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THE EFFECTS OF ADVANCE NOTICE AND BEST-PRICE
POLICIES: THEORY, WITH APPLICATIONS TO ETHYL

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THE EFFECTS OF ADVANCE NOTICE AND BEST-PRICE
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by

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I. Introduction

One of the long standing issues in industrial organization is the possibility that even in the absence of overt collusive activities, firms in a concentrated industry may succeed in raising price above the competitive level. The terms commonly used to describe such a situation are "tacit collusion" or "oligopolistic interdependence." There has been some recent effort to identify specific, observable actions of firms that may facilitate tacit collusion. Some of the most commonly mentioned "facilitating practices" are:¹ product standardization, delivered pricing, exchange of information, advance notification of price increases, and "price-protection" clauses in contracts such as meet-or-release and most-favored-customer clauses. Meet-or-release (MOR) clauses require a seller to meet a lower offer to his customer or to release the customer from the contract. A most-favored-customer (MFC) clause guarantees that the buyer is receiving the best price offered to anyone by the seller.

Our primary interest in this paper is in the effects of advance notification and "price-protection" clauses on the levels of both list and transactions prices in a homogeneous-product oligopoly. There have been two major antitrust actions brought by the government involving one or more of these facilitating practices. In 1976 the Department of Justice entered a modification of the 1962 consent decree arising from a "electrical equipment conspiracy case." This modification enjoined the defendants from engaging in a number of pricing practices including the use of most-favored-customer clauses.²

Perhaps the most significant litigated case involving facilitating practices was the 1983 Federal Trade Commission (FTC) decision in the Ethyl case. The respondents were producers of lead-based anti-knock compounds that are used as gasoline additives. The case involved a number of facilitating practices, and the Commission specifically found that the respondents' use of public advance notification of list price increases, sale on a uniform delivered price basis, and use of most-favored-customer clauses³ had unreasonably restrained price competition in violation of Section 5 of the FTC Act.⁴ Briefly, the government argued that the use of public advance notification of list prices and sale on a uniform delivered price basis was a method of "price signalling" that facilitated a consensus on list prices and that the use of MFC clauses and sale on a uniform delivered price basis restricted the incentives of the firms to engage in discounting from a supra-competitive list price. The case was

dismissed by the Second Circuit on appeal. The respondents in Ethyl also used contracts with MOR clauses, another practice that has been argued to have the potential to facilitate collusion. The MOR clauses were not litigated in the Ethyl case, and their legality apparently has never been determined. When both MOR and MFC clauses are used in sales contracts, we will say that the contract contains a "best-price" provision, i.e., a provision that guarantees that the buyer can obtain the seller's lowest sale price and that the buyer will not be required to purchase at a price that exceeds the lowest price granted by any other seller.

There have been two recent papers examining the theoretical implications of best-price policies. Steven Salop (1982) presents some discrete-price duopoly examples that show that the use of meet-or-release and most-favored-customer clauses can have an upward effect on prices.⁵ Thomas Cooper (1981) considers the effects of the use of most-favored-customer clauses in a duopoly model with firms that produce differentiated products. He shows that most-favored-customer clauses can result in prices above the "no-clause" Nash equilibrium level for price-setting firms.

The theoretical literature has provided little insight into the magnitude of the price increases that could possibly result from the use of best-price policies. One of the contributions of this paper is to provide explicit bounds for the potential magnitude of the effect of the practices analyzed on equilibrium

prices. Another contribution of this paper is to explicitly distinguish between list and transactions prices; many of the existing theories of oligopoly do not make this distinction. This is unfortunate, since empirically, a significant deviation between list and transactions prices, especially for producer goods, is common.⁶

David Grether and Charles Plott (1981) report the results of a series of laboratory experiments designed to determine whether facilitating practices can result in tacit collusion that raises prices.⁷ Among the facilitating practices they included in their set of treatment variables were most-favored-customer pricing policies and advance notification of price changes. With advance notification, all transactions were required to be at announced prices and announced prices were continuously displayed to all buyers. Thus a price cut would be public and effective immediately, resulting in all discounts being non-selective. In their experiments, all trades were final, so there was a "no-release" provision built into all contracts. The limited number of experiments conducted by Grether and Plott makes it difficult to assess the separate effects of the various facilitating practices. The overall effect of all facilitating practices considered was to raise prices to a level that was about midway between the competitive level and the "Cournot price" that would result in a Nash (Cournot) equilibrium for a game in which firms choose output quantities, not prices. Under the control treatment with none of the practices, prices were close to competitive

levels. Sellers were rarely able to use the advance notification process to coordinate price increases up to the Cournot level.

The failure of prices to rise to collusive levels in the Grether and Plott experiments is surprising because they present a theoretical argument that the practices taken as a group yield "...a prediction that prices should equilibrate at the lowest of the optimum industry prices from the individual firm's point of view..." (Grether and Plott, 1981, p. 5). One of our objectives is to provide an analysis of the effects of the practices that is consistent with the experimental evidence.

In this paper we model the determination of list prices and transactions prices and address the question of whether, in the absence of overt collusion by the producers in an industry, contractual provisions can stabilize list and/or transactions prices above the competitive level even in the presence of the usual incentives for producers of a homogeneous product to discount when the price exceeds marginal cost.

The major producers in the anti-knock compound industry, Ethyl and Dupont, produced a homogeneous product and generally used 30 days advance notice, meet-or-release (MOR), and most-favored customer (MFC) provisions in their contracts. We work with an oligopoly model with these characteristics in this paper, and we show that under some conditions, including those approximating the fact situation in Ethyl, the use of public advance notification of list price increases and of contracts with best-price provisions can result in equilibrium list and transactions

prices that exceed the competitive level. However, our analysis shows that the use of best-price clauses and advance notification, alone, do not ensure that equilibrium transactions prices will be above the competitive level.

Under conditions that lead to supra-competitive transactions prices we also characterize a range of possible list prices that are not subject to discounting, and discuss market conditions under which the upper limit of this range is no greater than the "Cournot price" level, which following Grether and Plott (1981), we define to be the price that would result if firms were to choose Nash equilibrium output quantities in a game in which the decision variables are outputs. For all of the potential market conditions considered, we show that firms would always have incentives to engage in unilateral price cutting at all prices that exceed the Cournot price, even if contracts contain best-price provisions. Thus the Cournot price that results when decision variables are outputs can provide a useful benchmark even though firms' decision variables in our model are actually prices. The intuitive reason for this is that the meet-or-release provision allows a firm to maintain its output level when a rival cuts its price, and the most-favored-customer provision forces a firm to apply any discount to all units that it contracts to sell.

We do not model any efficiencies that may arise from the use of advance notification and best-price policies. Our focus instead is on the anticompetitive potential of such policies.

Thus, our analysis should not be judged as conclusive on the net competitive effects of these policies.

The remainder of this paper is organized as follows. Section II contains a discussion of some institutional features of the producer goods markets that interest us. Section III contains the model and the characterization of the Cournot benchmark. The relationship between the structural parameters of the model and the range of prices that are not subject to unilateral discounting is developed in Sections IV and V. The advance notification practice is analyzed in Section VI. Section VII contains a summary and conclusions.

II. Producer Goods Markets: The Institutional Setting

In producer good industries such as the anti-knock lead additives (AK) industry, it is common for producers to have publicly announced list prices. In such markets sales are often made by contracts of a specific duration. These contracts generally also specify a range of (unit) sales within which the buyer is expected to purchase. In such markets any spot market often represents a minor fraction of the total volume of transactions, and in some cases the spot market essentially does not exist. When the product is essentially homogeneous as in the AK industry, publicly announced list prices of different sellers, as would be expected, are generally identical. However, it is also common in producer products markets for the publicly announced

(contract) price to differ from many purchasers' actual transactions prices specified in their contracts. This is often accomplished by a producer granting a "temporary competitive allowance" (TCA) or "temporary voluntary allowance" (TVA) which is an amendment to the initial contract, stated as a discount from the publicly announced list price. In some producer goods industries (not AK) there have been considerable periods of time in which the transactions prices in buyers' contracts were virtually all below the publicly announced list price. In such a situation, the reason for the continued existence of list prices may not be clear. Presumably, the existence of publicly announced list prices in the presence of substantial discounting from list indicates that the list prices nonetheless serve the function of transmitting some useful information to sellers and buyers. Under the FTC's theory in Ethyl, the existence of list prices may indicate that sellers have committed to a policy of price signalling. A different theory might suggest that list prices signal some information to buyers. In this paper we will assume that the producers have adopted a policy of having publicly announced list prices and that sales are typically made by contract.

In producer goods industries of the kind we have been discussing it is common for contracts to contain a clause guaranteeing that the seller will give the buyer advance notice of intentions to increase the list price during the duration of the contract. For example, a contract may be for one year with a

guarantee of 30 days advance notice of any price increase.

(Because discount contract sales typically quote a price as a discount from list, increases in the list price generally signal a probable increase in transactions price). At approximately the same time that customers are notified in advance of a future price increase, firms typically make a public announcement of the contemplated price increase. We will assume that sales contracts have advance notification provisions and that firms make advance notifications publicly.

When advance notification of list price increases are made public and the good is homogeneous, the process by which list price changes occur generally takes some time. For example, if the advance notification provision requires 30 days advance notice, typically firms begin to announce contemplated price increases more than 30 days in advance (in the Ethyl litigation this was termed by the government "advance-advance notice"). In a typical situation firm A announces a price increase of 10 percent to become effective in 32 days on April 30. Then firm B follows with an announced price increase of 5 percent, also effective on April 30. Since the good is homogeneous, both firms are likely to have the same list price on April 30. Therefore, sometime prior to March 31, firm A will lower its price increase to 5 percent or firm B will raise its price increase to 10 percent or a consensus is reached somewhere in between. This sort of behavior has been termed "price signalling" in the industrial organization and antitrust literature.

In our model we will assume that the practice of advance notification results in the following sequence of market activity: First, firms announce proposed list prices and adjust their proposed list prices, if necessary, in response to competitors' proposed list prices. This announcement of prices occurs prior to the deadline specified by the requirement of advance notification. Then, firms and buyers strike sales contracts. For simplicity we will assume that sales contracts set specific amounts that the customer must purchase during the period of the contract. Since advance notification is not required for price decreases, there may be discounts from the list price. Finally, firms produce the quantities that they sold.

As was noted above, the transactions price actually paid by a customer in producer goods markets is often not the list price. In principle, a model that sought to explain short run equilibrium in such markets should explain the possible discrepancy between list and transactions prices. We will return to this issue at the end of this paper. However, the main purpose of this paper is somewhat different. In competitive producer goods markets with no contractual restrictions on discounting, list prices may at times be above the competitive level, but discounts from list price lead to competitive transactions prices. Our purpose here is to demonstrate that the use of public advance notification and best-price policies may lead to equilibrium list and transaction prices above the competitive level. The proof of this proposition will follow from a demonstration that under

certain circumstances list prices above the competitive level will exist at which no producer has a unilateral incentive to offer discounts and that the use of public advance notification of list prices is likely to lead to list prices above the competitive level.

III. The Cournot Equilibrium Price as a Benchmark

This paper considers a standard model of a homogeneous-product oligopoly in which unilateral price cuts are always perceived to be profitable if price exceeds firms' marginal costs and there are no best-price policies. The Nash equilibrium in prices, the "Bertrand equilibrium", implies extremely competitive behavior, i.e., that price will be driven down to a level at which unilateral price cuts are no longer profitable. A common reaction to this observation is to reject the Bertrand approach because it typically implies that perfect competition is established even under duopoly. The most common alternative approach is to assume that firms' strategies or decision variables are output quantities, not prices. The static Nash equilibrium in quantities, the "Cournot equilibrium", results in an industry output and an associated market price that typically exceeds marginal cost for each firm. This price will be called the "Cournot price".

The specification of strategies here is not arbitrary. The focus of this paper is on markets in which firms first post prices and then produce in response to orders received. Thus

firms choose prices independently, but the quantity of output sold by each firm may depend on the others' prices. It is appropriate to model firms' decision variables as being prices, not quantities, for such markets. We begin, however, by characterizing the Cournot equilibrium outputs and price for a model in which firms choose outputs, in order to establish a benchmark that can be used to evaluate the effects of contracts with best-price provisions when firms post prices.

In this model, the market demand function that expresses quantity Q as a function of the price p is denoted: $Q = D(p)$. The inverse of this market demand function is denoted: $p = f(Q)$. The standard Cournot assumption is that the industry output, Q , determines the market price. We assume that this inverse demand function is twice continuously differentiable and strictly decreasing on the interval $(0, \alpha)$ and that $f(\alpha) = 0$ for some finite output level α . The first and second derivatives are denoted by $f'(\cdot)$ and $f''(\cdot)$ respectively, and we assume that

$$f''(Q)\frac{Q}{2} + f'(Q) \leq 0 \quad \text{for } Q \in (0, \alpha). \quad (1)$$

It is straightforward to show that (1) is equivalent to an assumption that the industry total revenue is a concave function of industry output.

We assume that there is a fixed number, n , of firms in the market. Their output quantities are denoted by q_i , $i = 1, \dots, n$,

and therefore $Q = \sum_i q_i$. We allow firms to have different variable cost functions, and these functions are denoted by $c_i(q_i)$. The variable cost functions are nondecreasing, twice continuously differentiable, and convex on $(0, \alpha)$, i.e., $c'_i(q_i) \geq 0$ and $c''_i(q_i) \geq 0$ for $q_i \in (0, \alpha)$. Firm i 's fixed costs are given by F_i . Of course, $c_i(0) = 0$, $i=1, \dots, n$. Additional cost assumptions that ensure nonnegative profits in equilibrium will be discussed as necessary.

The profit function for firm i is: $\pi_i = f(Q)q_i - c_i(q_i) - F_i$ if $q_i > 0$. If all firms have strictly positive outputs in a Cournot equilibrium, these outputs must satisfy the necessary conditions:

$$f'(Q^*)q_i^* + f(Q^*) - c'_i(q_i^*) = 0, \quad i = 1, \dots, n. \quad (2)$$

where Q^* and q_i^* are the Cournot equilibrium levels of Q and q_i respectively. It follows from (1), the convexity of (variable) cost functions, and the fact that $q_i^* \leq Q^*$ that the i th firm's profit is a strictly concave function of its output.

A Cournot equilibrium with positive outputs for n firms may not exist⁸ if fixed costs are high for some firm(s), but if a Cournot equilibrium exists with strictly positive outputs for all n firms in our model it will be unique. The uniqueness proof that follows will provide an inequality that will be useful in the analysis of the best-price provisions in the next section.

Consider the non-negative space R^{n+} in which a point represents a vector of outputs for the n firms. A ray from the origin in this output space has the property that the output for each firm i , $i = 1, \dots, n$, is equal to some constant fraction, s_i , of industry output: $q_i = s_i Q$. A ray is characterized by a set of s_i fractions that sum to one.

First we will show that there can be at most one equilibrium on a ray. The incentive for firm i to increase its output unilaterally is positively related to the sign of

$$f'(Q)q_i + f(Q) - c_i'(q_i). \quad (3)$$

Thus the firm's incentive to increase output unilaterally, at points on a ray characterized by $\{s_1, \dots, s_n\}$, is positively related to the sign of:

$$f'(Q)s_i Q + f(Q) - c_i'(s_i Q). \quad (4)$$

As Q increases, the industry output vector is moved outward along the ray, as illustrated for the two-firm case in figure 1. The derivative of the expression in (4) with respect to Q is:

$$f''(Q)s_i Q + (1 + s_i)f'(Q) - s_i c_i''(s_i Q). \quad (5)$$

It follows from the convexity of costs, the fact that $s_i/(1 + s_i) < 1/2$, and the concavity of industry total revenue (see equation 1) that the derivative in (5) is strictly negative if $s_i > 0$, $i = 1, \dots, n$. In a Cournot equilibrium, (3) must be zero for each firm. Then, since (5) is negative, there can be only one Cournot equilibrium on any ray.

Suppose there are two Cournot equilibria on distinct rays, as represented by points A and B in figure 1. Consider the hyperplane through point B which consists of all output vectors with a constant level of total industry output, denoted Q_B^* . Then for any point C on this hyperplane other than B at least one firm, say firm i, has an output that is less than its Cournot output at B (this would be firm 2 in figure 1). The incentive for the firm with the less-than-Cournot output to expand its output unilaterally is determined by the sign of $f'(Q_B^*)q_i + f(Q_B^*) - c'_i(q_i)$. It follows from (2) that this incentive to expand output for firm i is strictly positive for at least one firm at any point other than B on the hyperplane through B. Consider the point C at the intersection of this hyperplane and a ray from the origin through the other equilibrium at A. At least one firm has a unilateral incentive to expand output at C, and this firm would have a greater incentive to expand output at A because the expression in (5) is negative. Thus, if B is a Cournot equilibrium, then at least one firm has a unilateral incentive to expand output at A, so A cannot be a Cournot equilibrium. This argument demonstrates that there can be at most one Cournot equilibrium with strictly positive outputs for each firm in our model.

IV. The Effects of Best-Price Policies on the Incentive to Discount from List When Discounts Must be Nonselective

In this section we will assume that there is a common list price (arrived at by public advance notification) and we will examine the effects of best-price provisions in (list price)

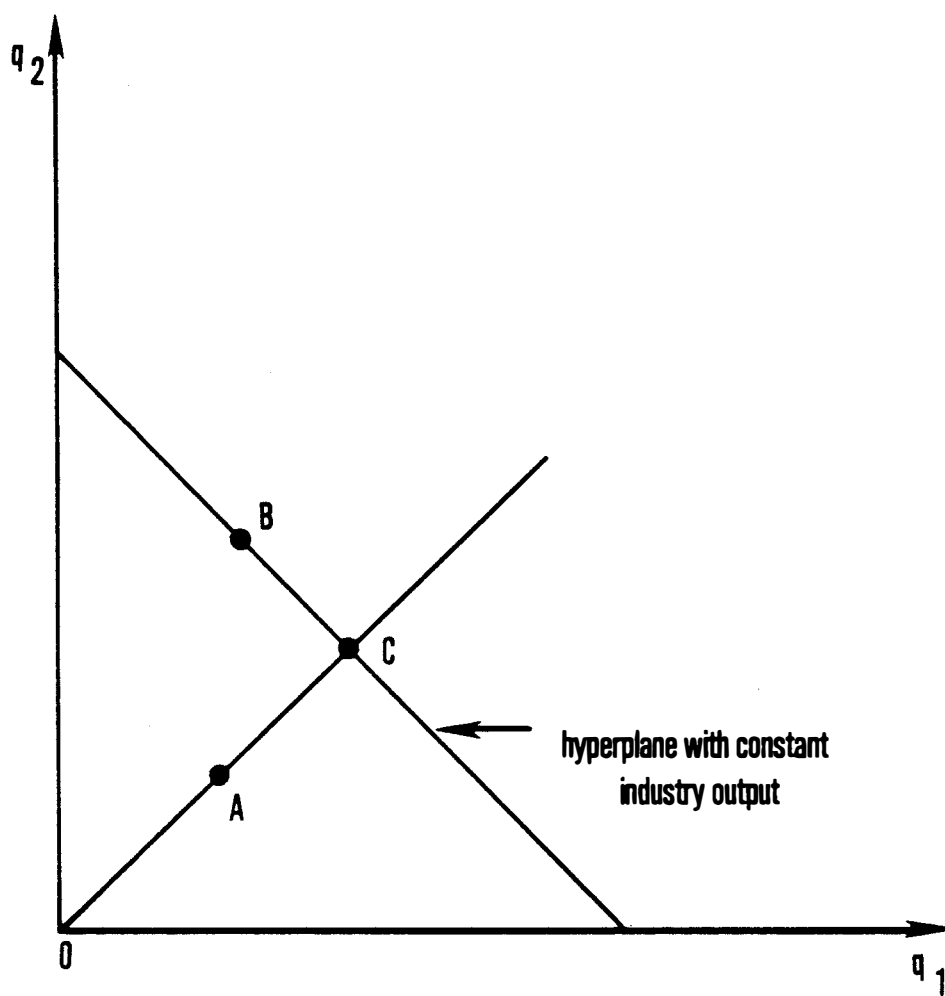


Figure I

sales contracts on the level of transactions prices. The issue here is whether the use of best-price provisions can restrict the incentives to discount for some list prices above the competitive level. With both MFC and MOR clauses, contract provisions allow the buyer to take the best price available. The MFC clause requires that if a firm offers a discount then the discount must be offered on all of the firm's existing contracts. In this section we also assume that any discount offer must be made non-selective in the sense that all buyers in the market receive the discount offer. The case of selective discounts will be considered subsequently.

Suppose that some common level of contract prices, denoted \bar{p} , has been determined and that \bar{p} is above the competitive price. We assume that list price sales contracts are signed for the total demand at price \bar{p} , $D(\bar{p})$.⁹ We leave to the end of this paper the modelling of the determination of list prices and the division of list price sales among producers. In this section we will assume that total sales at \bar{p} are $\bar{D}(\bar{p})$ and that list price sales are allocated among producers in some arbitrary manner, subject only to a conditions that no producer makes list price commitments at a level at which his marginal production costs exceed the list price \bar{p} . Therefore, the allocation of list price sales at list price \bar{p} will be denoted $\{\bar{q}_i\}$, and we assume that

$$(a) \quad \sum \bar{q}_i = D(\bar{p}), \quad (6)$$

$$(b) \quad c'_i(\bar{q}_i) \leq \bar{p}.$$

Since \bar{p} is assumed to be above the competitive price, there are an infinite number allocations of sales $\{\bar{q}_i\}$ that satisfy (6).

Given such an allocation, the issue to be addressed now is whether any producer has a unilateral incentive to discount from \bar{p} . In the absence of best-price provisions in sales contracts, producers would have the usual Bertrand incentives to discount from any price exceeding their marginal costs. We begin our analysis here by modelling the effects of best-price policies on producers' incentives to discount.

Given a supra-competitive list price \bar{p} and an allocation of sales $\{\bar{q}_i\}$ that satisfies (6), suppose now that firm i considers offering a non-selective discount. Of course for such an offer to be perceived as profitable for firm i , we must have

$c'_i(\bar{q}_i) < \bar{p}$. Since \bar{p} is above the competitive level there is at least one firm in this situation. To begin, we will assume that all producers have a level of sales at \bar{p} such that their marginal costs are exceeded by \bar{p} . Later we will relax this assumption.

Since sales contracts have MOR clauses, any non-selective discount offer will trigger the MOR clause in all of each producer's sales contracts. Because we are assuming here that $c'_i(\bar{q}_i) < \bar{p}$ for all producers, any offer of a discount price p_d

for which $c_i'(\bar{q}_i) \leq p_d$ for all producers will result in all producers matching the price p_d . Therefore, such a discount offer will not divert any existing sales from the discounter's competitors, and we assume that a firm offering a small discount does not anticipate that this discount will divert existing sales from its competitors. The potential for new sales at a price p_d slightly below \bar{p} is assumed to be $D(p_d) - D(\bar{p})$.

Because the product is homogeneous and the discount is non-selective, we assume that firm i expects that its new sales due to a discount price p_d will be $D(p_d) - D(\bar{p})$. This assumption maximizes the incentives for a firm to give a unilateral non-selective discount. Below we will discuss the implications of modifying this assumption.

Since firm i 's sales contracts have MFC provisions, firm i must offer any discount on all of its existing sales. Under our assumption that firm i expects to make new sales of $D(p_d) - D(\bar{p})$, firm i 's profit from offering a unilateral non-selective discount of p_d is

$$p_d [\bar{q}_i + D(p_d) - D(\bar{p})] - c_i(\bar{q}_i + D(p_d) - D(\bar{p})). \quad (7)$$

Recall that (7) is calculated for the case in which sales contracts have both MOR and MFC clauses and that the discount price p_d is matched by competitors.

Firm i 's profit from discounting can be written as function of quantity in the following way. Let x_i be firm i 's extra sales from discounting, so $p = f(\bar{Q} + x_i)$ and $x_i = D(p_d) - D(\bar{p})$. Then firm i 's profit from discounting can be written as a function of x_i :

$$f(\bar{Q} + x_i)[\bar{q}_i + x_i] - c_i(\bar{q}_i + x_i). \quad (8)$$

Notice that the effect of the use of MOR clauses is to change the usual Bertrand analysis of the profitability of discounting in which the discounter assumes that he will receive the whole market demand as a result of any discount below his competitors. With MOR clauses and our assumption that the discount offer is matched by all competitors, the discounter only expects to obtain new sales which are incremental to the market. Firm i 's profit-maximizing level of discounting from the price \bar{p} is determined by the maximization of (8) with respect to x_i .

However, this maximization is subject to the condition $x_i \geq 0$ (which is equivalent to the condition $p_d \leq \bar{p}$). The derivative of (8) with respect to x_i is

$$f'(\bar{Q} + x_i)[\bar{q}_i + x_i] + f(\bar{Q} + x_i) - c_i'(\bar{q}_i + x_i). \quad (9)$$

From (9) it is easily seen that a sufficient condition for a small nonselective discount from \bar{p} by firm i to be profitable is that (9), evaluated at $x_i = 0$, is positive:

$$f'(\bar{Q}) \bar{q}_i + f(\bar{Q}) - c'_i(\bar{q}_i) > 0. \quad (10)$$

It follows from (1) that the derivative of (9) with respect to x_i is negative, so (8) is concave in x_i . Therefore a necessary and sufficient condition for a small nonselective discount from \bar{p} by firm i not to be profitable is that the expression on the left side of (10) be negative.

Now we will show that for any list price \bar{p} above the Cournot level p^* and any allocation of sales $\{\bar{q}_i\}$, it is profitable for at least one producer to give a small nonselective discount from \bar{p} . The proof follows directly from the analysis of uniqueness in the previous section. Let the industry output vector $\{\bar{q}_i\}$ be represented by point A in figure 1, and let the Cournot equilibrium output vector be represented by point B. Note that point A is below the constant-industry-output hyperplane passing through point B because $\bar{Q} < Q^*$ and $\bar{p} > p^*$. By definition, no firm has an incentive to increase output at the Cournot point B, and the argument given in the previous section's uniqueness proof indicates that at least one firm has a unilateral incentive to increase output at point A. (This argument, although represented in two dimensions in figure 1, applies to the n-dimensional case.) Thus, the expression in (10) is positive for at least one firm, giving us the following proposition:

Proposition 1

At any list price above the Cournot equilibrium price at least one producer has an incentive to offer a small nonselective discount.

Notice that if we were to relax the assumption that the discounter obtains all new sales at p_d , then this would reduce the profitability of discounting. In this case there could be a price \bar{p} above p^* and an output vector $\{\bar{q}_i\}$ for which no firm has a unilateral incentive to discount.

Proposition 1 shows that list prices above the Cournot equilibrium price are not sustainable as transactions prices, even when best-price policies are used. This relationship between the Cournot model and the incentive to give small non-selective discounts is more fully revealed by a comparison of (2) and (10). That comparison shows that there is a close relationship between the profitability of discounting and the conditions determining the Cournot reaction functions of the producers. The Cournot reaction function of firm i in this context gives firm i 's output as a function of the sum of the other firms' outputs. Firm i 's Cournot reaction function is determined implicitly by the equation

$$f'(Q) q_i + f(Q) - c'_i(q_i) = 0, \quad (11)$$

subject to the provision that $0 < q_i < Q$.

The second-order condition for the Cournot profit-maximization problem requires

$$f''(Q) q_i + 2f'(Q) - c_i''(q_i) < 0, \quad (12)$$

which is guaranteed by (1) and our assumption of non-decreasing marginal costs. Thus, for any quantity q_i below the level determined implicitly by (11), firm i will have an incentive to increase output unilaterally by offering a nonselective discount. This is illustrated in two dimensions in figure 2, where the reaction functions for firms 1 and 2 are labeled R_1 and R_2 respectively. Firm 1 has a unilateral incentive to discount anywhere in the shaded area to the left of R_1 , and firm 2 has a similar incentive in the shaded area below R_2 . The unique Cournot equilibrium occurs at the intersection of the reaction functions.

It follows from the argument given in the previous section's uniqueness proof that, at the Cournot price p^* , there is only one vector of firms' outputs (the Cournot vector) for which no firm has a unilateral incentive to increase output. At any other output vector that yields an industry output of Q^* (e.g., point Z in figure 2), at least one firm has an incentive to increase its output unilaterally by offering a nonselective discount when contracts contain best-price provisions. Next, suppose that the common list price \bar{p} is below p^* , so $\bar{Q} > Q^*$. It follows from the strict negative sign of the expression in (5) that the incentive for each firm to increase output unilaterally decreases as the

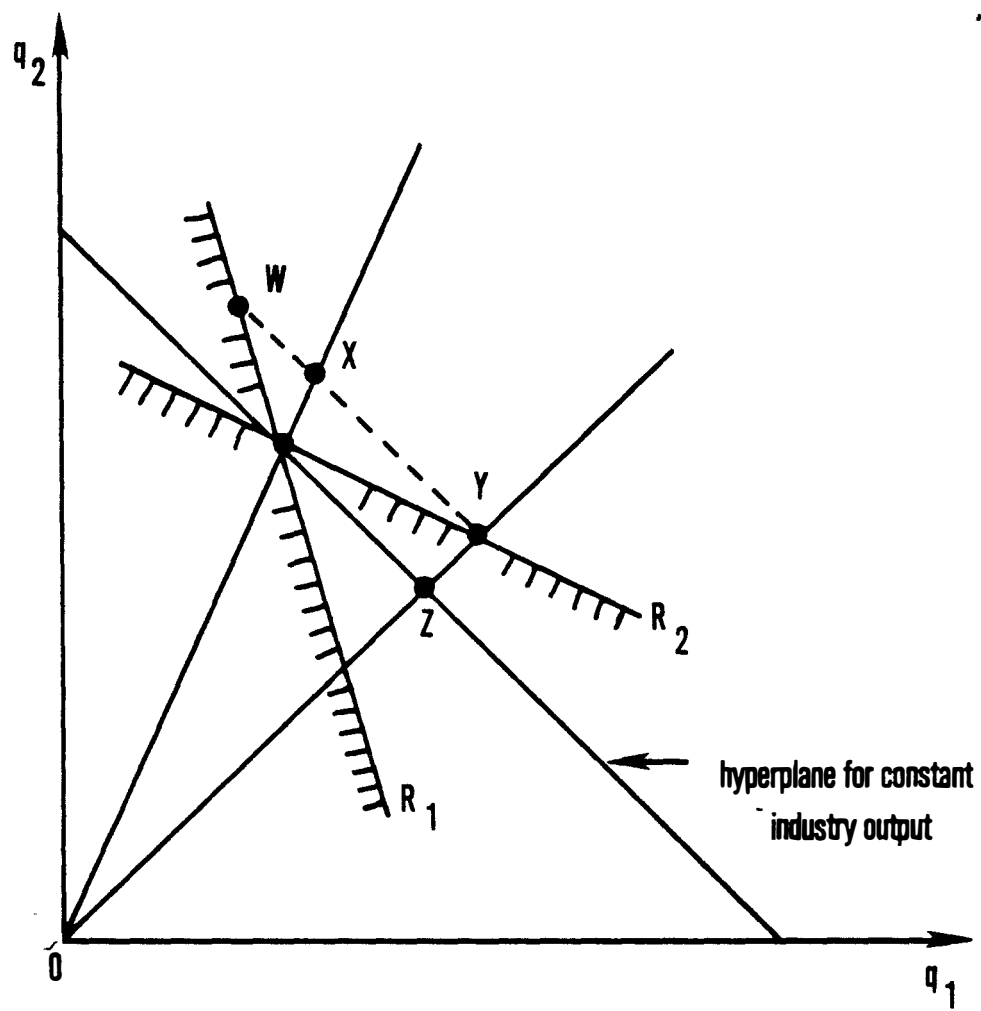


Figure II

vector of firms' outputs moves out along any ray from the origin in output space. Thus, no firm has an incentive to offer a non-selective discount at a point on a ray through the Cournot point with $\bar{Q} > Q^*$, a point such as X in figure 2. Consider a hyperplane through X that maintains a constant industry output \bar{Q} . It follows from our continuity assumptions that all points on such a hyperplane in some neighborhood of X represent output vectors for which no firm has a unilateral incentive to discount non-selectively; such points are found on the line WY in figure 2. Put differently, at any price strictly between the competitive price and the Cournot price, there are an infinite number of market share divisions from which no firm has an incentive to discount.

Thus, a common contract price \bar{p} that is below the Cournot price is more stable with respect to nonselective discounts in the following sense. If \bar{p} equals p^* there is only one vector of firms' sales quantities, the Cournot vector $\{q_i^*\}$, that will not provide at least one firm with an incentive to discount. But if \bar{p} is less than p^* there are an infinite number of divisions of industry sales that do not result in incentives to discount. Because the incentive for each firm to discount nonselectively decreases with movements outward on any ray from the origin in output space, successively lower common contract prices result in wider variations in firms' market shares that do not result in incentives to discount. These results are summarized:

Proposition 2 (incentives to discount
nonselectively with best-price
provisions)

If all firms use best-price provisions in sales contracts, then the highest price for which no firm has a unilateral incentive to discount nonselectively is less than or equal to the Cournot price. At the Cournot price, there is only one vector of sales quantities, the Cournot vector, that does not result in incentives to discount nonselectively. At any common contract price below the Cournot price and above the competitive price, there is a range of firms' market shares that are impervious to nonselective discounting, with lower prices resulting in wider ranges of firms' market shares that have this stability property.

Extreme cost asymmetries can result in a situation in which some firms constitute a competitive fringe, operating at outputs for which marginal cost equals price. It is shown in Appendix A that, in this case, the highest price that is not subject to unilateral nonselective discounting is less than the Cournot price when contracts contain best-price provisions. The method of proof is straightforward and involves subtracting the fringe

supply from the market demand to obtain a residual demand for firms that are not in the fringe.

Grether and Plott (1981) conducted some experiments with advance notification and MFC clauses in which all transactions were required to be at announced prices and announced prices were continuously displayed to all buyers. Thus a price cut would be public and effective immediately, resulting in all discounts being non-selective. All contracts were binding in these experiments, and the resulting "no-release" condition is as strong a deterrent to nonselective discounting as the use of MOR clauses. Their market structure was symmetric in the sense that the two large sellers that were not on the competitive fringe had identical cost functions. The net demand for these two firms is the market demand minus the supply of the fringe firms, as functions of price. This net demand can be used to compute the Cournot price for the duopoly consisting of the two large firms that face the net demand curve. Proposition 2 indicates that we would not expect to see prices above the Cournot level in these experiments. Prices in the experiments with the practices described above were about halfway between the competitive and Cournot levels, the average being a little closer to the Cournot level. The average price did not exceed the Cournot price in any period in any experiment. Under the control treatment with none of the practices, prices were close to competitive levels.

V. Best-Price Provisions with Selective Discounts

In the preceding section we assumed that discounts were non-selective, i.e., that a discount was like an across-the-board price decrease, effective immediately for all buyers. This would occur, for example, if a seller made a public announcement of a "temporary voluntary allowance" (a uniform discount from list). As indicated in previous discussions of the Grether and Plott experiments, all prices were displayed continuously to all buyers in some of their experiments, and this would force discounting to be non-selective. Alternatively, any discount offer would become de facto non-selective if firms had best-price provisions and each customer made some purchases from each seller. In such a situation a seller, because of the MFC clauses in his sales contracts, could not offer a discount without offering it to all buyers. In the AK market it is of interest to note that apparently virtually all buyers brought some of their requirements from each of the two largest producers (Ethyl and Dupont).

Now let us consider the possibility of selective discounts. A selective discount is any discount offer made only to a particular group of buyers. Why would a seller wish to make such an offer? One reason would be a desire to keep the offer secret from one's competitors. However, when contracts contain MOR provisions, discounts offered to other firms' customers will be reported to those firms by their own customers. But the MFC provisions in sales contracts provide another incentive to discount selectively. If your competitor uses best-price clauses,

it may be possible to "steal" some of its customers with a selective discount offer because the MFC clauses in the competitor's contracts reduce its incentive to match such an offer (since if it matches, it must make the same offer to all of its customers). Clearly, having the option of making a discount selective does not lower the unilateral incentive to discount. Although a nonselective discount by one firm will always be matched by another firm exercising its MOR option if the discount price is above average cost, a large discount that is sufficiently selective may not be matched. The MOR clauses ensure that a discount communicated to any of the customers of another firm will be reported to that firm, which must then decide whether to match or release. A selective discount that is matched will be no more profitable than an equal non-selective discount that is matched, so we will restrict our consideration to selective discounts that are not matched.

Our analysis is for a duopoly in which one firm, the "discounter", considers a selective discount and another firm, the "victim", considers a matching price cut. As before, we will assume that the total potential new sales, x , available at any discount price p_d are given by the implicit equation

$p_d = f(\bar{Q}+x)$. In what follows, the critical assumption in the analysis pertains to the quantity of new sales (as opposed to diversions from a competitor) a discounter will make as the result of a selective discount offer with price p_d that is

unmatched. Let $\gamma_d(p_d)$ denote this quantity. Then $\gamma_d(p_d) \leq D(p_d) - D(\bar{p})$ and $\gamma_d(\bar{p}) = 0$. The magnitude of $\gamma_d(p_d)$ relative to $D(p_d) - D(\bar{p})$ depends on the number of "new" customers that the discounter can reach and on the amount of new sales embodied in $D(p_d) - D(\bar{p})$ that come from increased sales to existing customers. Because $\gamma_d(p_d)$ represents the quantity of new sales obtained by the firm making an unmatched discount these sales represent new purchases made (1) by the discounting firm's own customers, (2) by new buyers entering the market in response to the price reduction, and (3) by the subset of the victim's customers that were offered the discount price. Because the discount is selective (not all of the victim's customers receive the offer), $\gamma_d(p_d)$ may be strictly less than $[D(p_d) - D(\bar{p}_d)]$.

In addition to attracting new sales, an unmatched selective discount will divert existing sales from those of the victim's customers who actually receive the discount offer. The existing sales quantities for the discounter and the victim will be denoted by \bar{q}_d and \bar{q}_m respectively. Let δ denote the quantity of existing sales diverted in this way. A discount is selective in this context if $\delta < \bar{q}_m$. With this notation, the discounter's profit for an unmatched selective discount that is characterized by (p_d, δ) can be written as a function of p_d :

$$\pi_d(p_d) = (\bar{q}_d + \gamma_d(p_d) + \delta)p_d - c_d(\bar{q}_d + \gamma_d(p_d) + \delta), \quad (13)$$

where $c_d(\cdot)$ represents the cost function of the discounter.

Now we must determine the quantity of sales that can be diverted, i.e., the largest possible value of q_d for any discount price p_d . We assume that the victim will not match a selective discount offer if matching does not yield a greater profit. If a discount offer is matched, the victim must offer the better price to all of its customers because of the MFC provisions. In that case the matching firm would probably also be able to make some new sales. For example, its existing customers may desire to purchase more at a lower price. Let $\gamma_m(p_d)$ be the amount of new sales made by the matching firm.

The largest quantity of sales the discounter can divert will be the amount that would leave the competitor indifferent to matching the discount offer of p_d . The "no-matching condition" that determines this quantity of diverted sales is:

$$\bar{p}(\bar{q}_m - \delta) - c_m(\bar{q}_m - \delta) = p_d(\bar{q}_m + \gamma_m(p_d)) - c_m(\bar{q}_m + \gamma_m(p_d)), \quad (14)$$

where $c_m(\cdot)$ represents the matching firm's cost function. The value of δ determined by (14) goes to zero as p_d approaches \bar{p} ; a very small discount will be matched unless it is very selective.

It will be profitable for the discounter to offer an unmatched selective discount from list if $\pi'_d(p_d)$, evaluated at

at $p_d = \bar{p}$, is strictly negative. In order to evaluate this derivative, it is first necessary to calculate the slope of the relationship between p_d and δ , the maximum quantity of sales that can be diverted without retaliation. Using the facts that δ , $\gamma_m(p_d)$, and $\gamma_d(p_d)$ go to zero as p_d converges to \bar{p} , one can use (14) to show that

$$\left. \frac{d\delta}{dp_d} \right|_{p_d=\bar{p}} = -\gamma'_m(\bar{p}) - \frac{\bar{q}_m}{\bar{p} - c'_m(\bar{q}_m)}, \quad (15)$$

and one can then use (14) and (15) to show that

$$\pi'_d(\bar{p}) = [\gamma'_d(\bar{p}) - \gamma'_m(\bar{p}) + \Delta][p_d - c'_d(\bar{q}_d)], \quad (16)$$

where

$$\Delta \equiv \frac{\bar{q}_d}{\bar{p} - c'_d(\bar{q}_d)} - \frac{\bar{q}_m}{\bar{p} - c'_m(\bar{q}_m)}. \quad (17)$$

Recall that $\bar{p} < p_d$, so the derivatives in (15) - (17) are one-sided derivatives. The expressions in (15) - (17) that involve differences between price and marginal costs are non-negative because \bar{p} exceeds the competitive level and each firm can reject sales for which marginal cost exceeds price. We assume that these differences are strictly positive. It follows that the sign of $\pi'_d(\bar{p})$ in (16) is the same as the sign of

$[\gamma'_d(\bar{p}) - \gamma'_m(\bar{p}) + \Delta]$. Note that if Δ is positive for the

discounter, then it must be negative for the other firm, and

hence at least one of the two firms could consider a discount and have a negative value of Δ . If $\gamma'_d(\bar{p}) - \gamma'_m(\bar{p})$ is negative for the firm with the negative value of Δ , then $\pi'_d(\bar{p})$ is strictly negative, and this firm could offer a profitable, unmatched, selective discount. Summarizing, we have the following result.

Proposition 3 (incentives to discount selectively with best-price provisions)

Even if sales contracts have best price provisions, if selective discounts are possible, at least one firm will have an incentive to offer a selective discount from any common list price above the competitive level if $\gamma'_d(\bar{p}) - \gamma'_m(\bar{p})$ is strictly negative for some firm acting as a discounter.

Since the product is homogeneous, the case in which $\bar{q}_d = \bar{q}_m$ is of interest. In this case Δ is negative for the firm with the lowest marginal cost, and in this sense the low-cost firm is more likely to be able to discount profitably if sales at list are equal. On the other hand, if \bar{q}_m and \bar{q}_d were somehow set to equate marginal costs, as would be required for the maximization of industry profit, then the firm with higher costs would have lower list-price sales, giving a negative value of Δ to the firm with the higher marginal costs. Finally, note that if costs are

symmetric and list-price sales are equal, $\Delta = 0$ and the incentive to discount depends on the sign of $\gamma'_d(\bar{p}) - \gamma'_m(\bar{p})$.

Now consider the sign of $[\gamma'_d(\bar{p}) - \gamma'_m(\bar{p})]$. Recall that $\gamma_d(p_d)$ arises in a situation in which the discounter's selective discount is not matched, but $\gamma_m(p_d)$ arises in a situation in which the victim matches the discount offer. The assumption used in the previous section's analysis of nonselective discounting was that the discounter obtains all new sales, even though the discount is matched. This would imply that $\gamma_m(p_d) = \gamma'_m(\bar{p}) = 0$, and hence the sign of $\gamma'_d(\bar{p}) - \gamma'_m(\bar{p})$ would be negative. But the sign of this expression can be negative when the victim who matches can obtain some new sales. For example, suppose that all new sales (i.e., sales that represent an increment to industry list-price sales) arise from new customers (i.e., customers who are making no purchases at list). Suppose further that any firm offering a discount can make an offer to all relevant new customers. Then an unmatched discount offer of p_d will allow the discounter to obtain all new sales: $\gamma_d(p_d) = D(p_d) - D(\bar{p})$. If the discount offer is matched, new sales will be divided between the two firms. Thus $\gamma_m(p_d) = \beta[D(p_d) - D(\bar{p})]$, where β is the fraction of new sales obtained by the matching firm. Clearly,

$\gamma'_d(p_d) - \gamma'_m(p_d) = (1 - \beta)D'(p_d)$ for $p_d < \bar{p}$, so in the limit we have: $\gamma'_d(\bar{p}) - \gamma'_m(\bar{p}) = (1 - \beta)D'(\bar{p}) < 0$. In this example, no common contract price above the competitive level is impervious to selective discounting by at least one firm.

However, it is possible to construct examples in which $\gamma'_d(\bar{p}) = \gamma'_m(\bar{p})$ and for which there are common contract prices above the competitive level that are impervious to selective discounting. One such example involves a symmetric duopoly situation in which sellers have identical cost functions and buyers have identical, downward-sloping demand functions. In this example, suppose that buyers are equally divided between the two sellers, so each firm contracts to sell $\bar{q} \equiv D(\bar{p})/2$ units at the common list price \bar{p} . Therefore, a firm making a discount, characterized by (p_d, δ) , gives this discount selectively to a fraction, δ/\bar{q} , of the other firm's customers. Thus

$\gamma_d(p_d) = (.5 + \delta/2\bar{q})[D(p_d) - D(\bar{p})]$. Recall that the value of δ that satisfies the no-matching condition (14) goes to zero as p_d converges to p from below. It follows from these observations that $\gamma'_d(\bar{p}) = .5D'(\bar{p})$. If we assume that a firm that matches the other's discount will keep its own customers, then

$\gamma_m(p_d) = .5[D(p_d) - D(\bar{p})]$, and $\gamma'_m(\bar{p}) = .5D'(\bar{p})$. In this symmetric example, $\Delta = 0$, $\gamma'_d(\bar{p}) = \gamma'_m(\bar{p})$, and the derivative in

(16) cannot be used to determine the profitability of selective discounting. In fact, it can be shown that any common contract price up to the Cournot level is not subject to unilateral selective discounting in this example if firms have a common, constant average cost.¹⁰

We believe that in many markets it is reasonable to assume that $\gamma'_d(\bar{p}) < \gamma'_m(\bar{p})$, i.e., that a small, unmatched, selective discount will generate new sales for the discounter at a rate that is greater than the rate of new sales generated for the competitor that matches the discount. Recall that $\pi'_d(\bar{p})$ is exactly zero and $\gamma'_d(\bar{p}) = \gamma'_m(\bar{p})$ in the identical-buyers example in which all new sales would be made to existing customers of either the discounting firm or its competitor. Also, $\pi'_d(\bar{p})$ is strictly negative in the other example in which all new sales would be made to new customers who were not previously buying from either the discounting firm or its competitor. Of course, some of these "new" customers may have units that were released by fringe firms operating at outputs that equate price and marginal cost. Most market situations involve some mixture of the two extreme demand structures considered in the examples; some new sales will be to existing customers and some new sales will be to new customers that enter the market or are released by fringe firms. The firm that initiates an unmatched discount will have an advantage with the new customers. Thus, it would be expected that the discounter will generally gain new sales with an unmatched discount

at a rate that is greater than the rate of new sales generated by a competitor that matches a small selective discount, so $\gamma'_d(\bar{p}) < \gamma'_m(\bar{p})$ would be expected to hold generally.

Proposition 3 shows that even if sales contracts have best price provisions, as long as the condition $\gamma'_d(\bar{p}) - \gamma'_m(\bar{p}) < 0$ holds for some firm, then that firm will have an incentive to discount selectively from any common contract list price above the competitive level. Therefore, if discounts can be selective, it is unlikely that the use of best-price provisions in sales contracts will have an effect on the level of long run equilibrium prices (recall that we have assumed away any efficiency-augmenting effect of the practices).

In Ethyl, the two large producers, Ethyl and Dupont, apparently never offered a price discount. However, virtually all customers purchased some of their requirements from both Ethyl and Dupont, so that it was not possible for either Ethyl nor Dupont to offer a selective discount. This situation is perhaps to be expected. With MFC clauses the buyer may perceive that it is in his interest to purchase some of his requirements from each seller (assuming there are no diseconomies from such purchase-spreading) because this guarantees the buyer receives the lowest price in the market. Therefore, best-price provisions can result in transactions prices persisting above the competitive level, if the incentives created by the provisions for buyers to spread their purchases are not counteracted by diseconomies of purchase-spreading.

VI. Advance Notification

We begin our analysis by assuming that there are institutional restrictions prohibiting discounting from list price, and we then consider the discipline imposed on list prices by discounting possibilities. Although an analysis of a situation with such restrictions is not the central purpose of this paper, in some markets in North America there are regulations that impose such restrictions. For example, Ekel and Goldberg (1984) discuss the case of a regulatory authority in British Columbia which, in the name of deregulation, instituted a regulation on the brewers (beer producers) in the Province that required 30 day advance notification and prohibited discounting. In the U.S. many states have regulations on the sale of liquor from distillers to wholesalers or from wholesalers to retailers that are similar in nature. We do not know of similar examples for producer goods industries.

With advance notification, announced price increases are made during a window period prior to the advance-notice deadline, and a seller can always rescind an announced price increase if it is not matched by other sellers. A firm in deciding whether or not to match another firm's announced price increase, would have to forecast its own share of industry sales at the higher price. Suppose that sales across firms at a common list price are expected to be equal, as might be the case for a homogeneous product, and that firms have identical cost functions, denoted $c(\cdot)$. Then each firm's anticipated profit would increase until

the common price rises to the level, $f(\hat{Q})$, that is determined by the maximization of the common profit, $f(Q)(Q/n) - c(Q/n)$, with respect to Q . It is straightforward to show that the common price determined in this manner is the perfectly collusive price that maximizes industry profit. But if costs are asymmetric or if sales at list are not expected to be equal, then the preferred common price level might differ from firm to firm.

Grether and Plott (1981) suggest that the effect of advance notification (with public announcements prior to the deadline) would be to raise the level of prices to the minimum of the firms' preferred common prices. They term this price level the "price-leadership joint maximum." The main idea is that an announced price increase to be effective on date T must be announced prior to a date $T-k$, and any announcement at time $T - k - \epsilon$ can always be rescinded at $T - k - \epsilon/2$ for any $\epsilon > 0$. Thus firms have nothing to lose if they propose price increases, and such increases would be followed as long as the price does not exceed the minimum of the firms' preferred common prices.

If the firm with the lowest preferred common price has sufficient capacity, no other firm will want to have a final list price that is above the price charged by this firm because its capacity and low price would permit it to divert significant sales from the others. If capacities are limited (i.e., marginal costs rise sharply at low output levels), then it is possible to construct examples in which a firm would be willing to charge a list price which exceeds the lowest list price in the market.¹¹

In the AK market, all firms' effective list prices were always identical during the period covered by the FTC case.

To summarize, advance notification will result in a common list price that is equal to the minimum of firms' preferred common prices if: (1) the firm with the lowest preferred price has sufficient capacity to prevent others from operating profitably at higher prices, and (2) discounting from final list prices is not permitted. Thus, a regulatory policy that requires advance notification and prohibits discounting is likely to result in supra-competitive prices.

However, it is important to note that the effects of advance notification may depend critically on whether discounts can be made from list. Although advance notification can result in a common list price at the price-leadership-joint-maximum level, actual transactions will eventually be made at lower prices if the initial common list price is not impervious to discounting. The range of prices, which are not impervious to discounting when contracts contain best-price provisions, are characterized in propositions 1 - 3. If contracts contain no such provisions, unilateral selective discounts are profitable whenever list price exceeds a firm's marginal cost. It is interesting to note that, of all of the treatments used in the Grether and Plott experiments, the combination of practices that yielded prices closest to competitive levels was the treatment with advance notification and no MFC clauses.

VII. Conclusion

This paper contains an analysis of the possible anticompetitive effects of some business practices that may enable firms to coordinate price increases and resist the temptation to discount. The issue we consider is whether such practices facilitate tacit collusion among firms in a homogeneous-product oligopoly. The focus is on coordination that is tacit, not overt, and therefore we consider whether some combination of practices results in a market environment in which supra-competitive prices can be sustained even if firms are assumed to behave non-cooperatively and myopically, i.e., firms will discount if doing so is unilaterally profitable.

The results are stated in propositions 1 - 3 in the paper; but the general pattern of the main results can be summarized briefly.

We show that the use of advance notification of list price increases may result in list prices that are above the competitive level. If discounts are not permitted, advance notification may even result in a perfectly collusive price level; this may happen if cost functions are identical, for example. But, if discounts from list may be offered, list and transaction prices may differ, and supra-competitive list prices may be unsustainable in the long run.

The use of best-price policies can, under some circumstances, result in supra-competitive equilibrium list prices that are immune to discounting. If contracts contain best-price

provisions, i.e., both meet-or-release and most-favored-customer provisions, then we show that there is a range of firms' sales quantities at common list prices above the competitive level for which unilateral discounts are unprofitable if such discounts can only be given nonselectively to all buyers. If costs are symmetric and all firms contract to sell equal outputs at any common list price, then this range contains all prices up to the "Cournot price" that would result in a Cournot equilibrium with output quantities being selected noncooperatively. This is because (1) the meet-or-release clause enables competitors to maintain their outputs by exercising their contractual right to meet the discount price, and (2) the most-favored-customer clause requires the discounter to extend any price cut to all of the units that it has already contracted to sell. The finding that list prices between the competitive price and Cournot price are impervious to unilateral, nonselective discounting is consistent with the pricing behavior observed in some experiments conducted by Grether and Plott (1981).

If firms can give selective discounts (i.e., discounts offered to only a subset of a competitor's customers), then we show that the use of best-price clauses is not likely to result in supra-competitive list prices that are immune to discounting. Of course, with most-favored-customer clauses, selective discounting is not possible if each buyer purchases some units from each seller, so that buyer behavior is an important determinant of the level of transactions prices in the presence

of best-price clauses. It is of interest to note that in Ethyl, it would appear that virtually all customers made purchases from the two largest producers. Our results suggest that the combination of such buyer behavior (that rules out selective discounts) and best price clauses may lead to supra-competitive transactions prices.

Appendix A: Nonselective Discounting with a Competitive Fringe

This appendix extends the analysis of nonselective discounting in section IV to the case in which there are some firms on the competitive fringe. Suppose that sales at a common price \bar{p} are characterized by a vector of fractions $\{s_1, \dots, s_n\}$ that sum to one. These fractions may, but need not, equal $1/n$. There would be no competitive fringe if each firm were willing to sell its amount, $s_i \bar{Q}$ for firm i . Firm j , however, would be a competitive fringe firm at a price \bar{p} if $c'_j(s_j \bar{Q}) > \bar{p}$, and such a firm would choose to sell a quantity that is less than the amount, $s_j \bar{Q}$, that it could sell.

In this appendix it will be shown that, when contracts contain best-price provisions, the highest common price that is impervious to nonselective discounting is less than the Cournot price if there is at least one fringe firm. Let the number of firms not in the fringe be \bar{n} , so $\bar{n} < n$ in the analysis that follows. When the prevailing contract price equals the Cournot price p^* , each fringe firm by definition is unwilling to sell $s_i Q^*$, which is its part of the industry demand. A fringe firm's actual output would be the output for which its marginal cost equals $f(Q^*)$. The output for a fringe firm at the price p^* would exceed the output it would produce in a Cournot equilibrium resulting in the price p^* . This is because the firm's marginal revenue, not price, would equal its marginal cost at its Cournot output determined by (2). Thus, at least one fringe firm

contracts to sell more than its Cournot output when the prevailing contract price \bar{p} is equal to p^* and $\bar{Q} = Q^*$. It follows that one of the \bar{n} firms not on the fringe, say firm i , has an output that is less than its Cournot output q_i^* . Let this firm's output be denoted by \bar{q}_i , so $\bar{q}_i < q_i^*$. This firm has an incentive to offer a unilateral discount at the Cournot price p^* because its marginal revenue, which would be equal to marginal cost at the Cournot output q_i^* , is now greater than marginal cost at the lower contracted output \bar{q}_i , so that:

$$0 = f'(Q^*)q_i^* + f(Q^*) - c_i'(q_i^*) < f'(Q^*)\bar{q}_i + f(Q^*) - c_i'(\bar{q}_i). \quad (A1)$$

If the marginal effect of an increase in q_i (following a discount) on price were $f'(Q^*)$, then (A1) would imply directly that the firm has an incentive to discount from p^* . When there are fringe firms, however, the reduction in price needed for an extra unit of sales q_i is less than $f'(Q^*)$ because fringe firms will release some marginal sales in response to a price cut, and this observation reinforces the conclusion that firm i can profit from a unilateral discount when $\bar{p} = p^*$.

FOOTNOTES

¹ Donald Clark (1983) has written a recent survey of the economic and legal aspects of facilitating-practices cases.

² United States v. General Electric Co., "Plaintiff's Memorandum in Support of a Proposed Modification of the Final Judgment Entered on October 1, 1962, Against Each Defendant", December 1976, p. 8.

³ The most-favored-customer clauses in Ethyl were not retro-active and were not used by all respondents.

⁴ The FTC's economic expert witness, George Hay, outlined an economic theory applicable to the case in Hay (1979). Pautler (1981) summarizes the economic evidence developed in the case.

⁵ In addition, he provides an interesting discussion of the entry-deterrence effects of these clauses. Salop also discusses the possible effects of a number of other practices that may facilitate tacit collusion.

⁶ For a discussion of the empirical importance of the difference between list and transactions prices, see Stigler and Kindahl (1970).

FOOTNOTES--Continued

⁷ These experiments were funded by the FTC for potential use in the FTC's case against Ethyl. The experiments were not used in the litigation.

⁸ Of course, a Cournot equilibrium may not exist. Novshek (1984) contains an excellent discussion of existence issues. Novshek's Theorem 3 implies that a Cournot equilibrium will exist for the model presented in this section if $f''(Q)Q + f'(Q) < 0$. Note that this is a stronger condition than the concavity condition in (1).

⁹ Notice that if list price sales contracts have best price provisions and that discounts can only be nonselective, buyers are assured that they are obtaining the lowest price available in the market at any time. Therefore, buyers have no incentive not to sign list price sales contract--if a better price becomes available after list price contracts are signed, buyers will be able to obtain it.

¹⁰ Let \bar{c} denote the constant level of average cost, and let λ denote the proportion of the other firm's buyers that receive the discounting firm's offer: $\lambda \equiv q_d / \bar{q}$. Also, let $x \equiv D(p_d) - D(\bar{p})$.

It follows from the discussion in the text that $\gamma_m(p_d) = x/2$ and $\gamma_d(p_d) = (1 + \lambda)x/2$. Using these relationships, one can express

the no-matching condition in (14):

$(\bar{p} - \bar{c})\bar{q}(1 - \lambda) = (p_d - \bar{c})(\bar{q} + x/2)$. Similarly, the discounting firm's profit in (13) can be expressed as $(p_d - \bar{c})(\bar{q} + x/2)(1 + \lambda)$.

Then the expression for the no-matching condition can be used to write the discounting firm's profit: $(\bar{p} - \bar{c})\bar{q}(1 - \lambda)(1 + \lambda)$.

Recall that $q_d < \bar{q}$ if the discount is selective, so $\lambda < 1$, and

consequently, the discounting firm's profit is less than $(\bar{p} - \bar{c})\bar{q}$, which is the profit that is obtained without discounting. For any

unmatched discount p_d , the most profitable level of q_d is the

highest possible level, i.e., the level that satisfies the no-

matching condition. But such a discount will not be profitable in

this example. Therefore, with $\bar{q}_1 = \bar{q}_2$, any price below the Cournot

level is impervious to selective discounting. Given the cost

symmetry, the Cournot outputs for the two firms will be equal,

and it follows from proposition 2 that non-selective discounting

also is unprofitable at prices below the Cournot level).

FOOTNOTES--Continued

11 Let $f(p) = 10 - p$, $c_1(q_1) = 0$ up to a capacity of 6, and $c_2(q_2) = 3$ up to a capacity of 5, and suppose that sales are equal at any common price above 3. For firm 1, the best common price above 3 is the price 5 that maximizes $p(10-p)/2$, which yields an output of 2.5 and a profit of 12.5. But if this firm's list price is slightly below 3, it will sell its capacity output of 6 because firm 2 will not match a list price this low. This yields a profit of approximately 18 for firm 1, so its preferred list price is slightly below 3. Firm 2, left with the residual demand, will maximize its profit with a price of 3.5. This arrangement, although not a Nash equilibrium in a one-period duopoly game with prices as strategies, would be stable in the sense that if firm 1 increased its price to 3.4 at time $T - k - \epsilon$, firm 2 could respond with a lower price at a later time, say $T - k - \epsilon/2$. One interesting feature of this example is that the price charged by firm 1 is slightly below the competitive price.

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