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BILATERAL MONOPOLIES AND INCENTIVES FOR MERGER

by

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ABSTRACT

The paper presents a model of duopoly in which firms acquire inputs through bilateral monopoly relations with suppliers. It combines a bargaining model with a duopoly model to examine how input prices and profits are affected by the structures of the upstream and the downstream industries, by the demand relations among the final products, and by the nature of the bargaining between the suppliers and firms. The implications for the incentives for merger turn out to be significantly different from what they would be in an alternative environment where prices are not determined in bargaining.

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1. Introduction

This paper presents a model of a downstream oligopolistic industry whose firms purchase their inputs through bilateral monopoly relations with their suppliers. It models explicitly the fact that the terms of the transactions are determined in bargaining between each firm and its supplier. The focus is on the bargaining tactics and incentives for horizontal merger among firms that are locked into such relations. The analysis relates the bargaining power of the parties to the industry structure, and the resulting conclusions regarding the profitability of mergers are sometimes markedly different from the usual ones.

The interest in such a model is motivated by the fact that some important industrial inputs are acquired not in a conventional market, but rather through special relations between suppliers and buyers that are often characterized by elements of bilateral monopoly. Bilateral monopoly may result, for example, from irreversible investments by both supplier and buyer: when the supplier's product is an intermediate good that is specially tailored to the needs of the buyer, there may be irreversible R and D expenditure; when the product is a final good and the buyer is a local distributor, the irreversible investment may take the form of marketing expenditures. Bilateral monopoly may also result from the limited size of the market, as where suppliers and buyers are paired at separate locations and the input is costly to transport. Perhaps the most familiar is the important example of a firm whose labor force is unionized. In this case, although both the firm and the labor union may have some substitution possibilities, considerations such as investments in specific human capital, hiring costs and sometimes legal barriers essentially lock them into bilateral monopoly relations. But whatever the source of the bilateral monopoly is, it seems fairly accurate to assume that the terms of the transactions conducted

through such relations are determined in bargaining rather than being set unilaterally by one of the parties.

The analysis is conducted in the context of a simple model that features two firms whose products are either substitutes or complements. Each firm uses a single input and the price that it pays for the input is determined in bargaining with its supplier. We consider two cases regarding the structure of the upstream industry. In one, the suppliers of the two firms are independent of one another, and in the other the upstream industry is monopolized. We similarly consider alternative structures of the downstream industry. The bargaining components of the model are posed as Nash's bargaining problems, but in interpreting the solution we shall sometimes appeal to the known relations between Nash's solution and non-cooperative dynamic bargaining models.

The main observations show that some of the predictions of our model are qualitatively different from the predictions of a corresponding model in which input prices are not determined in bargaining. For example, it is shown that the total profit of the upstream industry is not necessarily maximized when the industry is monopolized -- under certain, not unusual, conditions in the downstream industry, the upstream industry's profit is greater with two independent suppliers. This finding is, of course, in contrast to the prediction of a corresponding model in which the suppliers have the power to set prices, since in that case a monopoly supplier would earn more than independent suppliers under all circumstances. What differentiates the behavior of the monopoly supplier from that of an independent supplier is that the former internalizes the cross effect: it takes into account how the price of one firm's input would affect the downstream interaction and hence the other firm's input demand. Now, when the supplier has the power to set prices, it is precisely the internaliza-

tion of these cross effects which makes a monopolized upstream industry more profitable. However, when prices are determined in bargaining, the internalization of the cross effects also influences the bargaining strength of the supplier. The bargaining theory used here has the property that a party's bargaining power is strengthened if it can make a credible commitment that increases the cost of concessions. Therefore, when the nature of the downstream interaction is such that a reduced input price for firm i leads, at equilibrium, to a stronger input demand by firm j , then the bargaining position of a monopoly supplier vis-a-vis each firm is weaker than that of an independent supplier facing the same firm. This "bargaining effect" is in turn translated into prices and profits. In the linear case on which we focus in the formal analysis below, this "bargaining effect" is neatly characterized in terms of the demand relations between the downstream industry's products: the upstream monopoly's position is weaker and hence its profits are lower than those of independent suppliers combined when the downstream products are complements, and these relations are reversed when the products are substitutes. In general, however, this classification is not as sharp and these relations are also influenced by whether the products are "strategic substitutes" or "strategic complements" (in the sense defined by Bulow et. al. [1985]).

Similar observations are made regarding the relations between industry structure and profitability in the downstream industry: in the case considered here, when there is a single input supplier, the total profit of the downstream industry is smaller or greater under monopoly than it is under duopoly according to whether the final products are substitutes or complements. This observation too owes to the "bargaining effects" described above. It contrasts, of course,

with standard oligopoly models where monopolization of the industry is always profitable.

Finally, it is shown that the order in which the contracts are negotiated with the two firms has significant effect on the outcome. For the case in which a single supplier faces two firms who produce substitutes, we examine an asymmetric solution in which the supplier negotiates first with one firm and only then with the other. Under certain conditions, this asymmetric arrangement enables the supplier to negotiate higher prices and hence get higher profits than with the symmetric procedure of simultaneous negotiations. This is because the sequential order captures the idea that the targeting of one firm enables the supplier to convince it correctly that it intends to insist on price increases throughout the industry. This observation too is in contrast to the case of a price setting supplier for which it is obviously of no consequence whether or not input prices are set simultaneously.

The results reviewed above have some explanatory power for observed behavior in industries with bilateral monopoly elements. The first two have clear implications for the incentives for merger in both the upstream and the downstream industries, suggesting that these incentives are sometimes significantly different from what they would be in the absence of the bilateral monopoly relations in which input prices are determined in bargaining. For example, whether labor unions in oligopolistic industries are organized in firm-specific or industry-wide unions is predicted to depend on potentially observable characteristics of the downstream industry. The last result provides an explanation for observable bargaining tactics in such industries. The advantage that may be enjoyed by the supplier where he deals with the firms in sequence offers some explanation of the use by industry-wide labor unions of "whipsaw"

tactics in which they negotiate with firms in sequential order (see, Flanagan, Smith, Ehrenberg [1984]).

Despite the relevance of the subject of the present paper, there have been only a few attempts to consider related questions in the context of formal models. Davidson [1985] considers a duopoly whose member firms face either two independent labor unions or a single industry-wide labor union and in this sense our analysis closely resembles his. However, Davidson restricted his attention to the case of homogenous final products and assumed simultaneous bargaining. Consequently, he did not analyze the main issues on which we focus in the present paper. Horn and Wolinsky [1985], and Jun [1986] consider different patterns of unionization among the workers of a firm that employs different types of labor and determines its wages in bargaining. These studies are related to the present one in the idea of incorporating considerations of bargaining power into a bilateral monopoly situation involving the supply of inputs. The present paper differs from them, however, both in important features of the model (downstream duopoly vs. a single firm) and in the qualitative questions considered.

The plan of the paper is as follows. The next section presents the model. Sections 3-5 present and analyze alternative structures in both the upstream and the downstream industries. Section 6 analyzes a scenario in which a monopoly supplier bargains with buyers in a sequence rather than simultaneously. Some concluding remarks are made in section 7.

2. The Basic Model

The industry consists of two firms 1 and 2 that produce related products. Firm i uses a single input ℓ_i (the inputs ℓ_1 and ℓ_2 could be the same product but need not be so). The input is supplied to each firm by a single

supplier and the price is determined in bargaining between the firm and its supplier. There is no competition among suppliers.

The events in this industry are modelled as taking place in two stages. In the first stage, each firm bargains with its supplier over the price of the input. In the second stage, the input price agreements are known and the firms interact in the product market. In the course of the product market interaction, the firms decide on the quantities and hence on their input purchases. The two-stage structure makes the model an appropriate description of a situation in which the input prices are determined for a relatively long period while production decisions are made for a relatively shorter period.

The demand for product i is given by

$$(1) \quad p_i(x_i, x_j) = a - cx_j - x_i \quad i \neq j = 1, 2,$$

where c , $|c| \leq 1$, parameterizes the nature of the relation between the products. When $c > 0$ the products are substitutes; when $c < 0$ they are complements. The technology displays constant returns to scale: input quantity ℓ_i produces output $x_i = \ell_i$ of good i . Thus, if the input price for firm i is w_i , its cost of production is $w_i x_i$.

In their product market interaction, the firms are assumed to be quantity setters. The equilibrium concept for this part of the interaction is the Cournot-Nash equilibrium. Given the input prices w_1 and w_2 paid by the two firms respectively, and given the demand and cost functions assumed above, it is straightforward to calculate the equilibrium output

$$(2) \quad x_i(w_i, w_j) = \ell_i(w_i, w_j) = \frac{a(2-c) + cw_j - 2w_i}{4 - c^2}$$

and the equilibrium profit

$$(3) \quad \pi_i(w_i, w_j) = \left[\frac{a(2-c) + cw_j - 2w_i}{4 - c^2} \right]^2 .$$

Observe that (1) - (3) already incorporate symmetry assumptions on the technology and demand faced by the downstream firms. These assumptions are imposed to simplify later expressions.

The objective of supplier i is to maximize $w_i \ell_i$. In the case of a non-labor input $w_i \ell_i$ has the straightforward interpretation of profit to a supplier that produces ℓ_i at zero cost (an introduction of a constant per unit cost will not affect the qualitative results). In the case of labor input, supplier i is a labor union that organizes the workers of firm i and its objective is maximization of the wage bill of its membership. The bargaining between a firm and its supplier is only over a uniform input price. The quantity is not subject to bargaining, and is left at the discretion of the firm (this assumption will be discussed in Section 7 below). When they bargain, the parties understand how the equilibrium in the product market will be affected by their input price agreement. The relevant utility functions for the analysis of the bargaining over price are thus $\pi_i(w_i, w_j)$ for firm i and $w_i \ell_i(w_i, w_j)$ for the supplier of ℓ_i , where $\ell_i(w_i, w_j)$ and $\pi_i(w_i, w_j)$ are as given by (2) and (3) above.

The outcomes of the bargaining are modeled using the formula of Nash's bargaining solution. As we are dealing with a compound problem that encompasses two bargaining processes, the application of Nash's solution is not entirely straightforward since the model must account for the interdependencies between

the different bargaining problems. The details of the solutions will be explained as we present the different scenarios of the following sections. In interpreting the solution we shall utilize Binmore's [1982] observation that Nash's solution is essentially implemented by noncooperative bargaining games of the type presented by Rubinstein [1982]. Therefore, although this will not be part of the formal model, it will sometimes be useful to think of the static model outlined above as the reduced form of an appropriate dynamic bargaining model.

3. Independent Input Suppliers

In the case considered in this section each firm is in bilateral monopoly relations with an independent input supplier so that supplier i 's objective, $w_i \ell_i$, is affected by w_j only indirectly through its effect on ℓ_i . The suppliers do not have an enforceable commitment to coordinate their positions.

The solution is a pair of input prices w_1^I and w_2^I such that w_i^I is Nash's solution to the bargaining problem between firm i and its supplier, given that both expect the price w_j^I to be agreed upon between firm j and its supplier. That is, given w_j^I , the bargaining problem between firm i and its supplier is described by the payoff pairs $B_i^I = \{[\pi_i(w_i, w_j^I), w_i \ell_i(w_i, w_j^I)] \mid w_i \geq 0\}$ and the disagreement point $(0,0)$. It can be verified that B_i^I is the boundary of a convex set. Thus, the solution is given by

$$(4) \quad w_i^I = \arg \max_{w_i} \pi_i(w_i, w_j^I) w_i \ell_i(w_i, w_j^I).$$

The first order conditions for (4) are

$$(5) \quad \left[\ell_i + w_i \frac{\partial \ell_i}{\partial w_i} \right] \pi_i + w_i \ell_i \frac{\partial \pi_i}{\partial w_i} = 0 \quad i = 1, 2.$$

Substituting (2) and (3) into (5) and solving yields

$$(6) \quad w_1^I = w_2^I = w^I = \frac{a(2-c)}{8-c}$$

$$(7) \quad \ell_i^I = \ell_i(w^I, w^I) = \frac{6a}{(2+c)(8-c)}.$$

Expressions (6) and (7) give the overall equilibrium when the suppliers are independent. This serves as a benchmark against which the outcomes obtained with a merged supplier are compared.

4. A Single Supplier: the symmetric solution

This section considers the case in which a single supplier supplies both firms. It shows how the incentives for merger in the upstream industry are different in the bilateral monopolies framework of the present paper from what they would be in an environment of price setting suppliers.

The supplier's objective is to maximize $w_1 \ell_1 + w_2 \ell_2$. There are two outcomes that can be thought of as equilibria for the compound bargaining problem between the supplier and the two firms. The symmetric outcome to be described in this section corresponds to a situation in which the supplier negotiates with the two firms symmetrically and simultaneously and all participants expect the

bargaining to be symmetric in this sense. This outcome is closely related to that analyzed by Davidson [1985] in his model of labor union bargaining in a homogenous product industry. This is in contrast to the asymmetric solution presented in section 6, which corresponds to a scenario where the supplier can negotiate first with one firm and then with the other.

The solution here is a pair of price agreements w_1^S and w_2^S such that w_i^S is Nash's solution to the bargaining problem between the supplier and firm i , given that both anticipate correctly that the other price will be w_j^S . That is, given w_j^S the bargaining problem between firm i and the supplier is described by the set of payoff pairs $B_i^S = \{[\pi_i(w_i, w_j^S), w_i \ell_i(w_i, w_j^S) + w_j^S \ell_j(w_j^S, w_i)] \mid w_i \geq 0\}$ together with a choice of the disagreement point. A proper specification of the latter point is not an obvious matter. If we adopt the viewpoint that the bargaining solution employed here should be interpreted by looking at an underlying dynamic game of the type proposed by Rubinstein [1982], then the disagreement point should correspond to the streams of income that accrue to the parties when they are in a state of disagreement (see Binmore, Rubinstein and Wolinsky [1986]). Here the disagreement point will be $(0, w_j^S \ell_j(w_j^S, w_i^S))$. If the bargaining were modeled as a dynamic process, this choice would correspond to a situation in which when firm i and the supplier cannot agree, the firm earns zero profit and the other firm, j , operates at the anticipated equilibrium level $\ell_j(w_j^S, w_i^S)$. However, it should be noted that there are other plausible specifications. For example, if as long as firm i does not reach agreement, firm j can take advantage of it and act as a monopoly, then the disagreement position of the supplier should be modified to $(a - w_j^S)w_j^S/2$. It turns out that these different specifications do not have qualitative effect on the points that

we make in this paper and the choice of $(0, w_j^S \ell_j(w_j^S, w_i^S))$ is preferred because it is computationally more convenient.

It can be verified that B_i^S is the boundary of a convex set. Hence, there is a unique level of w_i which maximizes Nash's product and the solution with respect to the chosen disagreement point is given by

$$(8) \quad w_i^S = \arg \max_{w_i} \pi_i(w_i, w_j^S) [w_i \ell_i(w_i, w_j^S) + w_j^S \ell_j(w_j^S, w_i) - w_j^S \ell_j(w_j^S, w_i^S)] \quad i = 1, 2$$

The first order conditions for (8) are:

$$(9) \quad \left[\ell_i + w_i \frac{\partial \ell_i}{\partial w_i} + w_j^S \frac{\partial \ell_j}{\partial w_i} \right] \pi_i + w_i \ell_i \frac{\partial \pi_i}{\partial w_i} = 0, \quad i = 1, 2.$$

Note that the difference between (8) and (4) is that in (8) the supplier's position depends not only on the effect of w_i on $w_i \ell_i$, but also on the effect of w_i on $w_j \ell_j$. Substituting (2) and (3) into (9) and solving yields:

$$(10) \quad w_1^S = w_2^S = w^S = \frac{a(2-c)}{8-2c}$$

$$(11) \quad \ell_i(w^S, w^S) = \frac{a(6-c)}{(2+c)(8-2c)} \quad i = 1, 2.$$

Let us now compare these equilibrium magnitudes to those of the previous section. From direct inspection of (6), (7), (10) and (11) we obtain:

Proposition 1:

If $c > 0$, then $w^S > w^I$ and $w^S \ell(w^S, w^S) > w^I \ell(w^I, w^I)$. If $c < 0$, these relations are reversed.

That is, a monopoly supplier in the upstream industry is more or less profitable than two independent suppliers according to whether the products are substitutes ($c > 0$) or complements ($c < 0$). For this result, the important difference between the merged supplier and an independent supplier is that the former internalizes the cross effect: it takes into account the effect of w_i not only on ℓ_i but also on ℓ_j . Of course, if the suppliers were free to set the prices, it is exactly the internalization of the cross effects which would make a merged supplier always more profitable than two noncooperating independent suppliers. However, when prices are determined in bargaining, the presence of these effects influences the bargaining strength of the merged supplier. The bargaining solution considered here has the property that a party becomes relatively stronger, if it can make a credible commitment that makes concessions more costly than otherwise. Therefore, when $\partial \ell_j / \partial w_i > 0$ the bargaining position of the merged supplier is tougher than the position of an independent supplier in the same situation, because a concession with respect to w_i decreases the former's profit at the rate of $\ell_i + w_i \partial \ell_i / \partial w_i + w_j \partial \ell_j / \partial w_i$ which is greater than the rate $\ell_i + w_i \partial \ell_i / \partial w_i$ at which it would decrease the profit of the latter. Thus, roughly speaking, the nature of the cross effect influences the strength of the bargaining position, which in turn is translated into prices and profits.

In the example analyzed here the sign of the cross effect $\partial \ell_j / \partial w_i$ is

completely determined by the sign of the parameter c , i.e., by whether the downstream products are substitutes or complements. However, this sharp relationship depends on the linearity of the example. In general, the sign of $\partial \ell_j / \partial w_i$ is influenced not only by the substitutability among products, but also by the "strategic substitutability" among the products (see Bulow et al [1985] for a discussion of this concept). Roughly speaking, the two products are strategic substitutes (complements) if the marginal profitability of firm 1 from acting more aggressively declines (increases) when firm 2 acts more aggressively. Let $\Pi_i(\cdot, \cdot)$ denote firm i 's profit as a function of the strategic variables. If quantities (resp. prices) are the strategic variables, acting aggressively means increasing quantity (resp. cutting price) and the products are strategic substitutes if $\partial^2 \Pi_i(x_i, x_j) / \partial x_i \partial x_j < 0$ (resp. $\partial^2 \Pi_i(p_i, p_j) / \partial p_i \partial p_j < 0$). Now, a decrease in w_i will normally induce firm i to act more aggressively. If the products are strategic substitutes, firm j will be induced to act less aggressively and ℓ_j will tend to fall, both when the strategic variables are the quantities and when they are the prices.

In the appendix we make the above argument more precise. We consider a duopoly model in which the cost and demand functions are not necessarily linear and allow for either quantities or prices to be the strategic variables. We show that, if certain regularity conditions hold, then: if the products are both conventional and strategic substitutes, $w^S > w^I$; if the products are both conventional and strategic complements, these relations are reversed.

The observations of this section have immediate implications for the merger incentives of the input suppliers. Under the assumptions of the example analyzed above, when the downstream products are substitutes, the total profit of the upstream industry is increased by monopolization and hence suppliers have an

incentive to merge. When the products are complements, a monopolized upstream industry is at disadvantage and there is disincentive to merge.

Thus, there are plausible circumstances under which the predictions of the present model differ quite sharply from the alternative model in which the suppliers unilaterally set the prices. For clearly when the suppliers can set prices, a merged upstream industry must always be more profitable than an industry consisting of independent suppliers, regardless of whether the products are substitutes or complements. Thus, the fact that industrial input prices are determined in bargaining is not a minor detail. It may have important effects not only on the distribution of gains between the upstream and downstream firms, but also on the industry structure.

Finally, observe from (8) that when $c > 0$, if the supplier could convince each firm that he intends to drive up the other's price, then both prices will be higher than w^S as given by (10) and the supplier's profits will be higher as well. The reason that the supplier cannot accomplish this in the symmetric scenario of this section can be explained by informally sketching a dynamic process that would implement this solution.

To this end let us think of the events in the model as taking place over time. Suppose that time is divided into discrete periods, that quantities and profits have the dimension of flows, that bargaining parties exchange offers over time and that impatience for the outcomes is captured by a common discount factor. Suppose, for example, that the supplier meets firm 1 in odd numbered periods and firm 2 in even numbered periods. In a meeting, one of the parties offers a price with the identity of the proposer being determined, say, by a random move which assigns probability $1/2$ to each of the possibilities. If the offer is rejected, the parties do not transact, and continue to negotiate (in

alternating periods). Once an offer is accepted, the buyer starts operating at the expected equilibrium level. Now, the solution captured by (10) and (11) corresponds to a subgame perfect equilibrium outcome of this game (when the pace of the bargaining is rapid). This equilibrium is symmetric in the sense that, in the event of disagreement, the supplier would keep negotiating alternately with the two firms making to them the same offers. Under the circumstances of this equilibrium, the supplier cannot "convince" a firm to agree to a higher price by promising to secure a higher price from the other firm as well, since the expectations of symmetric treatment would make it profitable for the firm to disagree and let the other settle first. This is in contrast to the asymmetric scenario considered in section 6, where the supplier can achieve an overall price increase by negotiating with one firm first.

5. Merger Incentive in the Downstream Industry

The analysis of section 4 suggests that the incentives for merger in the upstream industry do not always conform with the intuition developed in models involving price setting suppliers. The reason was that, with bilateral monopoly, changes in industry structure affect the bargaining positions of the parties. This section shows that similar observations can be made regarding the incentives for merger in the downstream industry.

First, observe that the profit maximizing outputs and maximized profit for a downstream monopoly who controls both firms and faces constant input prices w_1 and w_2 are

$$(12) \quad \hat{x}_i(w_i, w_j) = \hat{\ell}_i(w_i, w_j) = \frac{a(1-c) + cw_j - w_i}{2-2c^2}$$

$$(13) \quad \hat{\pi}(w_1, w_2) = \frac{1}{4(1+c)} [(a-w_1)^2 + (a-w_2)^2 + \frac{c(w_1 - w_2)^2}{1-c}]$$

where the functions, $\hat{x}$ and $\hat{\pi}$ differ from x and π of (2) and (3) in that the latter were derived for oligopolistic interaction. Obviously, for given input prices, a downstream monopoly is always more profitable than an oligopoly: $\hat{\pi}(w_1, w_2) > \pi_1(w_1, w_2) + \pi_2(w_2, w_1)$. However, the input prices are not given but rather depend on the bargaining positions of the downstream firm(s) vis-a-vis the supplier(s). These positions are, in turn, affected by the structure of the downstream industry and a profit comparison between a downstream monopoly and an oligopoly should account for these effects.

Consider the case of a single input supplier and suppose that the downstream industry is monopolized as well. The downstream monopoly bargains with the supplier over symmetric agreements $w_1 = w_2 = w$ (in the context of the present example, for any agreement (w_1, w_2) , there is a symmetric agreement $w = w_1 = w_2$ that is preferred by both the firm and the supplier). The bargaining problem is then given by the set of payoff pairs $B = \{(\hat{\pi}(w, w), 2w\hat{\ell}(w, w)) \mid w \geq 0\}$ and the disagreement point $(0, 0)$. The curve B is the boundary of a convex set. Hence, there is a unique w which maximizes Nash's product and the solution is given by

$$(14) \quad v^S = \arg \max_w \hat{\pi}(w, w) \hat{w}\hat{\ell}(w, w).$$

Deriving the first order condition from (14) and using (12) and (13), we get

$$(15) \quad v^S = \frac{a}{4}$$

Evaluating $\hat{\pi}(v^S, v^S)$ and comparing it to $\pi(w^S, w^S)$ from section 4, we have

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Proposition 2:

When $c > 0$, then $v^S > w^S$ and $\hat{\pi}(v^S, v^S) < 2\pi(w^S, w^S)$; when $c < 0$, these relations are reversed.

That is, when there is a single input supplier and the products are substitutes, the profit of a downstream monopoly is less than the total downstream industry's profit when it is an oligopoly. In other words the usual gains from monopolizing the downstream industry are more than offset by the losses due to a weakened bargaining position vis-a-vis the input supplier. The relatively weaker position of the downstream monopoly is explained by analogous reasons to those outlined in section 4. Each duopolist disregards in its considerations the cross effect $\partial\pi_j(w_j, w_i)/\partial w_i$. This effect is generally positive when the products are conventional substitutes and negative when they are complements (this classification is not special to the linear example and holds for the more general structure considered in the appendix). Thus, the internalization of this effect tends to weaken the bargaining position in the former case and strengthen it in the latter. Of course, the fact that this bargaining effect offsets the monopolization advantage precisely when the products are substitutes is rather special to the linearity and other special features of the present example. The qualitative conclusion is only that the bargaining effect pointed out here may have significant consequences for the incentives for downstream merger.

6. A Single Supplier: the asymmetric solution

In this section we return to the world of section 4 with a single supplier in the upstream industry and an oligopoly in the downstream industry. The focus of this section is on a solution in which the supplier does not bargain simultaneously with the two firms.

The solution is based on an asymmetric scenario in which the supplier singles out one firm to settle with first, and only then negotiates with the other firm. This asymmetric scenario is interesting for a number of reasons. First, it seems that the arrangement considered here is observed in practice, in particular in the important example in which the supplier is an industry-wide labor union. Second, as we pointed out, the only element that distinguished the results under independent suppliers from the results under a single supplier, who treats the two firms symmetrically, is the cross effect $\partial \ell_j / \partial w_i$. However, one expects that such cross effects are not the only distinguishing factor and that, in addition, an industry-wide supplier could be more effective in coordinating its price demands throughout the industry. As it will turn out, the asymmetric equilibrium discussed below captures such an element.

The interesting case for the purposes of this discussion is when the final products are substitutes ($c > 0$) and this will be assumed. Consider first the bargaining between firm 2 and the supplier over the price w_2 , given that firm 1 and the supplier have already agreed on some price w_1 and firm 1 is operating on the level $\tilde{\ell}_1$. The bargaining problem is described by the set of payoff pairs $B_2^A = \{[\pi_2(w_2, w_1), w_1 \ell_1(w_1, w_2) + w_2 \ell_2(w_2, w_1)] \mid w_2 \geq 0\}$ and the disagreement point $(0, w_1 \tilde{\ell}_1)$. B_2^A is the boundary of a convex set. Hence, there is a unique maximizer to Nash's product and the solution $w_2 = w_2(w_1, \tilde{\ell}_1)$ is given by

$$(16) \quad w_2(w_1, \tilde{\ell}_1) = \arg \max_{w_2} \pi_2(w_2, w_1) [w_1 \ell_1(w_1, w_2) + w_2 \ell_2(w_2, w_1) - w_1 \tilde{\ell}_1].$$

As in the previous cases we assume that, after reaching agreement, firm 1 starts operating at the expected equilibrium level of ℓ_1 , which means that $\tilde{\ell}_1 = \ell_1(w_1, w_2(w_1, \tilde{\ell}_1))$. Under this assumption, the first order condition for (16) is

$$(17) \quad \frac{\partial \pi_2}{\partial w_2} w_2 \ell_2(w_2, w_1) + [w_2 \frac{\partial \ell_2}{\partial w_2} + \ell_2 + w_1 \frac{\partial \ell_1}{\partial w_2}] \pi_2 = 0.$$

Using (2) and (3), equation (17) can be solved to yield the bargained price $w_2(w_1)$, as a function of the price w_1 paid by firm 1.

$$(18) \quad w_2(w_1) = \frac{a(2-c) + 2cw_1}{8}.$$

Next, consider the bargaining between the supplier and firm 1 over the price w_1 . The solution reflects the assumptions that, when the supplier negotiates with firm 1, all participants understand that the negotiations with firm 2 will be postponed until after an agreement is reached with firm 1, and that the eventual agreement with firm 2 will depend on w_1 as captured by $w_2(w_1)$. Thus, the bargaining between firm 1 and the supplier is described by the set of payoff pairs $B_1^A = \{[\pi_1(w_1, w_2(w_1)), w_1 \ell_1[w_1, w_2(w_1)] + w_2 \ell_2[w_2(w_1), w_1]] \mid w_1 \geq 0\}$ and by the disagreement point $(0, D)$. The supplier's disagreement utility, D , is exogenous to present model and we shall consider below the values that it is

likely to assume. It can be verified that B_1^A is the boundary of a convex set. The solution to this bargaining problem is then given by

$$(19) \quad w_1(D) = \arg \max_{w_1} \pi_1(w_1, w_2(w_1)) [w_1 \ell_1(w_1, w_2(w_1)) + w_2(w_1) \ell_2(w_2(w_1), w_1) - D].$$

The first order condition for (19) is

$$(20) \quad \left[\frac{\partial \pi_1}{\partial w_1} + \frac{\partial \pi_1}{\partial w_2} w_2'(w_1) \right] [w_1 \ell_1 + w_2(w_1) \ell_2 - D] + \pi_1 \frac{d}{dw_1} [w_1 \ell_1 + w_2(w_1) \ell_2] = 0$$

and using (2), (3) and (18), it may be solved for w_1 . Let the solution be denoted by (w_1^A, w_2^A) . Thus, $w_1^A = w_1(D)$ and $w_2^A = w_2(w_1^A)$, where the functions $w_1(\cdot)$ and $w_2(\cdot)$ are given by (18) and (19). Obviously, the solution depends on the level D , which is part of the description of the environment but is not determined in the model. Of course, if D is unreasonably high, the supplier would prefer not to reach agreement with firm 1 and the problem is uninteresting. Let us, therefore, restrict attention to reasonable levels of D extending from zero to some positive level at which the supplier still has an incentive to settle with firm 1, and the following statements will refer only to values in this range.

Proposition 3:

There exists some level $\bar{D}$, $0 < \bar{D} < w^S \ell(w^S, w^S)$, such that, if $D > \bar{D}$, then

$$(i) \quad w_1^A > w_2^A > w^S$$

$$(ii) \quad w_1^A \ell_1(w_1^A, w_2^A) + w_2^A \ell_2(w_2^A, w_1^A) > 2w^S \ell(w^S, w^S)$$

If $D < \bar{D}$, these inequalities are reversed.

Proof:

Observe that $w_1(D)$ is an increasing function of D (this can be established by verifying that the LHS of (20) is increasing in D and decreasing in w_1). Define $\bar{D}$ by $w_1(\bar{D}) = w^S$. Substitute $w_1 = w^S$ in the LHS of (20) and use (9), the fact that $w^S = w_2(w^S)$ and the monotonicity of $w_1(D)$ to verify that $0 < \bar{D} < w^S \ell(w^S, w^S)$. Now, (i) follows from the above and the fact that $w_2(w) > w$ ($< w$) when $w < w^S$ ($> w^S$). (ii) follows from the fact that in this range $w_1 \ell_1 + w_2 \ell_2$ is increasing in both w_1 and w_2 . Q.E.D.

To interpret the results, let us explain the role of D by referring to a dynamic bargaining process, although it is not part of the formal model. Recall that in section 4 the solution was related to a symmetric bargaining game in which the supplier exchanged offers with the two firms in a symmetric fashion. The asymmetric solution presented here corresponds to the equilibrium of an asymmetric bargaining game in which the supplier exchanges offers and responses with firm 1 first, and only after agreeing with 1 proceeds to negotiate with firm 2. With this interpretation the disagreement utility of the supplier for the bargaining with firm 1, D , should be identified with the flow of input purchases by firm 2 during the negotiations between the supplier and firm 1 (see Binmore, Rubinstein and Wolinsky [1986] for a detailed discussion of this point). Thus, if the modelled situation is such that firm 2 does not purchase the input before it negotiates the price with the supplier, then the appropriate choice is $D = 0$. If, however, the modelled situation is such that, as long as the negotiations with firm 1 go on, there is some temporary arrangement whereby firm

2 keeps operating and purchasing its input, then the appropriate level of D is positive. The latter situation can arise if the starting point of the present model is the time of renewal of contracts between the supplier and the two firms and if the arrangement is that firm 2 keeps operating under the terms of the expired contract until the supplier turns to negotiate with it.

What the proposition tells us is that if the "starting point" of the model is at the symmetric equilibrium of section 4, $w_1 = w_2 = w^S$, then the supplier can drive up both prices and its profit by negotiating with the firms in sequence. Intuitively, this arrangement weakens the bargaining position of firm 1, since it knows that the adverse effect on profit of any price concession that it makes will be partly offset by inducing firm 2 to settle for a higher price $w_2 = w_2(w_1)$. This also explains the asymmetry in prices $w_2^A > w_1^A$. The bargaining position of firm 2 is tougher since, when it negotiates, w_1 is already fixed and the firm cannot expect that price concessions will be accommodated by increases in w_1 .

However, when D is low the supplier is impatient to settle with firm 1, since delays of its agreement with 1 also delay its agreement with firm 2 and the resulting profit. This consideration weakens the bargaining position of the supplier vis-a-vis firm 1 and, when D is sufficiently low, it can be strong enough to more than offset the above described advantage that the supplier has in asymmetric bargaining.

7. Concluding Discussion

In the above we have considered a duopolistic industry which deals with its input suppliers under conditions of bilateral monopoly. An important feature of the model is that prices are determined in bargaining. With this feature, the

predictions of the model regarding incentives for merger in both the upstream and the downstream industries are significantly different from what they would be in an environment with price setting suppliers. We have also demonstrated that the order in which input prices for the downstream firms are determined may have important effects on the outcome.

The model embodies two important assumptions. First, a firm and its input supplier are already locked into bilateral monopoly relations when they bargain over the input price. Second, the object of the bargaining is a uniform input price rather than some non-linear price schedule. The problem with the first assumption stems from the fact that the bilateral monopoly relations are presumably explained by investments in specialized assets made by both parties.

But the possibility of ex-post expropriation of such investments in the bargaining process ought to induce the parties to reach price agreements before they are locked into the relationship, or to integrate vertically. The problem with the second assumption is that the uniform price contracts are generally inefficient -- it possible to have non-linear price contracts which are better for both parties. That is, both assumptions can be questioned on the grounds that in some sense they reflect imperfections in the environment that perhaps ought to be explained rather than assumed. But while this criticism is legitimate, we do not think that it invalidates the approach adopted here. We hold the view that one can fruitfully incorporate into a formal model assumptions that seem to accord well with observed practices, even if they represent imperfections in the environment and there is no available explanation for why these imperfections arise.

One important example which seems to accord well with our model is the case of unionized oligopolistic industries. Firstly, it is often justified to view

the union and the firm as being essentially locked into bilateral monopoly relations. Secondly, the conflict of interest is usually not resolved through vertical integration: the firm cannot own the union and the labor union does not normally own the firm. Thirdly, labor contracts very seldom condition wages on the level of employment (see, e.g., Oswald [1986]), so that our assumption that the bargaining is over a uniform price seems suitable. For the unionized labor case the above analysis provides possible explanations both for differences in patterns of unionization across industries and for certain practices of negotiation. Proposition 1 and the discussion that follows it relate the incentives of unions to organize across firms to the nature of the strategic substitutability among the downstream products. Proposition 3 provides some explanation of the use by multi-firm unions (such as those in the auto or the airline industry) of "whipsaw" tactics in which they target one firm with which the new contract is negotiated first, and only then negotiate with the other firms (see, e.g., Flanagan, Smith and Ehrenberg [1984]).

Appendix

Extension of Proposition 1

Let $L_i(x_i)$ be the amount of input required by firm i to produce x_i , so that firm i 's cost function is $w_i L_i(x_i)$. Let $D_i(p_i, p_j)$ and $P_i(x_i, x_j)$ be the direct and inverse demand functions for firm i 's product, $i \neq j = 1, 2$. Consider two alternative duopoly models. In the Cournot model the quantities x_1 and x_2 are the strategic variables and the payoff function is

$$(A.1) \quad \Pi_i(x_i, x_j) = x_i P_i(x_i, x_j) - w_i L_i(x_i)$$

In the Bertrand model the prices p_1 and p_2 are the strategic variables and the payoff function is

$$(A.2) \quad \Pi_i(p_i, p_j) = p_i D_i(p_i, p_j) - w_i L_i(D_i(p_i, p_j))$$

The following assumptions are made for both models: (i) The functions L_i, P_i and D_i are twice continuously differentiable; $L_i(0) = 0$ and L_i is strictly increasing, P_i and D_i are bounded and strictly decreasing in x_i and p_i respectively; there exist $\bar{x}_i$ and $\bar{p}_i$ such that $P_i(\bar{x}_i, x_j) = 0$ for any x_j and $D_i(\bar{p}_i, p_j) = 0$ for any p_j ; (ii) Π_i is concave in i 's own strategic variable (x_i or p_i in the Cournot or Bertrand setting respectively); (iii) For any w_1, w_2 there exists a unique Nash equilibrium. (iv) An interior equilibrium is locally strictly stable, i.e., $|\Pi| = \Pi_i^{ii} \Pi_j^{jj} - \Pi_i^{ij} \Pi_j^{ji} > 0$, where superscripts denote partial derivatives.

In the Cournot game we shall refer to the products as conventional substitutes (complements) if $\partial P_i(x_i, x_j)/\partial x_j < 0$ (>0) and as strategic substitutes (complements) when $\Pi_i^{ij}(x_i, x_j) < 0$ (>0). The corresponding definitions for the Bertrand game are when $\partial D_i(p_i, p_j)/\partial p_j < 0$ (>0) and when $\Pi_i^{ij}(p_i, p_j) < 0$ (>0).

Let $\pi_i(w_i, w_j)$ and $\ell_i(w_i, w_j)$ denote the equilibrium profit and quantity of input, given w_i and w_j . The following lemma refers to both scenarios. It follows from standard total differentiation of the appropriate first order conditions.

Lemma:

If $\ell_1 > 0$ and $\ell_2 > 0$, then when the products are both conventional and strategic substitutes (complements) $\partial \ell_i / \partial w_j > 0$ (<0).

Consider a symmetric duopoly in the sense that Π_1 and Π_2 are the same function and recall the cases discussed in sections 3 and 4. Assume that the sets B^I and B^S are boundaries of convex sets. A solution to the independent suppliers case is a pair (w_1^I, w_2^I) that solves equations (5)

$$(5) \quad [\ell_i + w_i \frac{\partial \ell_i}{\partial w_i}] \pi_i + w_i \ell_i \frac{\partial \pi_i}{\partial w_i} = 0 \quad i = 1, 2.$$

Let $\bar{w}(w_j)$ denote the w_i that solves (5), as a function of w_j . Similarly, recall that a solution to the merged supplier case is a pair (w_1^S, w_2^S) that solves equation (9),

$$(9) \quad [\ell_i + w_i \frac{\partial \ell_i}{\partial w_i} + w_j \frac{\partial \ell_i}{\partial w_j}] \pi_i + w_i \ell_i \frac{\partial \pi_i}{\partial w_i} = 0 \quad i = 1, 2.$$

Let $\tilde{w}(w_j)$ denote the w_i solution for (9), as a function of w_j .

Assume the following regularity conditions: if w satisfies $w = \bar{w}(w)$ (resp. $w = \tilde{w}(w)$), then the slope of $\bar{w}(\cdot)$ (resp. $\tilde{w}(\cdot)$) at w is smaller than 1.

Proposition 1*:

If the products are both conventional and strategic substitutes, then $w^S > w^I$; if they are both conventional and strategic complements, the inequality is reversed.

Proof:

The convexity of B^I and B^S implies that $\bar{w}(\cdot)$ and $\tilde{w}(\cdot)$ are well defined and continuous. Assumptions (i)-(iv) imply that $\bar{w}(0) > 0$, $\tilde{w}(0) > 0$

and that $\bar{w}$ and $\tilde{w}$ are bounded. These observations imply that there exist solutions $w^I = \bar{w}(w^I)$ and $w^S = \tilde{w}(w^S)$. The regularity condition assures uniqueness of w^I and w^S .

It follows from the definition of $\bar{w}(\cdot)$ that the LHS of (9), evaluated at any point (w_i, w_j) such that $w_i = \bar{w}(w_j)$, is equal to $w_j \pi_i \partial \ell_j / \partial w_i$. By the lemma this expression is positive (negative) if the products are conventional and strategic substitutes (complements). This and the convexity of the set bounded by B^S imply the statement of the proposition. Q.E.D.

Finally, it can be verified that the condition that the products are both conventional and strategic substitutes or complements is actually stronger than what we need. In the quantity setting version it is sufficient that the products are just strategic substitutes or complements.

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