 t + \frac{2}{3}t\frac{v-p_1}{t} + \frac{t}{2} \tag{56}$$

The first order conditions are given by:

$$0 = \frac{v-2p_1}{t} - \frac{2}{3} + \frac{14(v-p_1)}{9t}$$

$$p_1^A = \frac{23v - 6t}{32} \tag{57}$$

The cutoffs $\tilde{x}$ and y are given by:

$$\tilde{x} = \frac{3}{16} + \frac{9v}{32t} \qquad\qquad y = \frac{30 - 19v}{16t} \tag{58}$$

Now given such prices we have that $\tilde{x} \leq \frac{3}{4}$ whenever $t \geq \frac{1}{2}v$. In addition the conditions on y also need to be satisfied:

$$\frac{30t - 19v}{16t} \leq 0 \iff t \leq \frac{19}{30}v$$

Now if $\tilde{x} > \frac{3}{4}$ then $y = \max\left\{0, \frac{\frac{3}{2}t - v}{t}\right\}$

$$\pi_I^{A,T} = \left(\frac{v - p_1}{t}\right) p_1 + v \max\{0, \frac{3}{2} - \frac{v}{t}\} + \frac{t}{2}\left(\max\{0, \frac{3}{2} - \frac{v}{t}\}\right)^2 - \frac{3t}{2}y + \frac{9t}{16} \tag{59}$$

In this case, y and $\tilde{x}$ are constant in first period prices, thus the monopolist sets prices that are optimal in the one-period monopoly

$$p_1 = \begin{cases} \frac{v}{2} & \text{if } v \leq 2t \\ v - t & \text{otherwise} \end{cases} \tag{60}$$

In order to satisfy $\tilde{x} \geq \frac{3}{4}$ it is thus necessary that $t \leq \frac{2}{3}v$ which implies that $y = 0$. So whenever $t \in \left(\frac{1}{2}, \frac{2}{3}\right) v$ two candidates for the optimal price exist: $p_1 = \frac{v}{2}$ and $p_1 = \frac{23v - 6t}{32}$. Thus for such parameter values, I need to establish which candidate gives higher profits. So I will check for what values of t profits are equal in the interior of $t \in \left(\frac{1}{2}, \frac{2}{3}\right) v$

$$\pi^{A,T}_{\tilde{x} > \frac{3}{4}} = \pi^{A,T}_{\tilde{x} < \frac{3}{4}, y = 0} \tag{61}$$

$$\frac{v^2}{4t} - \frac{9}{16}t = \left(\frac{3}{16} + \frac{9v}{32t}\right)\frac{23v - 6t}{32} - \frac{7}{9}\left(\frac{3}{16} + \frac{9v}{32t}\right)^2 t + \frac{2}{3}t\left(\frac{3}{16} + \frac{9v}{32t}\right) + \frac{t}{2} \tag{62}$$

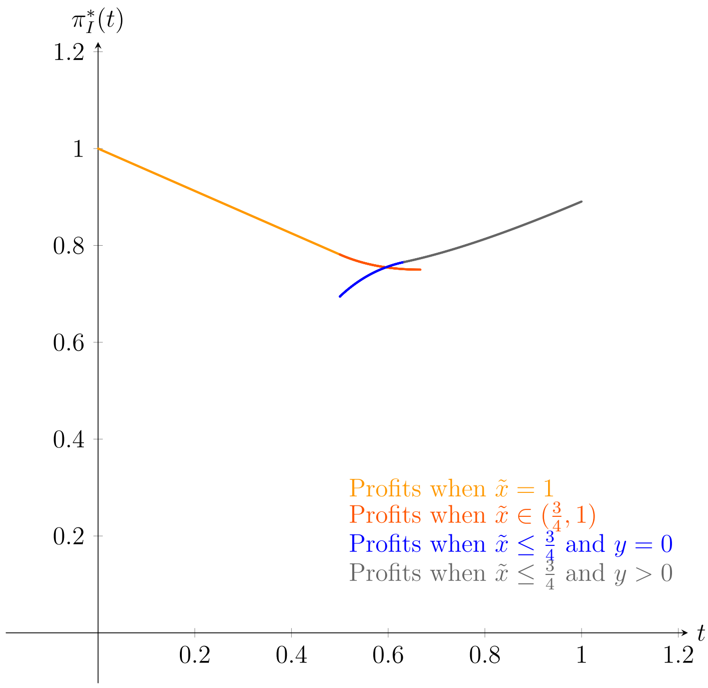
This equality holds for the following value of t

$$t = \frac{52 \pm 3\sqrt{6}}{75}v \tag{63}$$

Now due to the parameter restriction only the lower of the the two values is admissible

So overall we get the following expression of prices

$$p_1^A = \begin{cases} v - t & \text{if } t \leq \frac{1}{2}v \\ \frac{v}{2} & \text{if } t \in (\frac{1}{2}v, \frac{52 - 3\sqrt{6}}{75}]v \\ \frac{23}{32}v - \frac{3}{16}t & \text{if } t \in [\frac{52 - 3\sqrt{6}}{75}, \frac{19}{30}]v \\ \frac{11}{12}v - \frac{1}{2}t & \text{if } t \in [\frac{19}{30}, 1]v \end{cases} \tag{64}$$



C. Blockaded Entry

For $v \in [t, \frac{5}{4}t]$ the entrants profits under $p_{I,1}^M$ are given by:

$$\pi_E = \left(\frac{1}{2} - \frac{1}{3}\tilde{x}\right)\left(1 - \frac{2}{3}\tilde{x}\right)t \tag{65}$$

$$= \frac{t}{2} - \frac{2v}{5} + \frac{2v^2}{25t} \tag{66}$$

For profits under non-discriminatory pricing, we need to solve for optimal prices of both firm. The market boundary $\bar{x}$ is given by:

$$\bar{x} = \frac{p_E - p_I + t}{2t} \tag{67}$$

Therefore profit functions are given by:

$$\pi_I(p_E, p_I) = \left(\frac{p_E - p_I + t}{2t}\right) p_I \tag{68}$$

$$\pi_E(p_E, p_I) = \left(1 - \frac{p_E - p_I + t}{2t}\right) p_E \tag{69}$$

Optimal prices and equilibrium profits are given by:

$$p_I^* = t \qquad \pi_I(p_E^*, p_I^*) = \frac{t}{2} \tag{70}$$

$$p_E^* = t \qquad \pi_E(p_E^*, p_I^*) = \frac{t}{2} \tag{71}$$

D. Deterred Entry

This maximal reduction of the entrants profits corresponds to the following prices:

$$\frac{v-p_1}{t} = \frac{3}{4} \qquad \Longleftrightarrow \qquad p_1 = v - \frac{3}{4}t \tag{72}$$

Profits in monopoly under the suggested prices are given by:

$$\pi^{D_{max}} = \begin{cases} \frac{3}{4}(v-\frac{3}{4}t) + \int_0^{\frac{3}{4}} v - txdx + (\frac{1}{2t}+\frac{3}{8})\frac{1}{8} \\ \frac{3}{4}(v-\frac{3}{4}t) + \int_0^{\frac{3}{4}} v - txdx + (v-t)\frac{1}{4} \end{cases} = \begin{cases} \left(\frac{3}{4} + \frac{-54t^2+45t+4}{64t}\right) & \text{if } t \in [\frac{4}{5}, 1] \\ \frac{7}{4}v - \frac{35}{32}t & \text{if } t < \frac{4}{5} \end{cases}$$

Now the total profits of accommodating entry if there is room for deterrence $t \in [\frac{52-3\sqrt{6}}{75}, 1]v$ are given by:

$$\begin{aligned} \pi_I^A &= \begin{cases} \left(\frac{\frac{9}{32}v-\frac{3}{16}t}{t}\right)\left(\frac{23}{32}v-\frac{3}{16}t\right) - \frac{7}{9}t\left(\frac{\frac{9}{32}v-\frac{3}{16}t}{t}\right)^2 + \frac{2}{3}t\left(\frac{\frac{9}{32}v-\frac{3}{16}t}{t}\right) + \frac{t}{2} & \text{if } t \in [\frac{52-3\sqrt{6}}{75}, \frac{19}{30}]v \\ \frac{-12(\frac{11}{12}v-\frac{1}{2}t)^2-12t(\frac{11}{12}v-\frac{1}{2}t)+22v(\frac{11}{12}v-\frac{1}{2}t)-9t^2-13v^2+24tv}{6t} \end{cases} \\ &= \begin{cases} \frac{98t^2+21vt+36v^2}{256t} & \text{if } t \in [\frac{52-3\sqrt{6}}{75}, \frac{19}{30}]v \\ \frac{-35v^2-72t^2+156vt}{72t} & \text{if } t \in [\frac{19}{30}, 1]v \end{cases} \end{aligned} \tag{73}$$

$$\begin{aligned} \pi_I^A &= \left(\frac{\frac{9}{32}v-\frac{3}{16}t}{t}\right)\left(\frac{23}{32}v-\frac{3}{16}t\right) - \frac{7}{9}t\left(\frac{\frac{9}{32}v-\frac{3}{16}t}{t}\right)^2 + \frac{2}{3}t\left(\frac{\frac{9}{32}v-\frac{3}{16}t}{t}\right) + \frac{t}{2} \\ &= \frac{98t^2+21vt+36v^2}{256t} \end{aligned} \tag{74}$$

Now we can calculate the difference of the profits under accommodation and the profits of maximal deterrence:

$$\pi^A - \pi^{D_{max}} = \begin{cases} \frac{98t^2+21vt+36v^2}{256t} - \frac{7}{4}v + \frac{35}{32}t < 0 \quad \text{for } t \in [\frac{52-3\sqrt{6}}{75}, \frac{19}{30}] \\ \frac{-35v^2-72t^2+156vt}{72t} - \left(\frac{3}{4} + \frac{-54t^2+45t+4}{64t}\right) < 0t \in [\frac{19}{30}, \frac{137-3\sqrt{681}}{60}) \approx [\frac{19}{30}, 0.98) \end{cases}$$

Now the entrants profits as a function of p_1 are given by:

$$\begin{aligned} \pi_E &= \begin{cases} (\frac{1}{2}-\frac{1}{3}\tilde{x})\left(1-\frac{2}{3}\tilde{x}\right)t & \text{if } \frac{v-p_1}{t} \leq \frac{3}{4} \\ \frac{t}{8} & \text{otherwise} \end{cases} \\ &= \begin{cases} \frac{t}{2} - \frac{2(v-p_1)}{3} + \frac{2(v-p_1)^2}{9t} & \text{if } \frac{v-p_1}{t} \leq \frac{3}{4} \\ \frac{t}{8} & \text{otherwise} \end{cases} \end{aligned} \tag{75}$$

In order to deter entry, prices must be set such that they reduce the entrants profits below the fixed costs:

$$F > \max\left\{\frac{1}{2}t - \frac{2}{3}(v-p_1) + \frac{2}{9}\frac{(v-p_1)^2}{t}, \frac{t}{8}\right\}$$

Thus, entry is deterred whenever possible. Now we can calculate the prices necessary to deter entry in case $\frac{1}{2}t - \frac{2}{3}(v - p_1) + \frac{2}{9}\frac{(v-p_1)^2}{t} \geq \frac{t}{8}$ by solving the following quadratic formula

$$\frac{1}{2}t - \frac{2}{3}(v - p_1) + \frac{2}{9}\frac{(v - p_1)^2}{t} - F = 0 \tag{76}$$

$$p_{1_{1,2}} = v - \frac{3}{2}t \pm \frac{3}{4}t\sqrt{\frac{8F}{t}} \tag{77}$$

$$p_1 = v - \frac{3}{2}t - \frac{3}{4}t\sqrt{\frac{8F}{t}} \tag{78}$$

where the last line follows from the fact we have a quadratic equation in p_1. Now we have:

$$v - \frac{3}{2}t + \frac{3}{4}t\sqrt{\frac{8F}{t}} < v - \frac{3}{4}t \iff \frac{3}{4}t\sqrt{\frac{8F}{t}} < \frac{3}{4}t \iff \frac{t}{8} < F \tag{79}$$

The last line follows from the fact that prices have to

$$p_1 = v - \frac{3}{2}t + \frac{3}{4}t\sqrt{\frac{8F}{t}} \tag{80}$$

Profits under optimal deterrence, where $F = ct$

$$\Big\{\left(\tfrac{3}{2} - \tfrac{3}{4}\sqrt{8c}\right)\left(1 - \tfrac{3}{2} - \tfrac{3}{4}t + \tfrac{3}{4}t\sqrt{8c}\right) + \tfrac{1}{2}\left(\tfrac{3}{2} - \tfrac{3}{4}\sqrt{8c}\right) - \tfrac{1}{4}t\left(\tfrac{3}{2} - \tfrac{3}{4}\sqrt{8c}\right)^2 + \tfrac{1}{t} \quad \text{if} \tag{81}$$

$$\Big\{\tfrac{-90ct^2+72\sqrt{2}\sqrt{c}t^2-27t^2+16}{16t} \quad \text{if } \tfrac{3}{2} - \tfrac{3}{4}\sqrt{8c} + \tfrac{v}{2t} \leq 1 \tag{82}$$

E. Policy Intervention

E.1. Ban of Price Discrimination

E.2. Information Sharing Requirement

Proposition 7 (Anticipated Information Sharing) *Under an anticipated information sharing agreement, maximal deterrence becomes again optimal. Thus entry does not occur whenever $F > \frac{2}{11}t$. When compared to the baseline, entry occurs for lower fixed costs.*

Proof. First I derive optimal behaviour under accomodated entry. Optimal prcicing in $t = 2$ has already been derived above. Now total profits in Period 1 can be given by:

$$\pi_{I,T} = \frac{1 - p_1}{t}p_1 + \int_0^{\min\{\frac{1}{2},\tilde{x}\}}(1 - 2x)tdx + \int_{\tilde{x}}^{\max\{\bar{x},\tilde{x}\}}(1 - \frac{4}{3}\tilde{x})tdx \tag{83}$$

$$= \begin{cases} \frac{1-p_1}{t}t - \left(\frac{1-p_1}{t}\right)^2 t + 2t(\frac{1}{2} - \frac{2(1-p_1)}{3t})^2 & \text{if } \frac{1-p_1}{t} \in [0, \frac{1}{2}) \\ \frac{1-p_1}{t}t + \frac{t}{2} - \frac{t}{4} + 2t(\frac{1}{2} - \frac{2(1-p_1)}{3t})^2 & \text{if } \frac{1-p_1}{t} \in [\frac{1}{2}, \frac{3}{4}) \\ \frac{t}{4} & \text{if } \frac{1-p_1}{t} \in [\frac{3}{4}, 1]\frac{1-p_1}{t}t \end{cases} \tag{84}$$

When $\tilde{x} \leq \frac{1}{2}$ the incumbent serves all consumers that can be discriminated against. Otherwise consumers in $[\frac{1}{2}, \tilde{x}]$ are served by the entrant. I proceed to to case-wise profit maximization.

Case 1:$\tilde{x} \in [0, \frac{1}{2})$ The interior solution of the profit maximization gives the following expression for the optimal price:

$$p_1^*(t) = \frac{3t}{20} + \frac{11}{20} \tag{85}$$

Notice that the restriction on $\tilde{x}$ are met whenever

$$\frac{1 - \frac{3t}{20} + \frac{11}{20}}{t} \in [0, 0.5) \iff t \in (\frac{9}{13}, 3]$$

Case 2:$\tilde{x} \in [\frac{1}{2}, \frac{3}{4})$ The interior solution of the profit maximization gives the following expression for the optimal price:

$$p_1^*(t) = 6t - \frac{7}{2} \tag{86}$$

Notice that the restriction on $\tilde{x}$ are met whenever

$$\frac{1 - 6t - \frac{7}{2}}{t} \in \left[\frac{1}{2}, \frac{3}{4}\right) \iff t \in \left(\frac{2}{3}, \frac{9}{13}\right]$$

Case 3:$\tilde{x} \in \left[\frac{3}{4}, 1\right]$ The interior solution of the profit maximization gives the following expression for the optimal price:

$$p_1^*(t) = \frac{1}{2} \tag{87}$$

Notice that the restriction on $\tilde{x}$ are met whenever

$$\frac{1 - \frac{1}{2}}{t} \in \left[\frac{3}{4}, 1\right) \iff t \in \left(\frac{1}{2}, \frac{3}{2}\right]$$

No whenever $t \leq \frac{1}{2}$ the profit maximization problem has a corner solution s.t. $\tilde{x} = 1$

$$p_1(t) = 1 - t \tag{88}$$

So overall we get the following for optimal prices:

$$p_1^*(t) = \begin{cases} 1 - t & \text{if } t \in \left[0, \frac{1}{2}\right] \\ \frac{1}{2} & \text{if } t \in \left(\frac{1}{2}, \frac{2}{3}\right] \\ 6t - \frac{7}{2} & \text{if } t \in \left(\frac{2}{3}, \frac{9}{13}\right] \\ \frac{3t}{20} + \frac{11}{20} & \text{if } t > \frac{9}{13} \end{cases} \tag{89}$$

Now profits are given by the following expression:

$$\pi^*_{I,T}(t) = \begin{cases} 1 - \frac{3t}{4} & \text{if } t \in \left[0, \frac{1}{2}\right] \\ \frac{t^2+1}{4t} & \text{if } t \in \left(\frac{1}{2}, \frac{2}{3}\right] \\ \frac{19t}{4} + \frac{9}{4t} - 6 & \text{if } t \in \left(\frac{2}{3}, \frac{9}{13}\right] \\ \frac{3(3-2t+7t^2)}{40t} & \text{if } t > \frac{9}{13} \end{cases} \tag{90}$$

Next I determine when there is scope for entry deterrence. There is scope for entry deterrence whenever the fixed cost is above the entrants minimal profit level.Profits of the entrant are given by:

$$\pi_E = \int_{\frac{1}{2}}^{\max\{\frac{1}{2},\tilde{x}\}} (2xt - t)\, dx + \int_{\max\{\tilde{x},\bar{x}\}}^{1} \left(\max\left\{ (1 - \frac{2}{3}\tilde{x})t, \frac{t}{2} \right\} \right) dx \tag{91}$$

$$= \begin{cases} (1-\bar{x})(1-\frac{2}{3}\tilde{x})t & \text{if } \tilde{x} \le \frac{1}{2} \\ \left(\tilde{x}^2 t - \tilde{x}t - \frac{1}{4}t + \frac{1}{2}t\right) + \int_{\tilde{x}}^{1} \left((1-\frac{2}{3}\tilde{x})t\right) dx & \text{if } \tilde{x} \le \frac{3}{4} \\ \left(\tilde{x}^2 t - \tilde{x}t - \frac{1}{4}t + \frac{1}{2}t\right) + \int_{\tilde{x}}^{1} \left(\frac{t}{2}\right) dx & \text{if } \tilde{x} > \frac{3}{4} \end{cases} \tag{92}$$

$$= \begin{cases} \frac{1}{2}\left(1 - \frac{2}{3}\tilde{x}\right)^2 t & \text{if } \tilde{x} \le \frac{1}{2} \\ \left(\frac{11}{9}\tilde{x}^2 - \frac{5}{3}\tilde{x} + \frac{3}{4}\right) t & \text{if } \tilde{x} \le \frac{3}{4} \\ \left(\tilde{x}^2 - \frac{3}{2}\tilde{x} + \frac{3}{4}\right) t & \text{if } \tilde{x} > \frac{3}{4} \end{cases} \tag{93}$$

Now profits of the entrant are minimal at $\tilde{x} = \frac{15}{22}$. Thus the entrants minimal profits are given by: $\pi_E^{min} = \frac{2}{11}t$. Thus, whenever $F \le= \frac{2}{11}t$ entry cannot be deterred. Next I establish that for any $F >= \frac{2}{11}t$ deterrence will be optimal. The incumbents prices pushing the entrants profits to their minimal level is given by:

$$p_1^{MD} = 1 - \frac{15t}{22} \tag{94}$$

$$p_2^{MD} = \begin{cases} 1 - t & \text{if } t < \frac{22}{29} \\ \frac{1}{2}\left(1 - \frac{15t}{22}\right) & \text{if } t \ge \frac{22}{29} \end{cases} \tag{95}$$

Profits of the incumbent are given by:

$$\pi_{1,T}^{MD} = \begin{cases} \int_0^{\frac{15}{22}} (1-tx)\ dx + \frac{15=1-\frac{15t}{22}}{22} + \left(1 - \frac{15}{22}\right)(1-t) & \text{if } t < \frac{22}{29} \\ \int_0^{\frac{15}{22}} (1-tx)\ dx + \frac{15=1-\frac{15t}{22}}{22} + \left(1 - \frac{15}{22}\right)\frac{1}{2}\left(1 - \frac{15t}{22}\right) & \text{if } t \ge \frac{22}{29} \end{cases} \tag{96}$$

$$= \begin{cases} \frac{37}{22} - \frac{983t}{968} & \text{if } t < \frac{22}{29} \\ \frac{1}{484}(737 - 390t) & \text{if } t \ge \frac{22}{29} \end{cases} \tag{97}$$

Now I proceed to compare profits under maximal deterrence and optimal accommodation to obain that $\forall t \pi_{1,T}^{MD} > \pi_{1,T}^{Acc}$

Case 1:$t \in [0, \frac{1}{2})$

$$\pi_{1,T}^{MD} - \pi_{1,T}^{Acc} > 0 \iff \tag{98}$$
$$\frac{1}{968}(660 - 257t) > 0 \iff \tag{99}$$
$$660/257 > t \tag{100}$$

Hence for all admissible values of t maximal deterrence leads to higher profits

Case 2:$t \in [\frac{1}{2}, \frac{2}{3})$

$$\pi_{1,T}^{MD} - \pi_{1,T}^{Acc} > 0 \iff \tag{101}$$
$$-\frac{1225t}{968} - \frac{1}{4t} + \frac{37}{22} > 0 \iff \tag{102}$$
$$t \in \left(\frac{11\left(74 - \sqrt{3026}\right)}{1225}, \frac{11\left(74 + \sqrt{3026}\right)}{1225}\right) \tag{103}$$

Hence for all admissible values of t maximal deterrence leads to higher profits
Case 3:$t \in [\frac{2}{3}, \frac{9}{13}]$

$$\pi_{1,T}^{MD} - \pi_{1,T}^{Acc} > 0 \iff \tag{104}$$
$$-\frac{5581t}{968} - \frac{9}{4t} + \frac{169}{22} > 0 \iff \tag{105}$$
$$t \in \left(\frac{11\left(338 - \sqrt{13786}\right)}{5581}, \frac{11\left(338 + \sqrt{13786}\right)}{5581}\right) \tag{106}$$

Hence for all admissible values of t maximal deterrence leads to higher profits
Case 4:$t \in [\frac{9}{13}], \frac{22}{29})$

$$\pi_{1,T}^{MD} - \pi_{1,T}^{Acc} > 0 \iff \tag{107}$$
$$-\frac{932t}{605} - \frac{9}{40t} + \frac{403}{220} > 0 \iff \tag{108}$$
$$t \in \left(\frac{11\left(403 - 7\sqrt{1945}\right)}{7456}, \frac{11\left(403 + 7\sqrt{1945}\right)}{7456}\right) \tag{109}$$

Hence for all admissible values of t maximal deterrence leads to higher profits
Case 5:$t \in [\frac{22}{29}, 1]$

$$\pi_{1,T}^{MD} - \pi_{1,T}^{Acc} > 0 \iff \tag{110}$$
$$-\frac{6441t}{4840} - \frac{9}{40t} + \frac{92}{55} > 0 \iff \tag{111}$$
$$t \in \left(\frac{11\left(368 - \sqrt{77455}\right)}{6441}, \frac{11\left(368 + \sqrt{77455}\right)}{6441}\right) \tag{112}$$

Hence for all admissible values of t maximal deterrence leads to higher profits

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F. Market Shares in Equilibrium

v	F	Entry	p_1	$\tilde{x}$	$p^I_{2,ND}$	p^E_2	$\bar{x}$
$\geq 2t$	$\leq \frac{t}{8}$	A	$\frac{v}{2}$	1	> 0	$\frac{t}{2}$	$\frac{3}{4}$
	$> \frac{t}{8}$	B	$v - t$	1			1
$\in [\frac{5}{4}t, 2t)$	$\leq \frac{t}{8}$	A	$\frac{23}{32}v - \frac{3}{16}t$	$\frac{9v+6t}{32t}$	$\frac{26t-9v}{32}$	$\frac{14t-3v}{16}$	$\frac{3v+18t}{32t}$
	$> \frac{t}{8}$	B	$\frac{2v-t}{3}$	$\frac{t+v}{3t}$	$v - t$		1
$\in [t, \frac{5}{4}t)$	$\leq \frac{t}{8}$	A	$\frac{23}{32}v - \frac{3}{16}t$	$\frac{9v+6t}{32t}$	$\frac{26t-9v}{32}$	$\frac{28t-6v}{32}$	$\frac{3v+18t}{32t}$
	$> \frac{25t-20vt+4v^2}{50t}$	B	$\frac{2v}{5}$	$\frac{3v}{5t}$	$\frac{v}{5}$		$\frac{4v}{5t}$
	$> \frac{t}{8}$	D	$v-\frac{3t}{2}+\frac{3t}{4}\sqrt{\frac{8F}{t}}$	$\min\left\{\frac{3v}{5t}, \frac{3}{2}-\frac{3}{4}\sqrt{\frac{8F}{t}}\right\}$	$\min\{\frac{v}{5}, v-t\}$		$\min\{1, \frac{4v}{5t}\}$

Table 2: Overview over market structure and prices for different parameter values

$\tilde{x}$ gives the share of the market that is covered in period 1 $\bar{x}$ is the market share of the incumbent both when entry occurs and when it does not occur.