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Raising Rivals' Costs Through Buyer Power*

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Abstract

We re-examine the view that a ban on price discrimination in input markets is particularly desirable in the presence of buyer power. This argument crucially depends on an inverse relationship between downstream firms' profits and the uniform input price. Assuming different input efficiencies among downstream firms, we derive a necessary and sufficient condition such that a higher input price benefits a subset of relatively efficient downstream firms. In such instances, consumers may be better off if discriminatory pricing is feasible.

JEL Classification: L13, D43, K31.

Keywords: Price discrimination, Buyer Power, Raising Rivals' Costs.

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1 Introduction

We contribute to the literature that compares different pricing regimes (*discriminatory* vs. *uniform* pricing) in vertical settings, where an upstream monopolist supplies an input to downstream firms which compete in Cournot fashion in the final goods market. In a seminal contribution to the topic Katz (1987) has shown that price discrimination can raise the price to all buyers when they are Cournot competitors in the downstream market. In that setting downstream firms are assumed to be symmetric except that one of the buyers (the "dominant" firm) has a better outside option than rivals.[1]

Katz's result can be described for the two-firms case as follows. Suppose that the dominant firm's outside option is a binding constraint both when discrimination is forbidden and when it is allowed. Under discriminatory pricing, the dominant firm obtains a relatively low input price because of its outside option. In equilibrium it is indifferent between purchasing from the supplier and using the outside option. If, however, price discrimination is banned, typically the monopolist adjusts by lowering the price for the rival firm, but raising the price for the dominant firm. But this is not optimal in the presence of buyer power since a price reduction to the rival firm reduces the dominant firm's profit. Therefore, a price reduction to the rival firm must be accompanied by a reduction in the price charged from the dominant firm to prevent it from turning to its outside option. This reasoning gives rise to a new (low-uniform price) equilibrium if the own profit effect dominates the cross profit effects; that is, if an increase in the dominant firm's input price affects its profit by more (in absolute value) than an increase in the rival's wholesale price. Then, raising the dominant firm's price toward the rival's price in order to satisfy the non-discrimination constraint will not work if the seller wishes to continue selling to the dominant firm. Thus, the monopolist must lower the uniform input price for both firms. Since both prices fall, a non-discrimination rule reduces the final

[1] See Inderst and Valetti (2009) for a generalization of Katz (1987) and O'Brien (2014) for a qualification of Katz's result. The latter work is complementary to our undertaking. It shows that the dominant firm's source of bargaining power is critical for the Katz result to hold.

good price and increases consumer surplus.

Our point is that this reasoning is not valid anymore when downstream firms are asymmetric; in particular, when firms differ in their productivity levels with regard to the use of the input. In such a setting, cross profit effects might dominate own profit effects such that the dominant firm's profit is increasing rather than decreasing in a common wholesale price. If this is the case, then a downstream firm's buyer power unfolds upward pressure on the uniform input price as an input price increase raises the marginal cost of the rival by more than it raises the marginal cost of the dominant firm. If differences in input efficiencies are sufficiently pronounced, then a relatively efficient downstream firm benefits from a high uniform input price because of a raising rivals' costs effect (see Williamson, 1968). Here, the seller's optimal response to a non-discrimination constraint is to raise rather than lower the price it charges the dominant firm. Therefore, we reverse Katz (1987) by establishing that in the presence of buyer power consumers may be better off if discriminatory pricing is feasible.

In Section 2, we introduce the model. We provide an example in Section 3 and prove its generality in Section 4. Finally, Section 5 concludes.

2 The Model

We consider an upstream monopolist producing an input good which it sells to n downstream firms (indexed by $i \in I = \{1, ..., n\}$) at price w_i. Under discriminatory pricing (indexed by "D") the upstream monopolist can charge different prices from downstream firms. When discriminatory pricing is banned (indexed by "U"), the monopolist must charge a uniform input price from all downstream firms. We consider a two-stage game, where the upstream firm first sets either discriminatory prices (regime D) or a uniform price (regime U). In the second stage, downstream firms compete in the final goods market à la Cournot.

Let q_i denote firm i's output of the homogenous final good. The inverse demand function $P(Q)$ is downward sloping, $P'(Q) < 0$, where $Q := \sum_i q_i$. Firm i's cost function is given by $C_i(q_i, w_i) = \alpha_i w_i q_i + \beta_i q_i$, for $i = 1, ..., n$, where $\alpha_i \geq 0$ measures the input efficiency of firm i ("α-efficiency") and $\beta_i \geq 0$ represents additional marginal production costs of firm i ("β-efficiency").[2] Firm i's profit function is then given by $\Pi_i = P(Q)q_i - \alpha_i w_i q_i - \beta_i q_i$.

Downstream firm $k \in I$ has buyer power through an outside option which gives rise to a profit level of V^0.[3] We assume that this outside option is binding and effectively constraints the upstream monopolist's maximization problem which is given by[4]

$$\begin{aligned} \max_{w_1,...,w_n \geq 0} L &= \sum_{i=1}^{n} \alpha_i q_i w_i \\ \text{subject to } \Pi_k(q_k, Q_{-k}) &\geq V^0, \end{aligned}$$

where $Q_{-k} := \sum_{j=1, j\neq k}^{n} q_j$. If price discrimination is banned, then the monopolist's problem is additionally constrained by the requirement $w_1 = ... = w_n$.

We assume that each firms' reaction function slopes downward with slope between -1 and 0, which follows from[5]

$$P''(Q)q_i + P'(Q) < 0 \text{ for } i = 1, ..., n. \tag{1}$$

[2] Yoshida (2000) established the discinction between α- and β-efficiencies. Whereas the assumption of symmetric α-efficiencies may be plausible with respect to storable retailing and durable goods, there are many conceivable instances where downstream firms differ in their α-efficiencies. In the case of unionized labor, firms may differ in their labor productivities such that (presumably, more capital-intense) firms can use their labor force more efficiently than others. Or, in the case of raw materials, some firms may produce less waste and thus use their inputs more efficiently in the production process of the final good. In the case of tradable emission rights for carbon dioxide, firms typically differ in their emission levels that are necessary to produce a given quantity of electricity, steel, or cement, to name just a few examples. Even with respect to retailing and perishable goods certain retailers may be more efficient while others generate more spoiled goods.

[3] See Dertwinkel-Kalt et al. (2014) for an example with an endogenous outside option, where a firm can integrate backward as in Katz (1987).

[4] We assume throughout our analysis that the upstream monopolist finds it optimal to sell to all downstream firms. Hence, in equilibrium all downstream firm are active and procure the input from the monopolist. This assumption is also critical in Katz (1987) and Yoshida (2000).

[5] This inequality holds if the industry demand curve satisfies $P''(Q)Q + P'(Q) < 0$.

We first present an example to show that buyer power can make discriminatory pricing more attractive than uniform pricing from a consumer surplus perspective. In a second step we show the generality of our result.

3 Example

We show by example that in the presence of buyer power (i.e., a dominant downstream firm has an outside option) consumers can be made better off under discriminatory than under non-discriminatory pricing. Let $P = 1 - Q$, $n = 2$, $\beta_1 = \beta_2 = 0$, $\alpha_1 = 1$ and $\alpha_2 = 3$ and let the upstream supplier produce at cost zero. Solving downstream firms' first-order conditions we obtain firms' optimal outputs $q_1(w_1, w_2) = 1/3 - 2w_1/3 + w_2$ and $q_2(w_1, w_2) = 1/3 + w_1/3 - 2w_2$. If the input price is uniform, then $q_1(w) = (1 + w)/3$ and $q_2(w) = (1 - 5w)/3$. Given those derived demands, we examine the optimal price setting of the input supplier.

We first analyze the price discriminatory regime. The upstream manufacturer solves

$$\max_{w_1, w_2 \geq 0} (\alpha_1 w_1 q_1(w_1, w_2) + \alpha_2 w_2 q_2(w_1, w_2)).$$

This gives rise to the first-order conditions

$$\alpha_i q_i + \alpha_i w_i \frac{dq_i}{dw_i} = 0, \text{ for } i = 1, 2,$$

which yield the equilibrium input prices $w_1^D = 1/2$ and $w_2^D = 1/6$.

Second, we solve the manufacturer's maximization problem under uniform pricing. The upstream firm solves $\max_{w \geq 0} w(q_1(w) + q_2(w))$, which yields the first-order condition

$$Q + w \left(\frac{dq_1}{dw} + \frac{dq_2}{dw} \right) = 0.$$

This gives the optimal uniform input price $w^U = 1/7$. Firm 1 earns under the price-discriminatory regime $\pi_1^D = 1/36 \approx 0.028$, while it realizes $\pi_1^U = 64/441 \approx 0.145$ under the uniform pricing regime. It is easily checked that consumers strictly favor uniform pricing.

Now we introduce an outside option for firm 1 which provides profit level V^0. Assume that the outside option binds under both regimes.[6] We show that the profit of the relatively efficient firm increases over some range in the common wholesale price, such that under uniform pricing the input price will rise in firm 1's outside option. Under the discriminatory regime, w_1 is decreasing in V^0 and w_2 is independent of V^0. Solving for the optimal input prices (provided that V^0 binds) gives $w_1^D = 3/4 - 3\sqrt{V^0}/2$ and $w_2^D = 1/6$ and under uniform pricing $w^U = w_1^U = w_2^U = 3\sqrt{V^0} - 1$. Defining the sum of firm's marginal costs as $MC := \sum_i \alpha_i w_i + \beta_i = \alpha_1 w_1 + \alpha_2 w_2$, we obtain $MC^D = 5/4 - 3\sqrt{V^0}/2$ and $MC^U = 12\sqrt{V^0} - 4$, so that

$$MC^D < MC^U \text{ if and only if } V^0 > \frac{49}{324} \approx 0.151 > \pi_1^U.$$

Note that consumer surplus is monotonically increasing in the overall quantity Q, while Q is monotonically decreasing in the sum of firms' marginal costs. It follows that, if firm 1's outside option is sufficiently attractive, final consumers benefit from input price discrimination. Instead, uniform pricing induces firm 1 to use its buyer power to establish higher input prices, which leads to a reduction in consumer surplus.

4 General Analysis

We investigate the previous example in a more general setup and derive conditions on the downstream firm's input efficiencies for which the result by Katz (1987) is reversed; i.e., where consumers favor a discriminatory pricing regime. The key element of our general analysis is to specify a necessary and sufficient condition for firm k's profit to increase with a rise in the uniform input price. Firm k's profit increases in the uniform input price

[6] This is of course a simplification which allows us to abstract from a full specification of subgames which would follow if firm 1 reverts to its outside option. In general, the outside option may be binding only in one regime and the upstream monopolist may want to supply only firm 2 instead of meeting firm 1's outside option (see Dertwinkel-Kalt et al., 2014, for such an analysis).

w if and only if

$$\frac{d\Pi_k(q_k, Q_{-k})}{dw} = \frac{\partial \Pi_k}{\partial w} + \frac{\partial \Pi_k}{\partial q_k}\frac{dq_k}{dw} + \frac{\partial \Pi_k}{\partial Q_{-k}}\frac{dQ_{-k}}{dw} > 0 \tag{2}$$

holds, where $\frac{\partial \Pi_k}{\partial w} = -\alpha_k q_k$, $\frac{\partial \Pi_k}{\partial q_k}\frac{dq_k}{dw} = 0$ (envelope theorem), and $\frac{\partial \Pi_k}{\partial Q_{-k}}\frac{dQ_{-k}}{dw} = P' q_k \frac{dQ_{-k}}{dw}$. Thus, (2) is equivalent to

$$q_k \left(-\alpha_k + P' \frac{dQ_{-k}}{dw} \right) > 0. \tag{3}$$

In a Cournot-Nash equilibrium, all firms' first-order conditions are fulfilled; i.e.,

$$\Pi_i' = P' q_i + P - \alpha_i w - \beta_i = 0, \text{ for all } i \in I. \tag{4}$$

Summing over all $i \in I \backslash \{k\}$ first-order conditions yields

$$P' Q_{-k} + (n-1)P - \sum_{i \neq k} (\alpha_i w + \beta_i) = 0. \tag{5}$$

Note that in equilibrium the total output Q is inversely proportional to the sum of firms' marginal production costs $MC := \sum_{i=1}^{n} \alpha_i w_i + \beta_i$. Taking the total derivative of (5) with respect to w, q_k and Q_{-k} gives

$$(P'' Q_{-k} + nP') dQ_{-k} + (P'' Q_{-k} + (n-1)P') dq_k - \left(\sum_{i \neq k} \alpha_i \right) dw = 0,$$

which is equivalent to

$$\frac{dQ_{-k}}{dw} = \frac{\sum_{i \neq k} \alpha_i - (P'' Q_{-k} + (n-1)P') dq_k / dw}{P'' Q_{-k} + nP'}. \tag{6}$$

Accordingly, taking the total derivative of firm k's first-order condition and re-arranging, we obtain

$$\frac{dq_k}{dw} = \frac{\alpha_k - (P'' q_k + P') dQ_{-k}/dw}{P'' q_k + 2P'}. \tag{7}$$

Substituting (7) into (6) and plugging this into (3), we obtain the following condition which ensures that firm k's profit depends positively on the uniform input price:

$$\frac{a_k}{\sum_{i \neq k} \alpha_i} < \frac{2P' + P'' q_k}{2nP' + P''(q_k + 2Q_{-k})}. \tag{8}$$

If firms are sufficiently asymmetric with regard to their α-efficiencies, then there is always some firm j for which $\alpha_j / \sum_{i \neq j} \alpha_i \geq 1/(n-1)$ holds, while the right-hand side of (8) is strictly smaller than $1/(n-1)$.[7] Thus, condition (2) implies that $d\Pi_i(q_i, Q_{-i})/dw < 0$ holds for some $i \in I$. Consequently, if firm k's profit is increasing in the uniform input price, then there is at least one other firm i for which the profit decreases in w. In particular, firms which produce with an α-efficiency below the market's average can never benefit from input price increases. Interestingly, in order for condition (2) to hold, it is not important how many firms are more or less efficient than firm k, but only the relation to firms' average efficiency in the market is critical. It is noteworthy that only α-efficiencies play a role since they can, in contrast to β-efficiencies, result in overproportional disadvantages for rival downstream firms. An increase in the input price can, therefore, benefit a firm only if other firms are harmed overproportionally so that a *raising rival's cost* effect exists.

Lemma 1. *Firm k's profit is increasing in the uniform input price w if and only if condition (8) holds which depends on downstream firms' α-efficiencies but not on their β-efficiencies. For the linear demand case, with $P'' = 0$, this condition reduces to*

$$\frac{a_k}{\sum_{i \neq k} \alpha_i} < \frac{1}{n}.$$

Next, we compare the discriminatory and the non-discriminatory pricing regimes. We show that consumer surplus can be lower under non-discriminatory pricing. Suppose an equilibrium under discriminatory pricing $(w_1^D, ..., w_n^D)$. Suppose also that in this equilibrium the dominant firm's outside option is binding. This equilibrium gives rise to a certain consumer surplus level which is inversely related to the sum of firms' marginal costs. We can next calculate the uniform input price, $\overline{w}$, which gives rise to the same sum of firms' marginal costs (and hence the same consumer surplus level) as under the discriminatory prices $(w_1^D, ..., w_n^D)$. This "consumer-surplus fixing" price is given by $\overline{w} =: \sum_i \alpha_i w_i^D / \sum_i \alpha_i$. Assume that the dominant firm's profit level is smaller under the uniform input price $\overline{w}$ than under the discriminatory pricing equilibrium. Hence, the dominant firm's outside option is better in this case, but suppose that the resulting gap

[7] It is obvious that it is below $1/(n-1)$ if $P'' \leq 0$. If $P'' > 0$, then condition (1) implies $2nP' + P''(q_k + 2Q_{-k}) = 2(n-1)P' + P''q_k + 2(P' + P''Q_{-k}) < 2(n-1)P' + P''q_k$ so that the right hand side of condition (8) is below $1/(n-1)$.

is not too large. Given that condition (8) holds, it then follows that the upstream monopolist must *increase* the uniform input price above $\bar{w}$ to induce the dominant firm to accept the offer. The following proposition summarizes this reasoning.

Proposition 1. *Let $(w_1^D, ..., w_n^D)$ be the vector of input prices in the discriminatory equilibrium in which the dominant firm's outside option binds. Let $\overline{w}$ be the uniform input price which gives rise to the same consumer surplus as under the discriminatory equilibrium. Assume that the dominant firm's profit level is smaller under the uniform input price $\overline{w}$ than in the discriminatory equilibrium. If the dominant firm's outside option can be made profitably binding and if condition (8) holds, then the equilibrium uniform input price fulfills $w^U > \overline{w}$. In that case, consumer surplus is strictly lower under uniform pricing when compared with discriminatory pricing.*

Proposition 1 reverses the result by Katz (1987) that price discrimination bans are desirable from a consumer's perspective in the presence of buyer power. In Katz's model the dominant firm's binding outside option unfolds downward pressure on the uniform input price, which leads to a lower final good price and an increase in consumer surplus. This relationship follows from the assumption that firm i's marginal cost function is given by $w + \beta_i$, so that firms are allowed to differ only with respect to their β-efficiency, but not with respect to their α-efficiency.

5 Conclusion

We have provided a rationale why the exercise of buyer power of downstream firms vis-à-vis an input supplier may result in an overall higher input price under uniform pricing, which reduces consumer surplus. Based on this, we have argued why price discrimination of a monopoly supplier may benefit consumers in the presence of downstream buyer power. A relatively efficient downstream firm may benefit from a higher uniform input price because of a raising rivals' costs effect where rival firms' are harmed overproportionally from an input price increase. This, however, can only happen if firms are sufficiently asymmetric with regard to their input efficiencies.

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