Intrapersonal price discrimination in a dominant firm model

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Abstract

The standard dominant firm (DF)-competitive fringe model, in which all firms sell the good through linear pricing, is extended to the use of nonlinear contracts in the form of two-part tariffs (2PT). We show that under general conditions, the DF practices intrapersonal price discrimination, and supplies to fewer consumers than under linear pricing. As a consequence, nonlinear pricing leads to an inefficient result and consumers are worse off than when the DF uses linear prices; on the contrary, fringe firms are better off as they end up charging a higher price for the good.

Keywords: Dominant firm, fringe firms, linear and nonlinear contracts, intrapersonal price discrimination

JEL Classification: L11, L14

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1. Introduction

The features of the standard dominant firm (DF, from now on) or price-leadership model are well known: a large firm that supplies most of the market demand coexists with a number of small firms — referred to as the competitive fringe — that take the industry price as given. The sum of the marginal cost curves for the fringe firms (essentially their supply schedule), which the DF knows, represents the quantity of the good that together they want to supply at any observed price. Subtracting the collective supply curve of the fringe firms from the market demand curve affords the DF's residual demand curve and allows the DF to optimally choose the market price (Carlton and Perloff, 2000). This model fits a number of industries well, especially those emerging from restructuring processes, where the incumbent is obliged to sell a portion of its production capacity to different firms and new independent manufacturers (see some examples in Kahai et al., 1996; Rassenti and Wilson, 2004; Gowrisankan and Holmes, 2004; Bonacina and Gulli, 2007; Golombek et al. 2018; Brown and Eckert, 2021).

However, in real-world industries with a single large firm plus a set of small firms, the standard DF model fails to satisfactorily account for a commonly observed business practice: intrapersonal price discrimination (Stole, 2007). The aim of this paper is to fill that gap by extending the standard DF model, in which prices are restricted to being linear, to simulate intrapersonal price discrimination, reconciling the potential and merits of an extended DF model with nonlinear pricing to industries where the DF framework fits better than the oligopoly model.

In our setup, although there is no inter-consumer heterogeneity, intra-heterogeneity over the marginal value of each unit of consumption remains. Thus, a firm can capture part of the consumer surplus associated with intra-heterogeneity by offering a two-part tariff (2PT) contract. Our first finding is that, if feasible, the DF prefers intrapersonal price discrimination rather than a linear pricing setting.

A well-known result in a pure monopoly that sells a good to homogeneous consumers is that intrapersonal price discrimination through nonlinear (2PT) contracts leads to an efficient outcome, although at the expense of a reduced consumer surplus (see Tirole, 1988). Likewise, in a duopoly the bilateral relationship between each firm and the set of consumers with whom the bilateral relationship is established is also efficient whenever nonlinear pricing contracts are allowed (see Armstrong and Vickers, 2001; Armstrong, 2006; Stole, 2007). Hence, a market-power firm, whether a monopolist or duopolist, optimally renders the non-fixed part of the contract equal to its marginal production cost and extracts rents through the fixed part of the contract.

We show how the abovementioned result extends to a DF-fringe firms model in which the DF resorts to nonlinear pricing to sell the good.[1] Although the nonlinear contract offered by the DF to its consumers maximizes the joint surplus in their bilateral relationship, inefficiency now emerges since, in equilibrium, the DF supplies too few consumers.[2] What drives this inefficiency is that consumers accept the entire offer of either the DF or a fringe firm, i.e., there is 'one-stop shopping', so the surplus extracted by the DF depends on the value supplied to consumers by fringe firms. The more consumers seek to purchase from fringe firms, however, the less attractive this option becomes. Hence, the DF strategically reduces the number of consumers it supplies as a way to decrease their reservation values. Consumers supplied by the DF end up paying lower average prices and receiving more product than consumers served by the fringe for an identical product.

In addition, we show that in our revisited DF model, Armstrong and Vickers (2001)'s finding that nonlinear pricing contracts are pro-competitive and lead consumers to be better off no longer holds. In equilibrium, the fringe attends more consumers when the DF uses nonlinear prices that when it is restricted to use linear prices. As a consequence, when the DF uses nonlinear prices it turns out that consumers are worse off and both the DF and fringe firms benefit.

The rest of this paper is organized as follows. In Section 2, we outline the model. In Section 3, we examine the optimal pricing policy for the DF both under linear and nonlinear prices, as well as its impact on industry performance (consumer surplus and industry profits). We conclude in Section 4. An Appendix contains all the proofs of the results.

2. The model

Consider an industry comprised of a large firm (DF) and a fringe of smaller, competitive firms, with all of them producing a homogeneous good. We start by detailing preferences, technology and market interaction in this industry.

Preferences. There is a continuum of consumers of size one purchasing the good. Each consumer has preferences given by the same quasi-linear utility function $u(q, m) = U(q) + m$, where $U(q)$ represents the utility derived from consuming quantity q of the good and m stands for the numeraire. As usual, we assume that the inverse demand function $P(q) = U'(q)$ satisfies

[1] It is straightforward to extend the model to show that fringe firms prefer to maintain linear-pricing contracts.

[2] For product-differentiation models with free entry Bhaskar and To (2004) show that another inefficiency emerges, namely, the number of firms is always excessive.

the usual conditions $P(q) > 0$, $P'(q) = U''(q) < 0$ and $\rho \equiv -\frac{qP''(q)}{P'(q)} < 2$.[3] Finally, the consumer surplus function is defined as $CS(q) \equiv U(q) - P(q)q$.

Technology. The DF has a constant marginal cost of production c that satisfies $0 \leq c < P(0)$. Fringe firms, on the other hand, can together produce at most k units of the good at a constant unit (and marginal) cost $c_f \leq c$ (where the subscript f denotes fringe). We consider the fringe's capacity k below a given level $\bar{k}$ that satisfies $P(\bar{k}) = c$.

Market interaction. The interaction between the DF, fringe firms and consumers follows the standard treatment as described in textbooks.[4] Fringe firms cannot individually affect overall market performance due to their small production capacity, and given that the fringe size satisfies $k \leq \bar{k}$, there will be no slack fringe capacity in equilibrium. The timing of the industry game is as follows:

1. The DF decides whether to choose a nonlinear or linear pricing contract to sell the good to its consumers. With nonlinear pricing, the DF offers the price schedule $T(q) = F + pq$, whereby it sells the quantity q in exchange of total payment $T(q)$. Thus, any consumer that chooses the DF's contract can obtain the quantity q that maximizes the consumer surplus, i.e., that which satisfies the condition $P(q) = p$, and so ends up with a net surplus $CS(q) - F$. With linear pricing, on the other hand, it holds that $F = 0$ and a uniform per unit price emerges, whereby the payment for supplying quantity q is reduced to pq.

2. Fringe firms and consumers observe the contract offered by the DF. If that contract satisfies $CS(q) - F > CS(k)$, then the number of consumers n_f that purchase the good from the fringe will satisfy $CS(q) - F = CS\left(\frac{k}{n_f}\right)$.

3. The DF supplies the good to the (residual) $n \equiv 1 - n_f$ consumers not supplied by fringe firms.

3. The optimal choice of selling method

To evaluate inefficiencies caused by the selected selling method, we consider, as the first-best outcome, the aggregate welfare achieved when the quantity produced in the industry is that which solves the problem:

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[3] Condition $\rho < 2$ on the convexity of the demand function ensures that the second-order condition of the monopolist's problem is satisfied, and also ensures that the second-order condition of the DF's problem under both linear and nonlinear prices are satisfied (see footnotes 6 and 7 below).

[4] See, for instance, Carlton and Perloff (1994) and Gowrisankaran and Holmes (2004).

$$\max_{Q} \left\{U(Q+k) - cQ - c_f k\right\}. \quad (1)$$

From Eq. (1) the DF's production defining the first-best scenario, Q^{fb}, is that which satisfies $P\left(Q^{fb}+k\right) = c$ or $Q^{fb} = \bar{k} - k$ and so each consumer purchases $Q^{fb} + k = \bar{k}$. We define $n^{fb} = \frac{\bar{k}-k}{\bar{k}}$ as the number of consumers served by the DF in the first-best scenario. Finally, a competitive market would implement this equilibrium outcome with a price $p = P(\bar{k})$ and consumers would obtain a consumers surplus $CS(\bar{k})$.

We now investigate the DF's behavior and the resulting market performance for any given price schedule. When the DF supplies the good through a nonlinear pricing contract $T(q) = F + pq$, its consumers purchase quantity q verifying $P(q) = p$. Thus, if the DF has n consumers, its profits amount to $n\,(T(q) - cq) = n\,(F + P(q)q - cq)$. Since, in equilibrium, consumers are indifferent between purchasing from the fringe or the DF, it must follow that

$$CS(q) - F = CS\left(q_f(n)\right), \quad (2)$$

where $q_f(n) \equiv \frac{k}{1-n}$ denotes the quantity that consumers purchase to the fringe (we will frequently write q_f instead of $q_f(n)$ to save on notation). Note that

$$\frac{\partial q_f(n)}{\partial n} = \frac{q_f(n)}{1-n} > 0, \quad (3)$$

whereby the more consumers the DF supplies, the fewer consumers each fringe firm supplies, leading these consumers to receive a better deal from fringe firms. The mirror view is that, for the DF to retain more consumers, it must offer a better deal; thus, consumers remaining with a fringe firm will also receive a better deal, as they will purchase more quantity at a lower price.

In the analysis below, it is convenient to interpret the DF's selling method as a decision on the number of consumers it deals with in equilibrium. Taking into account both the impact on fringe firms' offers to their consumers according to Eq. (3) and the relationship between the fixed part of the nonlinear contract and the number of consumers the DF can retain,

$$F = CS(q) - CS\left(q_f(n)\right), \quad (4)$$

and the DF's profits can be rewritten as

$$\pi = n\left\{U(Q/n) - CS\left(q_f(n)\right)\right\} - cQ. \quad (5)$$

3.1 Only linear pricing contracts are allowed

The case in which the DF can only offer a linear pricing contract to consumers leads the (standard) DF model to be stated as follows: the DF plays as the price leader, the fringe firms decide how much to produce and the DF acts as the residual claimant. However, following the above discussion, we can restate this model in terms of the number of consumers supplied by the DF instead of the more standard residual-demand interpretation.[5]

Since all firms charge the same price $p = P(q_f)$ in equilibrium, DF's problem becomes

$$\max_{Q} \pi^l = [P(Q+k) - c]Q, \tag{6}$$

(where the superscript l refers to linear pricing) and its optimal production Q^l is that which satisfies the first-order condition (FOC)[6]

$$0 = \frac{\partial \pi^l}{\partial Q} = \left(P\left(Q^l + k\right) - c\right) + P'\left(Q^l + k\right) Q^l \,. \tag{7}$$

Fulfillment of the FOC in Eq. (7) yields $P\left(Q^l + k\right) > c$, which is the well-known inefficiency outcome according to which the DF sets the price above the marginal production cost, and hence, above the competitive price.

Finally, if we define $n^l \equiv \frac{Q^l}{Q^l + k}$ as the number of consumers the DF deals with, the following lemma summarizes the equilibrium outcome under linear pricing.

Lemma 1. *If only linear prices are feasible, the following hold:*

(i) *The quantity of good supplied by the DF is inefficiently low,* $Q^l < Q^{fb}$.
(ii) *The number of consumers the DF serves is below that which maximizes welfare,* $n^l < n^{fb}$.
(iii) *Consumers are worse off than in the competitive equilibrium,* $CS\left(Q^l + k\right) < CS\left(\bar{k}\right)$.

Proof. From Eq. (7) we know that, in equilibrium, the quantity supplied by the DF, q^l, satisfies $P\left(q^l + k\right) > c$, whereas the efficient quantity satisfies $P\left(q^{fb} + k\right) = c$. Since $P'(\cdot) < 0$, it follows that $q^l < q^{fb}$. From here, it immediately follows that

$$n^l = \frac{q^l}{q^l + k} < n^{fb} = \frac{q^{fb}}{q^{fb} + k}$$

[5] Under linear pricing contracts consumers can purchase at no cost from many suppliers at the same time. This way of stating the DF's behavior will be useful later on when comparing the results obtained if the DF can set a nonlinear price.

[6] The DF's problem given in Eq. (6) is strictly concave in q provided that $\frac{\partial^2 \pi^l}{\partial Q^2} = 2P'(Q^l + k) + P''(Q^l + k)Q = P'(Q^l + k)\left(2 + \frac{P''(Q^l + k)q}{P'(Q^l + k)}\right) < 0$ given the assumption $-\frac{P''(Q)Q}{P'(Q)} < 2$.

Finally, since the consumer surplus increases with the quantity consumed, we have

$$CS(q^l + k) < CS(q^{fb} + k)$$

which completes the proof of the lemma. ■

In equilibrium, the DF sets price above the marginal cost and reduces the quantity produced; this is equivalent to stating that, in equilibrium, a price above the marginal cost leads the DF to reduce the number of consumers it deals with. Consumers are worse off than in a competitive equilibrium, because fringe firms have an enlarged consumer base for their limited production capacity, which leads to higher prices for consumers and reduced consumption.

3.2 Nonlinear pricing contracts are allowed

We now consider the scenario in which the DF can resort to a nonlinear 2PT contract, $T(q) = F + pq$. Consumers accepting this offer obtain $CS(q) - F$ as the net consumer surplus. In equilibrium, fringe firms provide the same consumer surplus to their consumers, possibly through a different level of consumption and a different price.

When the DF uses a 2PT contract, fringe firms supply the quantity $q_f(n)$ satisfying Eq. (2). Therefore, in equilibrium it follows that $T(q) = U(q) - CS\left(q_f(n)\right)$ and the DF's payoff can be written as

$$\pi^c = n\left(U(q) - cq - CS\left(q_f(n)\right)\right), \tag{8}$$

(where the superscript c denotes (nonlinear) contracts to sell the good). In choosing the pair $\{q, n\}$ that maximizes profit given in Eq. (8), the optimal quantity q^c is that which satisfies

$$P(q^c) = c \tag{9}$$

or $q^c = \bar{k}$; hence, the DF offers each consumer a 2PT contract that maximizes the joint profits of their bilateral relationship. Note that the DF's profit under this nonlinear contract is, of necessity, higher than the profit under linear pricing. In fact, the DF could supply the same number of consumers under nonlinear 2PT contracts as under linear contracts, $n = n^l$, in which case the pricing of fringe firms would not change compared to pricing when all firms sell through linear pricing, and consumers supplied by the fringe would obtain the consumer surplus $CS\left(q_f(n^l)\right)$. However, the DF could offer a larger quantity to its consumers, $q > q_f^l$, and charge them a fee.

Using condition given in Eq. (9), the FOC to maximize profits given in Eq. (8) can be written as[7]

$$0 = \frac{\partial \pi^c}{\partial n} = \left[U(q^c) - cq^c - \left(U(q_f) - P(q_f)q_f\right)\right] + n\,P'(q_f)\,q_f\,\frac{\partial q_f}{\partial n}, \tag{10}$$

where the term — with a positive sign — within brackets, measuring the direct impact of a change in its number of consumers on the DF's profits, is related to the fee of the 2PT contract that the DF can charge its consumers, whenever it charges its consumers a lower marginal price than fringe firms (and hence offers them to increase purchases). As for the term — this time with a negative sign — outside brackets, this reflects the strategic impact of a change in the number of DF's consumers on the DF's profits: a lower consumer base for fringe firms means that consumers receive a better deal, and this forces the DF to reduce the fee. In equilibrium, the fee paid by the DF's consumers amounts to $F^c = CS(q^c) - CS\left(q_f(n^c)\right)$, and therefore, all consumers, irrespective of whether they are supplied by the DF or fringe firms, end up with the same net consumer surplus.

The next lemma characterizes the market equilibrium resulting from the DF's optimal choice of the number of consumers to be served and the quantity of the good to be supplied to each.

Lemma 2. *If the good can be sold through nonlinear contracts, then intrapersonal price discrimination emerges in equilibrium. Moreover:*

(i) *The DF serves fewer consumers than it would serve in the first-best scenario,* $n^c < n^{fb}$.

(ii) *Fringe consumers' purchases are below the efficient level,* $q_f(n^c) < \bar{k}$.

(iii) *Consumers are worse off than in the competitive equilibrium,* $CS(\bar{k}) - F^c = CS\left(q_f(n^c)\right) < CS(\bar{k})$.

Proof. From the FOC given in Eq. (10), the number of consumers the DF chooses n^c is that which satisfies $CS(\bar{k}) > CS(q_f(n^c))$, or

$$q_f(n^c) = \frac{k}{1-n^c} < \bar{k} = \frac{k}{1-n^{fb}}$$

and inequality (A3) implies $n^c < n^{fb}$.

[7] The DF's problem is strictly concave in n provided that $\frac{\partial^2 \pi^c}{\partial n^2} = P'(q_f)q_f^2\left[2 + n\left(1 + \frac{P''(q_f)q_f}{P'(q_f)}\right)\right] < P'(q_f)q_f^2(2 - n) < 0$ given the assumption $-\frac{P''(Q)Q}{P'(Q)} < 2$.

Although each DF consumer receives the efficient quantity $\bar{k}$, the fact that each share of consumers is less than optimal implies that the DF's production is below the optimal production, namely $q^c = n^c\bar{k} < q^{fb} = n^{fb}\bar{k}$.

The consumer surplus is below the efficient level both for consumers served by fringe firms and consumers served by the DF. Consumers supplied by the fringe pay a higher unit price, $P\left(q_f(n^c)\right) > P(\bar{k})$, and therefore are worse off than in a competitive market, $CS\left(q_f(n^c)\right) < CS(\bar{k})$. On the other hand, consumers supplied by the DF have optimal consumption, but in addition to the unit price $P(\bar{k})$ they are charged a strictly positive fee; hence, their consumer surplus $CS(\bar{k}) - F$ is strictly below that which they would obtain in a competitive market. ■

The DF has an incentive to reduce the number of consumers it supplies (compared to the situation of competitive equilibrium) because fringe firms offer worse deals to the remaining consumers; hence the (alternative) option of purchasing from fringe firms becomes less attractive and the DF can charge a higher fee. In striking contrast, therefore, with the standard result of price-discrimination efficiency in pure monopoly, intrapersonal price discrimination in a DF model leads to inefficiencies: the DF supplies fewer consumers than in the first-best scenario and production and consumption are thus inefficiently distributed. The consumers supplied by fringe firms receive a smaller quantity of the good than the consumers supplied by the DF (who pay a positive fee in exchange).[8]

Our findings crucially depend on the fact that the consumer surplus of consumers supplied by fringe firms — their reservation value when they have to accept or reject the DF's contract — is endogenous to the number of consumers supplied by fringe firms and, moreover, can be manipulated by the DF. If the DF instead faced n potential consumers with an exogenous alternative reservation value CS below $CS(\bar{k})$, i.e., a value that the DF could not manipulate, then the DF would supply all consumers, offering them the efficient quantity $\bar{k}$ and charging them a 2PT with the unit or marginal price $p^m = P(\bar{k})$ and the strictly positive fixed fee $F^m = CS(\bar{k}) - CS > 0$.

4. The impact of nonlinear prices

[8] Moreover, consumers supplied by fringe firms consume a smaller quantity of the good than in a competitive market, whereas those supplied by the DF consume a larger quantity than in a competitive market.

In the previous section, two results were demonstrated. First, whenever nonlinear 2PT contracts are feasible to selling the good, the DF practices intrapersonal price discrimination. Second, irrespective of whether or not firms are limited to selling through uniform prices, the DF restricts the number of consumers it supplies, thereby distorting the market. However, it is not immediate whether the DF supplies fewer consumers under linear contracts or under nonlinear contracts. Two countervailing effects hold if the DF moves from linear pricing to more general nonlinear contracts when choosing its market share. On the one hand, the increase in efficiency achieved when a 2PT contract is used means that higher rents can be extracted from each consumer, and the fact that each consumer is more valuable under a nonlinear contract will push the DF towards supplying more consumers. On the other hand, the DF wishes to restrict the number of consumers to be supplied as a means of increasing the fee it can charge, since the alternative — to purchase from fringe firms — is worse if more consumers use this channel. Thus, the DF can extract more surplus if it supplies fewer consumers, i.e., reduces its market share. In the following proposition, we summarize the impact on market performance of a nonlinear 2PT pricing contract versus a linear pricing contract.

Proposition 1 summarizes this discussion.

Proposition 1. *The DF supplies fewer consumers under nonlinear contracts than under linear contracts,* $n^c < n^l$.

Proof. First, consumers supplied by the DF receive a lower quantity of good if pricing is linear rather than nonlinear; namely, $q^l + k < q^c$. (From Eqs. (7) and (9), it follows that $P\left(q^l + k\right) > c = P(q^c)$, since $P'(\cdot) < 0$, which leads to $q^l + k < q^c$).

Define the function

$$H(n, q) = \left[(U(q) - cq) - U(q) - cq - CS(q_f(n))\right] + \frac{P'(q)q + P(q) - c}{P'(q)q} P'\left(q_f(n)\right) q_f(n) n \frac{\partial q_f(n)}{\partial n}$$

which particularizes as $H\left(n^l, q^l\right) = \left[P'\left(q^l\right)q^l + P\left(q^l\right) - c\right] n^l \frac{\partial q_f}{\partial n} = 0$ (the term in brackets is the FOC of the DF's maximization problem when restricted to sell the good through linear pricing), and particularizes as $H(n^c, q^c) = 0$ because $H(n^c, q^c)$ is equivalent to the FOC of the DF's maximization problem when nonlinear contracts are feasible to selling the good. Since $q^l < q^c$, we can analyze how n evolves when q increases in the interval $[q^l,\ q^c]$ to satisfy the condition $H(n(q), q) = 0$.

From the implicit function theorem, it holds that

$$\frac{\partial n}{\partial q} = -\frac{\frac{\partial H(n,q)}{\partial q}}{\frac{\partial H(n,q)}{\partial n}}$$

and $\frac{\partial H(n,q)}{\partial n}$ is given by

$$\frac{\partial H(n,q)}{\partial n} = P'(q_f)\frac{q_f}{1-n}\left[q_f + \frac{P'(q)q + P(q) - c}{P'(q)q}\frac{q_f + n\left(2 + \frac{P''(q_f)q_f}{P'(q_f)}\right)}{1-n}\right] < 0$$

where we drop the variable n in $q_f(n)$ when there is no possibility of confusion and we use the fact that $\frac{\partial q_f}{\partial n} = \frac{q_f}{1-n}$, $P'(q)q + P(q) - c < 0$, for $q \in (q^l,\ q^c)$, and that $2 + \frac{P''(q_f)q_f}{P'(q_f)} > 0$.

On the other hand, $\frac{\partial H(n,q)}{\partial q}$ can be written as

$$\frac{\partial H(a,q)}{\partial q} = P(q) - c + \frac{\partial\left(\frac{P'(q)q + P(q) - c}{P'(q)q}\right)}{\partial q}P'(q_f)q_f n\frac{\partial q_f}{\partial n}$$

and taking into account that

$$\frac{\partial\left(\frac{P'(q)q + P(q) - c}{P'(q)q}\right)}{\partial q} = \frac{P'(q)[P'(q)q + P(q) - c] - (P(q) - c)[P''(q)q + 2P'(q)]}{(P'(q)q)^2} > 0$$

and

$$P'(q_f)q_f n\frac{\partial q_f}{\partial n} < 0,$$

it follows that $\frac{\partial H(a,q)}{\partial q}$ verifies

$$\frac{\partial H(n,q)}{\partial q} < P(q) - c + \frac{P'(q)q + P(q) - c}{P'(q)q^2}P'(q_f)q_f n\frac{\partial q_f}{\partial n}.$$

Taking into account that from $H(n(q), q) = 0$ it holds that

$$\frac{P'(q)q + P(q) - c}{P'(q)q^2}P'(q_f)q_f n\frac{\partial q_f}{\partial n} = -\frac{U(q) - cq - CS(q_f)}{q}$$

we have that

$$\frac{\partial H(n,q)}{\partial q} < P(q) - c + \frac{P'(q)q + P(q) - c}{P'(q)q^2}P'(q_f)q_f n\frac{\partial q_f}{\partial n} = -\frac{CS(q) - CS(q_f)}{q} < 0,$$

from the fact that the consumer surplus is increasing in q and that $q > q_f$. Thus, $\frac{\partial H(n,q)}{\partial q} < 0$ and, therefore, $\frac{\partial n}{\partial q} < 0$. This implies $q^l < q^c$ and, consequently, $n^c < n^l$. This completes the proof of the Proposition. ■.

Proposition 1 shows that, of the two countervailing effects arising when the DF moves from linear pricing to more general nonlinear 2PT contracts, the dominant effect is the incentive to supply fewer consumers in order to increase the fee charged thanks to purchasing from fringe firms becomes less satisfactory for each consumer as more consumers purchase from them. Thus, the DF delivers a greater quantity to fewer consumers under nonlinear pricing contracts than under uniform prices.

An immediate consequence of Proposition 1 is the following result.

Corollary 1. *If the DF uses nonlinear contracts, then:*

(i) *Consumers are worse off than if the DF would set a linear price,* $CS(\, q^c) - F^c = CS\big(q_f(n^c)\big) < CS(\, q^l)$.

(ii) *All firms obtain more profits than if the DF would set a linear price.*

The use of nonlinear contracts by the DF causes a decrease in the consumer surplus. Given that purchasing from fringe firms is a less satisfactory option when more consumers use this option, the DF's consumers must pay higher prices. Also, both the DF and fringe firms obtain higher profits when nonlinear 2PT contracts are allowed. As discussed above, the DF increases its profit under nonlinear prices even if it supplies the same number of consumers as under linear pricing: this is because it offers a higher quantity and charges a fixed fee. But fringe firms also increase their profits when the DF sell the good through nonlinear contracts, because their consumer base is larger.

5. Final remarks

In this article, we have provided a rationale for a stylized fact commonly observed in real-life industries with a DF competing with a fringe of small firms; namely, that the DF prefers to set nonlinear prices whenever discrimination is feasible and intrapersonal price discrimination thus emerges in equilibrium. Furthermore, our model also suggests that consumers are worse off when the DF practices intrapersonal price discrimination, because the number of consumers the DF chooses to supply under nonlinear prices is even lower that when restricted to use linear prices. Finally, the use of nonlinear prices by the DF becomes a collusive device that benefits both the DF and fringe firms.

We focused on the case in which all consumers have the same preferences so as to concentrate on the rationale underpinning a nonlinear price strategy in a competition environment — not as a foreclosure device, but as a collusive device that may favor all firms in the industry and yield allocative inefficiencies. A circumvented question in the analysis, however, would be to examine how heterogeneous consumers with different degrees of willingness-to-pay for the good could affect firms' behavior in a nonlinear pricing context, e.g., to determine which firms would keep the consumers that most value the good.

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