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Competition or Collusion? Negotiating Discounts Off Posted Prices

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ECONOMIC ANALYSIS GROUP

DISCUSSION PAPER

**Competition or Collusion? Negotiating
Discounts Off Posted Prices**

by

Alexander Raskovich *

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* Economist, Antitrust Division, U.S. Department of Justice. The views expressed are solely my own and not those of the U.S. Department of Justice. For helpful comments and suggestions, I thank Patrick Greenlee, Russ Pittman and especially two anonymous referees and the editor, Bernard Caillaud.

Abstract

Opportunities for buyers to negotiate discounts can blunt competition in the initial posting of prices. It is always an equilibrium for identical suppliers to post price at the common marginal cost. If few buyers have opportunities to bargain, this equilibrium is unique. If many buyers have bargaining opportunities, however, a second equilibrium emerges in which suppliers post the monopoly price and then negotiate discounts individually with buyers. In this equilibrium, discounted prices are above marginal cost and profits increase with concentration. Advance price announcements may help suppliers coordinate onto their preferred equilibrium of posting the monopoly price.

JEL codes: C71, C78, L13, L41

1. Introduction

In a number of industries, suppliers post prices and then negotiate discounts off list with individual buyers. Advance price announcements, in which suppliers publish price changes ahead of their effective dates, are also common. These pricing practices have raised concerns as possibly facilitating collusion (e.g., Grether and Plott, 1984; Borenstein, 1994; Gillespie, 1995). How do opportunities for discounting affect market pricing? Selective discounting can of course undermine collusively set prices (Stigler, 1964). Cooper (1986) and Holt and Scheffman (1987) show that most-favored-customer and best-price provisions can support high posted prices by discouraging selective discounts. Yet recent research in laboratory markets finds seemingly contrary results on the effect of discounting. Introducing opportunities for consumers to bargain for discounts often leads to market outcomes *less* favorable for consumers. Cason et al. (2003) find that transaction prices are higher in “haggle” markets, where suppliers post prices but consumers can negotiate discounts, than in pure posted-offer markets. Davis and Holt (1994) similarly find that when opportunities for discounting are introduced into a posted-offer market, suppliers uniformly raise their list prices, sometimes dramatically, and net prices are high.

This paper develops a simple model that can explain such patterns. Identical suppliers post prices noncooperatively in an initial period, after which (some) buyers have an opportunity to approach a supplier and engage in an alternating-offers bargaining game. Posted prices affect the bargaining subgame in two ways. First, the option to buy at the lowest posted price serves as a buyer’s threat-point in bargaining for a discount. The higher the lowest posted price, the worse a buyer’s position in bargaining with any

supplier. Second, a supplier's posted price determines the supplier's attractiveness as a bargaining partner. In particular, a high posted price makes a supplier an attractive bargaining partner, by putting the supplier in a poor bargaining position (relative to rivals posting the lowest price). This creates an incentive for suppliers to post high prices to attract buyers seeking discounts. This incentive runs counter to the more familiar incentive suppliers have to post low prices to capture sales to buyers who do not have bargaining opportunities and so buy at posted price.

It is always an equilibrium for identical suppliers to post price at the common marginal cost. If the proportion of buyers with bargaining opportunities is large enough, however, a second equilibrium emerges in which all suppliers post the monopoly price and subsequently negotiate discounts with individual buyers.¹ In this equilibrium, discounted prices are strictly above marginal cost and supplier profits increase with concentration. Advance price announcements may thus help suppliers coordinate onto their preferred equilibrium of posting the monopoly price.

The remainder of the paper is organized as follows. Section 2 lays out the model setting, while Section 3 describes equilibrium. Possible implications for competition policy and extensions to the model are discussed in Section 4. Section 5 concludes.

2. Economic Setting

There are $N \geq 2$ suppliers producing a homogeneous good at the common constant marginal cost $c \geq 0$, and there is a continuum of consumers of measure one, each of whom has unit demand for the good at the common reservation value $v > c$. The game is played over an infinite number of periods, indexed by t . Suppliers (indexed by

¹ As shown below, when the pool of buyers with bargaining opportunities is large, there is also a razor's edge duopoly case for which a continuum of equilibria exists.

i) simultaneously post prices \bar{p}_i in period $t = 0$. At $t = 1$, every consumer has, with independent probability θ , an opportunity to make an offer to a chosen supplier. If the chosen supplier rejects a given consumer's offer, then with probability θ the supplier can make a counter-offer to the consumer at $t = 2$. Play between a paired consumer and supplier proceeds in this way as an alternating-offers bargaining game with exogenous probability of breakdown (Binmore et al., 1986). The consumer (supplier) makes an offer p_t in every odd- (even-) numbered period, until either an offer is accepted or (with probability $1 - \theta$ in each period) the opportunity for further negotiation ends. The structure of the game is common knowledge.

There is no discounting of the future. If an offer p_t is accepted in any period t , the negotiating consumer receives a payoff of $v - p_t$ and the supplier receives $p_t - c$ from the given sale. If in any period the opportunity for further negotiation ends, the consumer can still buy from any supplier i at the supplier's posted price \bar{p}_i , in which case the consumer receives $v - \bar{p}_i$ and the supplier receives $\bar{p}_i - c$ from the given sale.

If n suppliers offer a lowest posted price \bar{p}_L no greater than v , a consumer buying at posted price chooses among these suppliers with equal probability $1/n$. Likewise, if m suppliers post some price \bar{p} and a consumer with an opportunity to negotiate prefers to bargain with a supplier posting \bar{p} , the consumer chooses a bargaining partner among these suppliers with equal probability $1/m$.

To sum up: (1) the $1 - \theta$ consumers with no opportunity to negotiate buy the good at $t = 1$, each choosing with probability $1/n$ from among the n suppliers posting a lowest price \bar{p}_L no greater than v ; (2) the remaining θ consumers pair off with suppliers of

their choosing and each bilateral negotiation either ends in an agreement p_t in some period t or negotiations break down and the given consumer purchases with probability $1/n$ from among the n suppliers posting \bar{p}_L .

This last point is critical to the analysis. By assumption, a consumer negotiating with a supplier posting \bar{p}_L cannot threaten to buy with certainty only from one of the supplier's $n - 1$ rivals posting this price, in case negotiations break down. Such a threat could be credible, given the assumption of perfectly homogeneous goods, and would improve the consumer's bargaining position vis-à-vis the supplier. Nonetheless, such threats are assumed to be outside the bounds of negotiation.² The intent is to explore settings where buyers' bargaining power is more limited, albeit substantial.

3. Equilibrium

If the lowest price posted in $t = 0$ is c , all consumers purchase at price c in $t = 1$. If the lowest posted price \bar{p}_L is no greater than v but strictly above c , then the proportion θ of consumers with an opportunity to negotiate will make price offers in $t = 1$. In subgame perfect equilibrium, every negotiating consumer will make an offer that leaves the chosen supplier indifferent between accepting the offer and rejecting it in

² Alternatively, suppose every consumer has a "special" good, with reservation value $v + \delta$, where $\delta > 0$ but small. Each good has $1/N$ chance of being the special one for any given consumer. The identity of the special good is revealed after bargaining typically concludes, say at the close of $t = 1$. With δ small, a consumer will buy at the negotiated discount even if another supplier is revealed to offer the special good. Nor is delay to resolve the uncertainty worthwhile given the probability of breakdown. In this setting, the posited threat is not credible: the supplier with whom negotiations have broken down may turn out to have the consumer's special good.

order to make a counter-offer with probability θ in $t = 2$. Every such offer is accepted immediately.

If a given consumer's offer is rejected and the opportunity for further negotiation ends, the consumer buys at posted price, earning a payoff of $v - \bar{p}_L \geq 0$. In this case, the supplier's expected payoff with regard to the given consumer depends on whether the supplier has posted \bar{p}_L or some higher price. If the supplier has posted a price above \bar{p}_L , the supplier's expected payoff from the given consumer is zero if negotiations break down. This is because the consumer will certainly buy elsewhere at the lower price \bar{p}_L . If the supplier has posted \bar{p}_L , the expected payoff from the given consumer is $\frac{1}{n}(\bar{p}_L - c) > 0$ if negotiations break down, because the consumer is assumed to buy with equal probability from among the n suppliers posting \bar{p}_L .

3.1 Bargaining with a High-Posted-Price Supplier

Take first the case of a consumer bargaining with a supplier that has posted a high price. In odd-numbered period t , the consumer offers a transaction price of p_t , such that

$$p_t - c = \theta(p_{t+1} - c), \quad (1)$$

where p_{t+1} is the optimal counter-offer the supplier would make in period $t+1$ conditional on rejecting the consumer's offer of p_t in t . In subgame perfect equilibrium, the counter-offer p_{t+1} would be accepted by the consumer, yielding the supplier a payoff of $p_{t+1} - c$. This payoff would be realized with the probability θ that negotiations continue. Otherwise the supplier's payoff from the given consumer would be zero, given that the consumer would purchase elsewhere at the lower posted price \bar{p}_L . The supplier

is thus indifferent between accepting and rejecting the consumer's offer of p_t in equation (1), and so p_t is the lowest offer the supplier would accept.

The highest offer the consumer would accept in period $t + 1$ is given by

$$v - p_{t+1} = \theta(v - p_{t+2}) + (1 - \theta)(v - \bar{p}_L), \quad (2)$$

where p_{t+2} is the optimal counter-offer the consumer would make in $t + 2$ conditional on rejecting the supplier's offer of p_{t+1} . In subgame perfect equilibrium,

$$p_{t+2} = p_t. \quad (3)$$

That is, the parties' optimal offers and counter-offers do not change across periods.

Substituting (3) into (2), the supplier's optimal offer in $t + 1$ can be written as

$$p_{t+1} = \theta p_t + (1 - \theta)\bar{p}_L. \quad (4)$$

Substituting (4) into (1) and solving for p_t yields the consumer's offer in t as

$$p_t = \frac{1}{1 + \theta} (\theta \bar{p}_L + c) \quad (\text{to a high posted-price supplier}). \quad (5)$$

If a consumer were to offer the price p_t given in equation (5) to a supplier that has posted a high price, the supplier would accept immediately in period t .

3.2 Bargaining with a Low-Posted-Price Supplier

Now consider the case of a consumer bargaining with a supplier whose posted price is the low price \bar{p}_L . In contrast with equation (1), the lowest offer the consumer could make in t that the supplier would accept is now given by

$$p_t - c = \theta(p_{t+1} - c) + (1 - \theta)\left(\frac{1}{n}\right)(\bar{p}_L - c), \quad (6)$$

where the second set of terms on the right-hand side of equation (6) reflects the $1/n$ chance that the supplier would sell to the given consumer at posted price \bar{p}_L if the

supplier were to reject offer p_t and negotiations were to break down. Substituting (4) into (6) and solving for p_t , the buyer's offer in t can be written as

$$p_t = \frac{1}{1+\theta} [\theta \bar{p}_L + c + \frac{1}{n}(\bar{p}_L - c)] \quad (\text{to a low posted-price supplier}). \quad (7)$$

An offer of p_t given by equation (7) made to a supplier that has posted the low price \bar{p}_L would be accepted immediately in period t .

3.3 Equilibrium Posted Prices

By posting a high price, a supplier puts itself in a poor bargaining position and so makes itself an attractive bargaining partner, as shown presently.

Lemma 1. *If suppliers were to post differing prices, buyers that have an opportunity to negotiate discounts would choose high-posted-price suppliers as bargaining partners over suppliers posting the low price \bar{p}_L .*

Proof: From equations (6) and (7), a buyer pays a lower negotiated price by bargaining with a high-posted-price supplier than by bargaining with a supplier that has posted the low price. *Q.E.D.*

The intuition underlying Lemma 1 is that if negotiations with a high-posted-price supplier were to break down, the supplier would lose the sale to the given buyer with certainty. In contrast, a supplier posting the low price \bar{p}_L would still sell to the given buyer with probability $1/n$ if negotiations were to break down, where n is the number of suppliers posting \bar{p}_L . Thus a high-posted-price supplier is in a poor bargaining position and so is more attractive to buyers as a bargaining partner. Lemma 1 establishes an incentive for suppliers to post high prices, and indicates that this incentive is stronger the greater the proportion of consumers with bargaining opportunities.

Lemma 2. *All active suppliers post the same price in equilibrium.*

Proof: Suppose to the contrary that differing prices are posted by suppliers making positive sales. This implies the low posted price is $\bar{p}_L \in (c, v)$; otherwise no high-posted-price supplier would make any sales if $\bar{p}_L = c$. Also $\theta \in (0, 1)$ by Lemma 1; otherwise no high-posted-price supplier would make any sales if $\theta = 0$, and no low-posted-price supplier would make any sales if $\theta = 1$. Now note that a supplier's unit sales depend only on the supplier's price ranking and the number of suppliers posting the same price. Consider two cases involving suppliers posting \bar{p}_L . If only one supplier posts this price, that supplier could raise price somewhat without changing rank as lowest priced, and so could earn higher profit. If $n > 1$ suppliers post \bar{p}_L , then each makes $1/n$ of the aggregate unit sales made by suppliers posting this price, or $(1/n)(1 - \theta)$ by Lemma 1. Any such supplier could increase unit sales discretely to $1 - \theta$ by undercutting \bar{p}_L by an arbitrarily small amount, and so could earn higher profit. *Q.E.D.*

Lemmas 1 and 2 together indicate that the equilibrium posted price may be either very low or very high, depending on the pool of buyers with bargaining opportunities. If this pool is large, a high-posted-price equilibrium can be supported. The critical value of θ , derived in the Appendix, is:

$$\theta^*(N) = \frac{\sqrt{4N^3(N-1)+1} - 1}{2N^2}. \quad (8)$$

Proposition 1. *The following completely describes posted prices in subgame perfect equilibria of the game:*

- (i) *It is always an equilibrium (for any $\theta \in [0, 1]$ and $N \geq 2$) for suppliers to post price at the common marginal cost, $\bar{p} = c$, and*

- (ii) *this equilibrium is unique if the proportion of buyers with bargaining opportunities is $\theta < \theta^*(N)$.*
- (iii) *Given $N \geq 2$, if $\theta \geq \theta^*(N)$ and at least one of these two inequalities is strict, there is a second equilibrium in which suppliers post the monopoly price, $\bar{p} = v$, and there is no third equilibrium.*
- (iv) *In case $N = 2$ and $\theta = \theta^*(2)$, any common posted price $\bar{p} \in [c, v]$ is an equilibrium.*

Proof: The proof of part (i) is immediate. Proof of parts (ii)-(iv) is left to the Appendix, but is sketched here. Let Δ_L denote the incremental profit a supplier would earn by undercutting a common posted price $\bar{p} \in (c, v]$ by an arbitrarily small amount. It is shown in the Appendix that $\text{sign}(\Delta_L) = \text{sign}(\theta^*(N) - \theta)$. Thus if $\theta < \theta^*(N)$, a supplier could gain by undercutting any $\bar{p} > c$, and so posting $\bar{p} = c$ is the unique equilibrium in this case. Conversely, if $\theta \geq \theta^*(N)$ no supplier could gain by undercutting a common posted price $\bar{p} \in (c, v]$. Now let Δ_H be the incremental profit a supplier would earn by raising posted price above some $\bar{p} \in (c, v)$ (but no higher than v). It is shown in the Appendix that $\Delta_H > 0$ for $\theta \geq \theta^*(N)$ and given $N \geq 2$, if at least one of these two inequalities is strict. In this case, no $\bar{p} \in (c, v)$ is an equilibrium, but posting $\bar{p} = v$ is an equilibrium. Finally, if $N = 2$ and $\theta = \theta^*(2)$, it is shown that $\Delta_H = \Delta_L = 0$. In this razor's edge case, any $\bar{p} \in [c, v]$ is an equilibrium. *Q.E.D.*

3.4 Equilibrium Discounted Price

If $\theta \geq \theta^*(N)$ and the posted price is $\bar{p} > c$, the discounted price paid by negotiating buyers, \tilde{p} , can be obtained from equation (7) by setting $\bar{p}_L = \bar{p}$ and $n = N$:

$$\tilde{p} = \frac{1}{1+\theta} [\theta \bar{p} + c + \frac{1}{N} (\bar{p} - c)]. \quad (9)$$

Proposition 2. *Suppose $\theta \geq \theta^*(N)$ and consider the subgame perfect equilibrium posted price $\bar{p} > c$.*

- (i) *The discounted price paid by negotiating buyers is $\tilde{p} > c$.*
- (ii) *The discounted price \tilde{p} increases with θ and decreases with N .*

Proof: Subtracting c from equation (9), the margin earned on sales to negotiating buyers can be written as

$$\tilde{p} - c = \frac{1 + N\theta}{N(1 + \theta)} (\bar{p} - c) > 0, \quad (10)$$

which completes the proof of part (i). For proof of part (ii), differentiate equation (10) with respect to θ :

$$\frac{\partial}{\partial \theta} (\tilde{p} - c) = \frac{N-1}{N(1+\theta)^2} (\bar{p} - c) > 0. \quad (11)$$

Finally, the discounted price decreases with N by inspection of equation (9). *Q.E.D.*

Intuitively, increasing θ tends to improve a supplier's bargaining position by making it more likely that the supplier would have an opportunity to make a counter-offer after rejecting a buyer's initial offer.³ Conversely, increases in N tend to improve a

³ Suppliers' collective profits in posted-price equilibrium $\bar{p} > c$ are $(1 - \theta) \bar{p} + \theta \tilde{p}$ and decrease with θ . While \tilde{p} increases with θ given the greater chance the supplier has to make a counter-offer, this is more than offset by the lower proportion of buyers purchasing at \bar{p} . The model could be modified so that the proportion of buyers having an opportunity to make an initial discount offer is distinct from the continuation probability that a supplier can make a counter-offer. In such a setting, raising just the proportion of buyers with bargaining opportunities would certainly lower supplier profits (so long as $\theta \geq \theta^*(N)$ to begin with).

buyer's bargaining position by making it less likely ($1/N$) that the chosen supplier would make a sale to the given buyer if negotiations were to break down. These countervailing effects determine not only the net price \tilde{p} in the bargaining outcome, but also the critical value $\theta^*(N)$ above which high-posted-price equilibria are possible. Note from equation (8) that, for example, $\theta^*(2) \approx 0.59$, $\theta^*(3) \approx 0.76$, $\theta^*(10) \approx 0.94$, and generally that $\theta^*(N) \rightarrow 1$ as $N \rightarrow \infty$.

4. Discussion

The modeling results can be summarized as follows. Any given supplier sees an upside as well as a downside to posting a high price. Posting a price higher than rivals' posted prices loses sales to buyers that have no bargaining opportunities and so transact at posted price, but gains sales to buyers seeking discounts, by putting the supplier in a poor bargaining position. If few buyers have bargaining opportunities, the tradeoff favors posting lower prices. In this case suppliers compete fiercely in posting prices and all post price at the common marginal cost in the unique equilibrium. If many buyers have bargaining opportunities, however, the tradeoff favors posting higher prices. In this case, although it remains an equilibrium for suppliers to post price at marginal cost, a second equilibrium emerges in which suppliers post the monopoly price. In this second equilibrium, competition for sales to buyers with bargaining opportunities blunts competition in the initial posting of prices. More precisely, a perverse form of competition then takes hold, in which suppliers race to the top.

The outcome of the game when suppliers post a price above marginal cost reflects a form of price discrimination. Buyers without bargaining opportunities transact at posted price, while buyers with bargaining opportunities pay a discounted price and enjoy more

surplus. Surplus is then lower for every buyer and supplier profits are higher (positive) as compared with the equilibrium in which suppliers post price at marginal cost.

The remainder of this section discusses further implications and possible extensions of the model.

4.1 Advance Price Announcements and Mergers

By Proposition 1, there are multiple posted price equilibria when the proportion of buyers with bargaining opportunities is high, $\theta \geq \theta^*(N)$. By Proposition 2, suppliers earn highest profits in the equilibrium with $\bar{p} = v$. This suggests that suppliers may use advance price announcements as a means of coordinating onto their preferred equilibrium of posting the monopoly price. Advance price announcements are common, particularly in intermediate goods industries. While this pricing practice can improve efficiency,⁴ it has also raised concerns that it may facilitate collusion (e.g., Grether and Plott, 1984; Borenstein, 1994; Gillespie, 1995). Collusion concerns are tempered by recognition that secret discounting can unravel a cartel agreement.

In the present modeling context, effective coordination might be limited to suppliers choosing among noncooperative equilibria of the game; it need not involve an agreement to refrain from discounting. Such limited coordination might, nevertheless, raise prices substantially above marginal cost. Let $\mu(\theta, N)$ be the margin suppliers earn on sales at the negotiated price \tilde{p} , as a fraction of the monopoly margin: $\mu(\theta, N) \equiv (\tilde{p} - c)/(v - c)$. By equation (10), this equilibrium margin is

⁴ Blair and Romano (2002) show that when advance price announcements resolve cost uncertainty, both profits and consumer surplus rise.

$$\mu(\theta, N) = \frac{\theta N + 1}{(1 + \theta)N}. \quad (12)$$

The table below presents values of μ for $\theta = 1$ and various values of N .

N	2	3	4	5	6	7	8	9	10
$\mu(1, N)$	0.750	0.667	0.625	0.600	0.583	0.571	0.563	0.556	0.550

In a duopoly, margins are 75% of the monopoly level. Margins decline with the number of competing suppliers, but remain above half of the monopoly margin even for $N = 10$.

The table also suggests that if suppliers coordinate onto a high-posted-price equilibrium, a merger of homogeneous good suppliers could raise the equilibrium net price significantly. For example, if $v = 2c$ and $\theta = 1$, a four-to-three merger would raise net price by 2.6%, and a three-to-two merger would raise net price by about 5%.

4.2 Commitment Power

In a narrow bargaining context, the ability to commit to an offer is advantageous. Greater commitment power typically allows the committed party to capture more of the joint surplus from trade (e.g., Schelling, 1960; Crawford, 1982; Muthoo, 1996; Kambe, 1999). In the broader context of market equilibrium, however, such commitment power is disadvantageous in the present setting. Consider the case of $\theta \geq \theta^*(N)$ and equilibrium posted price $\bar{p} > c$. By assumption, suppliers cannot commit to their posted offer \bar{p} , so the proportion θ of buyers pays the lower negotiated price \tilde{p} given in equation (9). Now suppose instead that one or more suppliers can commit to a posted offer. In this case, $\bar{p} = c$ is the unique equilibrium. Starting with $\bar{p} > c$ as candidate equilibrium, a supplier with commitment power could capture the market by posting a price slightly below \tilde{p} , and would earn higher profit thereby.

This suggests that suppliers in posted-offer markets may have an incentive to soften their ability to commit to posted offers. Consistent with this possibility is the observation that suppliers in posted-offer markets sometimes encourage the formation of buyer groups that strengthen the bargaining power of smaller buyers.⁵

4.3 *Selective Discounts*

Suppliers are rather passive with respect to discounting in the model. Buyers with bargaining opportunities take the initiative in choosing bargaining partners and making discount offers. However, suppliers might also seek out buyers that have no bargaining opportunities and offer them selective discounts. Such supplier-initiated discounting could be profitable if suppliers could distinguish between buyer types well enough. Corts (1998) shows that, in an oligopoly market, third-degree price discrimination can intensify competition, lowering suppliers' profits and raising the surplus of every consumer type. A similar result holds in the present context. If selective discounting initiated by suppliers were individually profitable, a high-posted-price equilibrium could not be sustained.

Let γ be the probability with which a supplier could correctly identify a given buyer as lacking bargaining opportunities. Note that $\gamma \geq 1 - \theta$, the equality being strict if the supplier cannot distinguish buyer types better than a random draw. Now consider the case of $\theta \geq \theta^*(N)$ and equilibrium posted price $\bar{p} > c$. A supplier could profitably deviate from the posited equilibrium if the supplier could accurately identify which buyers lack bargaining opportunities and selectively offer just these buyers a price

⁵ See Matthewson and Winter (1997) for an alternative explanation of buyer groups, in which such groups help to internalize market externalities in a tradeoff between cost and variety.

slightly below \bar{p} .⁶ With probability γ , such an offer would be received by a buyer that lacks bargaining opportunities, in which case the supplier would increase the likelihood (from $1/N$ to 1) of selling to the buyer at price \bar{p} (less the vanishingly small discount offered). With probability $1-\gamma$ the supplier would err, the offer being received by a buyer with bargaining opportunities. In this case, by Lemma 1, the supplier would lose the $1/N$ chance of selling to the buyer at the negotiated price \tilde{p} . Altogether, the increment to a supplier's expected profit from sending a selective offer would be

$$\gamma \left(\frac{N-1}{N} \right) (\bar{p} - c) - (1-\gamma) \left(\frac{1}{N} \right) (\tilde{p} - c). \quad (13)$$

Substituting equation (10) into expression (13), note that expression (13) is positive if

$$\gamma > \frac{\theta N + 1}{(1+\theta)N^2 - N + 1}. \quad (14)$$

Substituting $\gamma = 1 - \theta$ into (14) would imply $\theta < \theta^*(N)$, a contradiction. This is unsurprising: if the supplier cannot distinguish buyer types better than a random draw, offering a selective discount would be unprofitable for the same reason that posting a price below the equilibrium \bar{p} would lower profits. Therefore γ must be strictly greater (and often substantially greater) than $1 - \theta$ for selective discounting to be profitable. For example, if $N = 2$ and $\theta = \frac{3}{4}$,⁷ inequality (14) requires $\gamma > \frac{5}{12}$, whereas $1 - \theta = \frac{1}{4}$.

⁶ Here the lack of bargaining opportunities by a buyer is interpreted as the supplier having the ability to make a take-it-or-leave-it offer to the buyer.

⁷ Recall that $\theta^*(2) \approx 0.59$.

If suppliers were adept enough at identifying buyer types, selective discounting could be profitable, in which case a posted price above marginal cost could not be sustained; posting $\bar{p} = c$ would be the unique equilibrium.

4.4 Bargaining Opportunities

Buyer bargaining opportunities have so far been treated as exogenous. Such opportunities of course depend on market characteristics. For example, the search costs facing buyers wishing to engage in serial discount negotiations may decline with the number of suppliers in the market. The ability to negotiate discounts also depends on such factors as a buyer's risk-aversion, impatience and outside options. The more these factors are associated with observable buyer characteristics, such as buyer size, the more information suppliers would tend to have on which to base selective discounts.

A growing literature has explored how buyer size may affect the prices buyers obtain. One strand of this literature involves models of bilateral and multilateral bargaining in which the parties split the increment to total surplus from their reaching a deal. Papers in this vein include Horn and Wolinsky (1988), Stole and Zwiebel (1996a,b), Chitty and Snyder (1999), Inderst and Wey (2003) and Raskovich (2003). These authors all find that larger buyers do not necessarily negotiate lower prices. The relationship between buyer size and price depends on the curvature of total surplus with respect to the volume of trade. If increments to total surplus diminish (grow) at the margin, a buyer's bargaining leverage falls (rises) with the size of the buyer's purchase requirements. Raskovich (2003) further shows that if a buyer is so large as to be pivotal to a supplier's entry decision, the buyer is in a worse bargaining position vis-à-vis the supplier than are smaller, non-pivotal buyers whose purchases have no effect on the supplier's decision to

sink costs.⁸ Experimental work by Normann et al. (2005) supports these conclusions, finding that large buyers receive discounts only in the case of increasing marginal costs (concave surplus function).

5. Concluding Remarks

Opportunities for buyers to negotiate discounts can affect competition in posted-offer markets in a surprising way. If the pool of buyers with bargaining opportunities is large enough, competition to attract such buyers can lead suppliers in a “race to the top” to post a high price in equilibrium. Given that it is also (always) an equilibrium for identical suppliers to post price at common marginal cost, advance price announcements might help suppliers to coordinate onto their preferred equilibrium of posting the monopoly price. Such (limited) coordination is stable because the agreed-upon posted price is a noncooperative equilibrium. When posted price is high in the market outcome, discounting off will be pervasive and vigorous, yet negotiated prices will remain well above marginal cost. In this case, a merger of homogeneous good suppliers could result in a significant increase in net prices.

Appendix

Proof of Proposition 1(ii): By Lemma 2, focus on cases in which all N suppliers post a common price \bar{p} . Suppose suppliers post $\bar{p} \in (c, v]$. The profit earned by each supplier would then be

$$\pi(\bar{p}) = \frac{1}{N} \{ [(1 - \theta) \bar{p} + \theta \tilde{p}] - c \}, \quad (\text{A1})$$

⁸ A supplier’s binary entry decision could be viewed as a special case of the total surplus function being convex with respect to the incremental volume of reaching a deal with a pivotal buyer.

given that the proportion $1 - \theta$ of buyers would pay posted price \bar{p} and θ would pay the negotiated price \tilde{p} in the candidate subgame perfect equilibrium. Adapting equation (7), \tilde{p} is given by

$$\tilde{p} = \frac{1}{1 + \theta} \left[\theta \bar{p} + c + \frac{1}{N} (\bar{p} - c) \right]. \quad (\text{A2})$$

Substituting (A2) into (A1) and simplifying yields

$$\pi(\bar{p}) = \frac{N + \theta}{N^2(1 + \theta)} (\bar{p} - c). \quad (\text{A3})$$

If a supplier were to post a price an arbitrarily small amount below \bar{p} , the supplier would sell to all $1 - \theta$ buyers that have no bargaining opportunities, but would sell to no other buyer, earning profit of

$$\pi_L(\bar{p}) = (1 - \theta)(\bar{p} - c). \quad (\text{A4})$$

The increment to profit from undercutting \bar{p} is then $\Delta_L \equiv \pi_L(\bar{p}) - \pi(\bar{p})$. Subtracting (A3) from (A4) to obtain Δ_L , note that

$$\text{sign}(\Delta_L) = \text{sign} \left(1 - \theta - \frac{N + \theta}{N^2(1 + \theta)} \right) \quad (\text{A5})$$

and the sign does not depend on the precise value of \bar{p} . The expression on the right-hand side of (A5) is zero when the following quadratic equation in θ holds:

$$N^2 \theta^2 + \theta - N(N - 1) = 0. \quad (\text{A6})$$

Solving (A6) for the critical value $\theta^*(N)$ yields equation (8) in the text. Now note that

$$\frac{\partial \Delta_L}{\partial \theta} = \frac{N - 1 - N^2(1 + \theta)^2}{N^2(1 + \theta)^2} (\bar{p} - c) < 0, \quad (\text{A7})$$

given $N \geq 2$. Thus for $\theta < \theta^*(N)$, $\Delta_L > 0$. In this case no $\bar{p} > c$ is an equilibrium, the unique equilibrium being $\bar{p} = c$. *Q.E.D.*

Proof of Proposition 1(iii): From the proof of part 1(ii), $\theta > \theta^*(N)$ implies $\Delta_L < 0$. Thus no supplier could gain by undercutting a common posted price $\bar{p} \in (c, v]$ in this case. Now consider the profit a supplier would earn by posting a price higher than \bar{p} (but no higher than v). By Lemma 1, such a supplier would sell to all θ buyers that have bargaining opportunities, but would sell to no other buyer, thereby earning profit of

$$\pi_H(\bar{p}) = \theta(\tilde{p} - c). \quad (\text{A8})$$

Let $\Delta_H \equiv \pi_H(\bar{p}) - \pi(\bar{p})$. By (A2), (A3) and (A8),

$$\Delta_H = \frac{N^2 \theta^2 + (N-1)\theta - N}{N^2(1+\theta)}(\bar{p} - c). \quad (\text{A9})$$

Note that the sign of Δ_H is the sign of the numerator in (A9),

$$N^2 \theta^2 + (N-1)\theta - N. \quad (\text{A10})$$

By (A6) and the definition of $\theta^*(N)$, $\theta \geq \theta^*(N)$ implies

$$N^2 \theta^2 \geq N(N-1) - \theta, \quad (\text{A11})$$

the inequality being strict when $\theta > \theta^*(N)$. Substituting the right-hand side of (A11) into (A10) and simplifying yields the expression

$$(N-2)(N+\theta), \quad (\text{A12})$$

which is strictly greater than (A10) when $\theta > \theta^*(N)$. But (A12) is nonnegative, thus both (A10) and (A9) are strictly positive when $\theta > \theta^*(N)$, as well as when $N > 2$ and $\theta = \theta^*(N)$, so $\Delta_H > 0$ in these cases. No posted price $\bar{p} \in (c, v)$ is then an equilibrium,

because any supplier could gain by posting a somewhat higher price; however $\bar{p} = v$ is an equilibrium. *Q.E.D.*

Proof of Proposition 1(iv): From the proof of part 1(ii), $\theta = \theta^*(N)$ implies $\Delta_L = 0$ for any $\bar{p} \in (c, v]$. From the proof of part 1(iii), $\theta = \theta^*(N)$ also implies that equality holds in (A11), and thus that expression (A12) equals expression (A10). Therefore from expression (A12) $\Delta_H = 0$ for any $\bar{p} \in (c, v)$ if and only if $N = 2$. In this case any commonly posted price $\bar{p} \in [c, v]$ is an equilibrium. *Q.E.D.*

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