

Eliciting demand information through cheap talk: An argument in favor of a ban on price discrimination

Lars Frisell^{a,*}, Johan N.M. Lagerlöf^{b,1}

^a *Sveriges Riksbank, Brunkebergstorg 11, 103 37 Stockholm, Sweden*

^b *University of Copenhagen, Denmark, and CEPR*

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Abstract

A uniform pricing rule may enable the communication of demand information from buyer to seller in situations where this would not have been possible if the seller could price discriminate. Importantly, such a rule can benefit both buyer and seller.

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1. Introduction

Antitrust policy has traditionally been very strict about price discrimination, sometimes even treating it as a per se offense. According to European competition law (specifically, Article 82 of the EC Treaty) it constitutes an abuse for one or several firms having a dominant position to apply “dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage”. In this judicial tradition, price discrimination is considered to be unfair because some buyers must pay a higher price than others for an equivalent good or service, unless the price differential is motivated by cost differences.²

The early economics literature focused on the exploitative effects of price discrimination, i.e., that it allows dominant firms to increase profits at the expense of consumers. It also stressed that the allocation of output tends to be inefficient when

different consumers meet different prices.³ However, more recent economic analysis has characterized circumstances under which price discrimination can increase both total welfare and consumer welfare. This may occur since allowing price discrimination may lead to higher output. The reason is that when sellers are forced to use linear pricing, they may (optimally) set prices so high that buyers with low valuation for the good are completely left out of the market. Today the prevailing view among economists seems to be that, although the welfare effect of price discrimination in general is ambiguous (Schmalensee, 1981; Varian, 1985), non-discrimination rules probably do more harm than good.

In this paper we bring forth a new argument in support of a ban on price discrimination in an incomplete-information environment. We show that a uniform pricing rule, which guarantees all (active) buyers a strict surplus, may enable information sharing between buyer and seller. Such communication increases welfare in two ways: it increases the probability of (efficient) production in instances where demand is high, and reduces the probability of (wasteful) production when demand is low. Moreover, the welfare gain may not accrue only to

* Corresponding author. Tel.: +46 87870275, fax: +46 8210531.

E-mail address: lars_usa@yahoo.com (L. Frisell).

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² For an in-depth discussion of price discrimination under EC competition law, see Geradin and Petit (2005). For a discussion of the fairness concept and price discrimination, see Gehrig and Stenbacka (2005).

³ For example, in the case of linear demand and constant returns to scale, it has been shown that, if all markets (customers) are served under linear pricing, allowing price discrimination strictly reduces welfare (Schmalensee, 1981).

buyers, which means that a ban on price discrimination may also be preferred by the seller. That is, a non-discrimination rule, properly enforced by the judicial system, constitutes a commitment device that sellers may be unable to achieve on their own.

Most closely related to the current paper is Farrell and Gibbons (1995). The authors consider a producer's problem of eliciting investment-specific information from a buyer. They show that reducing the producer's ex post bargaining power may enhance efficiency as the buyer's incentive to reveal his private information is increased. The authors also show that the gain in communication may outweigh the loss from the increased hold-up problem.

2. A simple model

A firm has the opportunity to produce a new good. There is no other firm that can do this, so if the firm produces it becomes a monopolist. A production decision implies a fixed start-up cost F , which is unknown at the outset. There is also a constant marginal cost of production, c , which is normalized to zero. The fixed cost may stem from setting up new machinery or infrastructure, training new staff, etc., and is sunk once incurred. There is a single buyer (or buyer representative). The buyer's utility function is $vq - \frac{1}{2}q^2 - T$, where v is the buyer's type, q is the quantity bought, and T is the total transfer paid to the firm.⁴ Note that with fixed unit price (linear pricing), demand is linearly decreasing in price, $q(p) = v - p$, as long as demand is positive.

The game proceeds as follows. In the first, "constitutional" stage of the game, the supplier chooses whether or not to commit to linear pricing. The buyer's and seller's types (v and F) are then realized. The buyer's type is private information to the buyer, such that $v \in \{v_L, v_H\}$ and $v_H > v_L > 0$. The common prior is that $v = v_H$ with probability μ and $v = v_L$ with probability $1 - \mu$. In turn, the fixed cost is private information to the firm. The common prior distribution is $G(F)$, where G is differentiable and has density $g(F) > 0$ for all $F \in [0, \bar{F}]$ and $g(F) = 0$ for all $F \notin [0, \bar{F}]$, \bar{F} finite. In what follows we shall often consider the uniform case $g(F) = 1 / \bar{F}$. We assume that $\bar{F} \geq v_H^2 / 2$, which implies that the cost density is strictly positive over the entire profit range, which simplifies the exposition.

The buyer then sends a (possibly uninformative) message "Low" or "High," meaning $v = v_L$ and $v = v_H$, respectively, to the firm. Messages are cheap talk. Given the message and the observed cost, the firm then decides whether to produce or not, and what price or price-quantity bundles to offer. Finally the buyer makes his consumption decision, and payoffs are realized. For brevity we only compare two pricing regimes, linear pricing and unrestricted (second-degree) price discrimination. This is sufficient to illustrate the firm's trade-off between improved ex ante communication and smaller ex post surplus.

⁴ The quadratic utility function is chosen for analytical simplicity, but we expect our qualitative results to hold for any utility function that exhibits strictly decreasing marginal utility. As long as this holds, linear pricing leaves the consumer with a positive surplus and gives the high type a certain incentive to reveal his type in order to increase the probability of production.

3. Linear pricing

Consider the situation where the seller commits to use linear prices. We first have to make sure that both buyer types have an incentive to report truthfully; if either type preferred to misreport the firm would gain no information relative to its prior, and would never choose the linear pricing regime.⁵ From the quadratic utility function we have that, conditional on a truthful message v_i , the firm optimally sets price $v_i / 2$, sells quantity $v_i / 2$ and makes gross profit $v_i^2 / 4$. This means in turn that, in a truthful equilibrium, the firm produces if and only if $F \leq v_i^2 / 4$.

The surplus for a type i buyer, if the firm believes he is of type j , is $\frac{1}{2} \left(\max \left(v_i - \frac{v_j}{2}, 0 \right) \right)^2$. Therefore, type i will reveal his type truthfully as long as

$$\frac{v_i^2}{8} G \left(\frac{v_i^2}{4} \right) \geq \frac{1}{2} \left(\max \left(v_i - \frac{v_j}{2}, 0 \right) \right)^2 G \left(\frac{v_j^2}{4} \right), \quad i \neq j. \quad (1)$$

For $2v_i > v_j$, these incentive constraints are not automatically satisfied. In particular, if $2v_L > v_H$ and the gain in production probability is sufficiently large, the low type might actually prefer to exaggerate his valuation. However, when $G(\cdot)$ is uniformly distributed and $2v_i \geq v_j$, Eq. (1) reduces to

$$v_i^4 \geq v_j^2 (2v_i - v_j)^2.$$

Taking square roots (both sides are positive) reduces the inequality to $(v_i - v_j)^2 \geq 0$. Hence, in the uniform case the incentive constraints always hold.

Since the firm only produces if expected revenues are greater than the realized start-up cost, its ex ante expected profit is, given a truthtelling equilibrium,

$$\begin{aligned} & (1 - \mu) \int_0^{v_L^2/4} \left(\frac{v_L^2}{4} - F \right) dG(F) \\ & + \mu \int_0^{v_H^2/4} \left(\frac{v_H^2}{4} - F \right) dG(F) \\ & = (1 - \mu) \int_0^{v_L^2/4} G(F) dF + \mu \int_0^{v_H^2/4} G(F) dF, \end{aligned} \quad (2)$$

where the last step is derived through integration by parts.

4. Price discrimination

When there is no ban on price discrimination, the buyer has clearly no incentive to reveal his type since the firm would extract all surplus. Hence, the firm necessarily faces uncertainty about the buyer's type. There are now two possibilities: either it is optimal for the firm to offer a menu such that both buyer types purchase a positive quantity, or it optimally serves only the high type.

⁵ For simplicity we restrict attention to pure-strategy equilibria. Moreover, as in any cheap talk game, there exists an equilibrium in which there is no information transmission at all, a so-called babbling equilibrium. We will disregard all babbling equilibria and restrict our attention to the equilibrium in which both buyer types report truthfully.

In the latter case it is clearly optimal to offer the high type his first-best quantity, v_H , and charge a lump-sum tariff $v_H^2/2$, thus extracting all surplus. The firm's ex ante expected revenue is in this case $\mu v_H^2/2$, and, analogous to above, the ex ante expected profit is

$$\int_0^{\mu v_H^2/2} G(F) dF. \tag{3}$$

If instead both types are served, two different tariff-quantity menus are offered. Denote these (T_H, q_H) and (T_L, q_L) . The incentive constraint for buyer type i reads

$$v_i q_i - \frac{q_i^2}{2} - T_i \geq v_i q_j - \frac{q_j^2}{2} - T_j, \quad i \neq j. \tag{4}$$

It is a standard exercise (see Frisell and Lagerlöf (2007)) to derive the optimal quantities and the associated tariffs

$$T_L^* = \frac{(\mu(v_H - v_L) + v_L(1 - \mu))(v_L - \mu v_H)}{2(1 - \mu)^2}$$

and

$$T_H^* = \frac{v_H^2(1 + \mu) - 2v_H v_L(1 + \mu) + 2v_L^2}{2(1 - \mu)}.$$

This holds as long as $\mu \leq v_L / v_H \equiv \mu^\#$. It is easily shown that if $\mu > \mu^\#$, only the high type should be served. The firm's ex ante expected revenue is

$$\mu T_H^* + (1 - \mu) T_L^* = \frac{1}{2} v_L^2 + \frac{\mu(v_H - v_L)^2}{2(1 - \mu)}.$$

It follows that the firm's ex ante expected profit is

$$\int_0^{\frac{1}{2} v_L^2 + \frac{\mu(v_H - v_L)^2}{2(1 - \mu)}} G(F) dF. \tag{5}$$

5. Committing to linear pricing or not

Consider first the case when $\mu \geq \mu^\#$, so that the firm, if price discriminating, only serves the high type. Define the ex ante expected difference in profits between price discrimination and linear pricing (using Eqs. (2) and (3)) as

$$\Delta_H(\mu) \equiv \int_0^{\mu v_H^2/2} G(F) dF - (1 - \mu) \int_0^{v_L^2/4} G(F) dF - \mu \int_0^{v_H^2/4} G(F) dF. \tag{6}$$

Linear pricing is thus preferred when $\Delta_H(\mu) < 0$. Note first that $\Delta_H(1) > 0$ if the firm knows that it faces high demand it strictly prefers to price discriminate. Differentiating Eq. (6) twice with respect to μ gives

$$\Delta_H''(\mu) = \frac{v_H^4}{4} g\left(\mu \frac{v_H^2}{2}\right) > 0,$$

so that $\Delta_H(\mu)$ is a convex function. It follows that there exists a unique $\mu = \mu^{\min}$ where $\Delta_H(\mu)$ attains its minimum value on $[\mu^\#, 1]$. Whether μ^{\min} is larger than or equal to $\mu^\#$ and whether $\Delta_H(\mu^{\min}) < 0$ depend on parameters. Intuitively, the more certain is the firm that it faces either high or low demand, the less there is to gain from communication.

The analogous argument holds for the case $\mu < \mu^\#$. Using Eqs. (2) and (5), let

$$\Delta_{LH}(\mu) \equiv \int_0^{\frac{1}{2} v_L^2 + \frac{\mu(v_H - v_L)^2}{2(1 - \mu)}} G(F) dF - (1 - \mu) \int_0^{v_L^2/4} G(F) dF - \mu \int_0^{v_H^2/4} G(F) dF$$

denote the ex ante expected difference in profits between price discrimination and linear pricing when $\mu < \mu^\#$. The firm strictly prefers to price discriminate if it knows that demand is low, i.e., $\Delta_{LH}(0) > 0$. Linear pricing becomes more profitable the larger is uncertainty over the buyer's type (i.e., $\Delta_{LH}(\mu)$ is also convex).

Proposition 1. For any distribution function G , there exist values of μ , v_L , and v_H such that (i) the firm's ex ante expected profit is strictly larger under linear pricing than under price discrimination, and (ii) the revelation constraints of Eq. (1) hold. In particular, this happens for μ 's close to $\mu^\#$ and for v_L 's close to zero.

Proof. First note that for v_L sufficiently close to zero, Eq. (1) holds for any distribution G and any $v_H > 0$. Let $\Delta^\#(v_L, v_H) \equiv \Delta_H(\mu^\#)$ ($\equiv \Delta_{LH}(\mu^\#)$). We thus have

$$\Delta^\#(v_L, v_H) = \int_0^{v_L v_H/2} G(F) dF - \left(1 - \frac{v_L}{v_H}\right) \int_0^{v_L^2/4} G(F) dF - \frac{v_L}{v_H} \int_0^{v_H^2/4} G(F) dF.$$

Clearly, $\Delta^\#(0, v_H) = 0$. Therefore, to prove the claim, it suffices to show that $\partial \Delta^\#(v_L, v_H) / \partial v_L < 0$ for v_L 's close to zero. Differentiating yields

$$\frac{\partial \Delta^\#(v_L, v_H)}{\partial v_L} = \frac{v_H}{2} G\left(\frac{v_L v_H}{2}\right) + \frac{1}{v_H} \int_0^{v_L^2/4} G(F) dF - \frac{v_L}{2} \left(1 - \frac{v_L}{v_H}\right) G\left(\frac{v_L^2}{4}\right) - \frac{1}{v_H} \int_0^{v_H^2/4} G(F) dF.$$

Evaluating this expression at $v_L = 0$ yields

$$\frac{\partial \Delta^\#(v_L, v_H)}{\partial v_L} \Big|_{v_L=0} = -\frac{1}{v_H} \int_0^{v_H^2/4} G(F) dF,$$

which is strictly negative. By continuity, it must be strictly negative also for some $v_L > 0$. \square

Numerically it is easy to show that linear pricing also is preferred for other parameter values than the ones considered in Proposition 1. Let $\mu'(v_L, v_H)$ denote the set of μ 's such that $\Delta_H(\mu) = 0$, and $\mu''(v_L, v_H)$ denote the set of μ 's such that

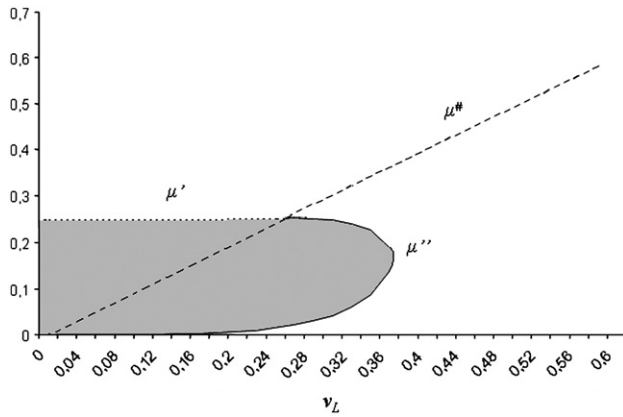


Fig. 1. Price discrimination vs. linear pricing with information transmission ($G(F)=F$, $v_H=1$). Linear pricing is preferred by the firm in the shaded area.

$\Delta_{LH}(\mu)=0$. Fig. 1 illustrates the firm's trade-off between linear pricing and price discrimination with a uniform cost distribution. (The data used to generate Fig. 1 is provided in Frisell and Lagerlöf (2007).)

To summarize, transmission of demand information increases the firm's profit in two ways: it generates additional sales when demand is unexpectedly high (and production was unprofitable ex ante), and saves the firm from production costs when demand is unexpectedly low (and production was profitable ex ante). The drawback is that linear pricing leads to lower quantities consumed (due to decreasing marginal utility) and thus lower ex post profit. Hence, the firm prefers linear pricing when uncertainty over the buyer's type is high (μ is neither very high nor very low) and when the profitability of production varies a lot depending on the contingency (v_H is much larger than v_L).

6. Buyer's welfare

Finally we check whether linear pricing is also in the buyer's interest. The buyer's ex ante expected surplus from linear pricing is

$$(1 - \mu) \frac{v_L^2}{8} G\left(\frac{v_L^2}{4}\right) + \mu \frac{v_H^2}{8} G\left(\frac{v_H^2}{4}\right) > 0. \quad (7)$$

This should be compared to his expected surplus under price discrimination. First, if $\mu > \mu^\#$ the firm would only serve the high type, which implies that the buyer gets zero surplus regardless of type. Hence, in this case the buyer obviously

prefers linear pricing. If $\mu \leq \mu^\#$, both types are served and the buyer's ex ante expected surplus is (the low type still gets zero surplus)

$$\mu \left(\frac{v_H^2}{2} - T_H^* \right) G \left(\frac{1}{2} v_L^2 + \frac{\mu(v_H - v_L)^2}{2(1 - \mu)} \right). \quad (8)$$

The difference Eq. (7)–Eq. (8) is ambiguous but seems to be positive in most cases when $\mu \leq \mu^\#$.⁶ Intuitively, the firm affords the high type a positive surplus under price discrimination only in order to keep him from switching to the low type's bundle. If this rent were too large (μ or v_H large), the firm would prefer to only serve the high type.

7. Conclusion

This paper puts forward a new argument in favor of pricing restrictions, namely that such restrictions, by giving buyers a larger share of the surplus from transactions, may enable the communication of demand information from buyers to sellers. We show that such a commitment may also be in the seller's interest, which means that regulation Pareto dominates non-regulation. Although the current model is simplistic, nothing suggests that the basic intuition would fail to apply to more complex environments, e.g., with several competing sellers. However, the beneficial effect of communication must then be traded off against other welfare costs of pricing restrictions, in particular, the potentially increased risk of price coordination. Such extensions are postponed for future research.

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⁶ For example, with G linear or exponential we have not been able to find a case where the buyer prefers non-linear pricing.