COMMON SUPPLY, COLLUSION AND ENTRY DETERRENCE

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Abstract

The paper analyzes a model in which two upstream firms compete to offer price contracts to two downstream firms. If one upstream firm has a first-mover advantage there is a unique equilibrium outcome: that firm excludes the other and earns the monopoly profit. This is achieved by negotiating exclusive-dealing two-part tariff contracts with price ceilings. If there is no first-mover advantage there are also equilibria in which the downstream firms collude by coordinating on a common supplier. The latter are the only stationary equilibria involving two-part tariffs with price no lower than marginal cost. Despite the possibility of private renegotiation, apparently innocuous contracts can, through their commitment value, have anti-competitive effects.

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1. Introduction

It is often the case that firms share a common supplier. For example, automobile firms who are in competition with each other in the downstream market frequently buy their supplies of wheels or brake systems from the same firm. One obvious reason why this should be so is that they want to take advantage of economies of scale. In this paper I examine another possibility which might in some circumstances also form part of the story: that the downstream firms coordinate on a common supplier in order to facilitate price collusion between them in the downstream market. I study a model of two upstream manufacturers supplying to two downstream firms who might be manufacturers or retailers. The upstream firms compete by offering price contracts to the downstream firms; the downstream firms accept the contracts that they prefer and then supply the downstream market using inputs supplied under the agreed contracts. I analyze two cases: one in which the upstream firms' offers are sequential (so that one firm has a first-mover advantage, perhaps because it is an incumbent in the upstream market) and one in which they are simultaneous. In the first case there is a unique equilibrium outcome. Both downstream firms sell at the monopoly price and the incumbent upstream firm gets all the surplus. Once the incumbent's equilibrium offers have been made the other upstream firm cannot make any counter-offers which will enable it to break into the market. The price contracts offered have four significant characteristics: (i) they are exclusive dealing contracts, i.e. they forbid the downstream firm to buy from the other upstream firm; (ii) the price schedule is a two-part tariff; (iii) the franchise fee is negative and (iv) they impose a price ceiling in the downstream market. In essence, the argument is the following. The downstream firms are charged a high price for the inputs and make an operating loss because the price ceiling prevents them from covering the cost. This loss is recouped via the negative franchise fee. If the potential entrant were to offer better contracts to the downstream firms and one of them were to accept, then the other one has a stronger incentive to accept the original contract, offered by the incumbent upstream firm. This is because price competition in the downstream market, possibly after the contracts have been renegotiated, will mean

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that the price ceiling will now no longer be a binding constraint causing the firm to make an operating loss. This in turn means that the entrant, to attract both firms, has to offer too much surplus and therefore cannot enter. In general one would expect publicly agreed (or offered) contracts not to have any commitment value because of the possibility of renegotiation. In this case the argument works precisely because renegotiation is possible. In a variant of this game vertical integration is allowed (with both downstream firms). In that case the equilibrium payoffs are of course the same but vertical integration does not take place with both downstream firms: instead the incumbent writes a contract of the type described above with at least one of the downstream firms. This shows that vertical separation has strategic value, despite the possibility of renegotiation.

In the simultaneous-offers case there exist, in addition to the entry-deterring equilibrium, downstream cartel equilibria. Both downstream firms charge the monopoly price but in this case they share all the surplus. They have a common supplier who charges them a high price (thus supporting the high downstream price) and the profit is transferred downstream through the franchise fee. Coordinating on a common supplier therefore acts as a collusive device. As before, the contracts employed are exclusive-dealing, two-part tariff contracts with negative franchise fees and price ceilings. While the entry-deterring equilibrium involves a contract which forces one of the parties to charge less than its marginal cost (which I refer to as *dumping*), the downstream cartel equilibria do not. Subject to a stationarity refinement, any equilibrium which involves exclusive-dealing two-part tariff contracts which do not give rise to dumping is a downstream cartel equilibrium (Proposition 4).

Taken together, these results suggest that if exclusive dealing is allowed then simple and apparently innocuous contracts can have strong anti-competitive and foreclosure effects, and, moreover, that one may expect such contracts to arise even if upstream firms are able to compete ex ante on an equal basis. This is contrary to the Chicago view (as argued, for example, by Bork, 1978) that exclusive dealing contracts only arise for efficiency reasons such as service externalities or economies of scale in distribution. Bork's argument is that a downstream

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firm will only accept an exclusive dealing arrangement if there is some efficiency gain from doing so. Otherwise the manufacturer will be obliged to pay the retailer for the exclusion an amount at least equal to what his rivals will be willing to pay to stop him, and therefore the arrangement cannot be profitable. The model of this paper suggests that this argument may not be correct, for different reasons to those given by recent theoretical treatments of the question, such as Bernheim and Whinston (1992) and Aghion and Bolton (1987).

The equilibria described rely on the negative franchise fee element in the contracts. It may be argued that such contracts are not observed in practice. On the other hand, wherever an arrangement involves a lump-sum transfer downstream (possibly disguised in some way) together with a linear price the contract implicitly takes the form described here. There are various ways in which this might happen. For example, exclusive dealing antitrust cases often concern firms which lease equipment associated with their product. One such case was International Salt Company v. United States (1947). The company leased machines that injected salt tablets into canned products on condition that the lessee used only International's salt tablets in the machines. If it is the case that such a lease is granted on favourable terms then the subsidy is equivalent to a negative franchise fee. Another example, more appropriate to the downstream cartel equilibria outlined above, might be the practice large firms have of delaying payment to small suppliers. The free credit amounts to a subsidy paid by the suppliers which might play the role of a negative franchise fee, at least if the size of the debt is not very sensitive to current purchases.

In the next section I describe the model and the game which the firms play. Section 3 contains results and Section 4 contains some concluding comments.

2. The Contract Game

There are two upstream firms (U_1 and U_2) and two downstream firms (D_1 and D_2). U_1 and U_2 produce a homogeneous good at zero fixed cost and at the same constant marginal cost θ. This good is used as the sole input into production by D_1 and D_2 who produce a homogeneous final good

using a common constant-returns-to-scale production technology. The amount of U_1's (resp. U_2's) output bought by D_i is x_{1i} (resp. x_{2i}). The downstream production coefficient is normalized to be equal to one, so that D_i's output is $y_i \equiv x_{1i} + x_{2i}$. U_j's total output is $x_j \equiv x_{j1} + x_{j2}$. The interaction between these four firms is modelled as an extensive-form game of imperfect information consisting of six stages. The first four stages involve negotiation and possibly renegotiation of legally binding contracts governing supply of the inputs and the final two stages involve production and competition in the final product market.

I assume that a contract between U_j and D_i specifies three things: (i) whether or not D_i is allowed to buy inputs from the other upstream firm (i.e. whether or not the contract is an exclusive dealing contract); (ii) whether or not D_i is subject to a price ceiling in the downstream market and, if so, what that price ceiling is; and (iii) a payment schedule specifying how much D_i is to pay to U_j as a function of x_{ji}. The payment schedule is unrestricted: simple linear contracts, two-part tariffs and non-linear price schedules are all allowed (in one variant, vertical integration is also permitted). On the other hand, this formulation rules out a large number of possible contracts. For example, U_1 and D_1 are not allowed to write a contract whereby D_1's payment to U_1 is conditional on the amount of input which D_1 buys from U_2 or on the quantity of D_1's final sales or profits. There are various reasons for excluding such contracts. One is that they may be relatively difficult to enforce. For example, although it may be possible for U_1 to establish that D_1 has bought some non-zero amount from U_2, it may not be able to tell precisely how much. Downstream sales and profits, likewise, may not be observable to the upstream firms. Secondly, the courts may not be willing to enforce certain contracts: for example, suppose that U_1 signs contracts with both downstream firms whereby, in return for lump-sum payments, U_1 is entitled to all the downstream revenues. The competition authorities would presumably regard that as equivalent to monopolization of the downstream market. The chief reason, however, is that I am mainly concerned in this paper to show that exclusive dealing contracts can have collusive and entry-deterring effects even when they take a simple and apparently innocuous form.

The rules of the basic vertical contract game G are as follows.

Stage 1 (public contract offers): U_1 offers contracts τ_{11} to D_1 and τ_{12} to D_2. U_2 observes this pair of offers and offers contracts τ_{21} to D_1 and τ_{22} to D_2. The vector of four contract offers is observable by all players.

Stage 2 (public contract acceptances): D_1 and D_2 sequentially accept or reject the contracts offered at stage 1. D_1 moves first and chooses one, both or neither of the offered contracts. D_2, after observing D_1's choices, chooses one, both or neither of the two contracts offered to him. If a downstream firm chooses an exclusive dealing contract from one upstream firm, it cannot also choose another contract. At the end of this stage all players know which contracts are in force.

Stage 3 (private renegotiation offers): U_1 and U_2 privately offer to renegotiate their existing contracts, if they wish. If U_j has agreed a contract with D_i at stage 2 then U_j offers a new contract to D_i. The new offered contract can be the same as the existing one, so that renegotiation is voluntary. Only U_j and D_i observe an offer made by the former to the latter at this stage.

Stage 4 (renegotiation acceptances): D_1 and D_2 privately accept or reject each renegotiation offer, if any, made at stage 3. Any contract accepted supersedes any contract agreed between the same parties at stage 2. The same restriction applies as in stage 2: i.e., a downstream firm cannot be a party to two contracts including at least one exclusive dealing contract.

Stage 5 (Bertrand competition): D_1 and D_2, if they have agreed contracts, simultaneously and publicly announce final good prices p_1 and p_2 respectively. If a downstream firm is without a contract, then it does not set a price (or, rather, sets an infinite price, since this makes later definitions simpler). If it has a contract with a price ceiling, its price must not exceed the ceiling.

Stage 6: If D_i has a contract with U_j $(i, j = 1, 2)$, D_i orders from U_j an input quantity x_{ji}; U_j supplies this quantity; D_i produces an output $y_i = x_{1i} + x_{2i}$. This production must be at least equal to D_i's demand, defined

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below. If D_i has no contract with either upstream firm then D_i orders nothing and produces nothing.

This completes the description of the order of moves. It is worth commenting on the renegotiation aspect of the model. Several authors (for example, Fershtman and Judd (1987), Rey and Stiglitz (1988), Bonanno and Vickers (1988)) have noted that contracts, if observable to non-signatories, can in some circumstances be used to establish a commitment and thereby benefit the parties to the contract. Bonanno and Vickers, for example, study a model of two vertical structures, each consisting of one upstream and one downstream firm, competing against each other. First each structure agrees a price contract for supply by the upstream firm (possibly a two-part tariff) which is observable to the other structure; at the second stage the two downstream firms compete. Bonanno and Vickers show that in equilibrium the upstream firms set two-part tariffs with high marginal prices in order to soften competition in the downstream market and then transfer the profit back through the franchise fee. Vertical separation is therefore a strategic choice which causes the market to be more collusive than it would be if the firms were vertically integrated. The objection to this theory (see, e.g., Tirole (1988)) is that if renegotiation were possible then this phenomenon would not arise: given the high price charged by, say, D_2, U_1 and D_1 could both increase their profit by negotiating a new contract with a lower price and a higher franchise fee. Therefore the equilibrium must be regarded as suspect. It is for this reason that I include the renegotiation stage in G. The formulation therefore allows for the possibility of commitment through public contracts but only if the contracts are immune to private renegotiation.

Payoffs

The payoffs are determined by Bertrand competition together with the contracts $(\hat{\tau}_{11}, \hat{\tau}_{12}, \hat{\tau}_{21}, \hat{\tau}_{22})$ in force at the end of stage four (if D_i and U_j have no contract then $\hat{\tau}_{ij} := \emptyset$). There is a market demand function $D(p)$ in the final good market which is strictly positive and strictly decreasing over some range $[0, \bar{p})$, where $D(\bar{p}) = 0$. Given the prices (p_1, p_2), the market demand for D_i's final good, $s_i(p_1, p_2)$, is given by

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$$s_i(p_1, p_2) := \begin{cases} D(p_i) & \text{if } p_i < p_j \\ D(p_i)/2 & \text{if } p_i = p_j \\ 0 & \text{if } p_i > p_j \end{cases}$$

Given $s_i(p_1, p_2)$, D_i chooses x_{1i} and x_{2i} (which have to be legal under $\hat{\tau}_{1i}$ and $\hat{\tau}_{2i}$) such that $x_{1i} + x_{2i} \geq s_i(p_1, p_2)$. D_i's payoff is then given by

$$\Pi_i^D(\hat{\tau}_{1i}, \hat{\tau}_{2i}, p_1, p_2, x_{1i}, x_{2i}) := p_i \, s_i \, (p_1, p_2) \, \hat{\phi}_{1i} \, (x_{1i}) - \hat{\phi}_{2i} \, (x_{2i})$$ where $\hat{\phi}_{ji}$ is the payment schedule specified by $\hat{\tau}_{ji}$ ($\hat{\phi}_{ji} \equiv 0$ if $\hat{\tau}_{ji} = \emptyset$). U_j's payoff is

$$\Pi_j^U \, (x_{j1}, x_{j2}, \hat{\tau}_{j1}, \hat{\tau}_{j2}) := \hat{\phi}_{j1} \, (x_{j1}) + \hat{\phi}_{j2} \, (x_{j2}) - \theta(x_{j1} + x_{j2}).$$

Variations on the Basic Game

In addition to G I analyze a number of related games. First, it is of some interest to examine the phenomenon of strategic separation in the context of this model. Therefore I consider a game which is the same as G except that the upstream firms are allowed to choose their offers from a wider class of contracts, both at stage 1 and at the renegotiation stage, stage 3. In this game they are allowed to integrate vertically with the downstream firms. Therefore to each downstream firm they either offer an arm's length contract as described above or they make an offer to buy the firm for some amount of money. If the downstream firm accepts an integration offer it leaves the game with payoff equal to the agreed bid and the upstream firm can then sell directly in the downstream market. An upstream firm can integrate with one downstream firm and have a supply contract with the other. I assume that it can also, if it wishes, integrate with both downstream firms. A downstream firm cannot both agree a supply contract with one upstream firm and sell out to the other (nor, obviously, can it sell out to both). Given that I assume that monopolization is legal in this game it would be surprising if the outcome were not collusive. The question is whether or not vertical integration takes place in equilibrium. I refer to this game as the *Vertical Integration Game.*

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Secondly, I consider a game, referred to as G_1, which is the same as G except that the two upstream firms move simultaneously at stage 1 rather than sequentially. This turns out to make a difference. G therefore models a situation in which one upstream firm has a first-mover advantage, perhaps because it is an incumbent in the market facing a potential entrant. In G_1, on the other hand, the upstream firms are in symmetrical situations.

Thirdly it is convenient to consider two games which are equivalent to certain subgames of G and G_1. The *Separate Supplier Game with Contracts* (τ_1, τ_2) is a game in which at the outset D_1 has agreed the contract τ_1 with U_1, D_2 has agreed the contract τ_2 with U_2 and no other contracts have been agreed (the above is public knowledge). The game then proceeds according to the rules of G, starting with stage 3. The *Common Supplier Game with Contracts* (τ_1, τ_2) is a game in which there is a single upstream firm U which has publicly agreed contracts τ_1 and τ_2 respectively with D_1 and D_2 and which then proceeds according to the rules of G, starting with stage 3.

Equilibrium Concept and Further Notation

G is a game of imperfect information and the description above implies an information partition of partial histories for each player at each stage. For example, after stage 3 firm U_1 cannot distinguish between histories which are identical in stages 1 and 2 but differ in renegotiation proposals made by U_2 at stage 3. U_1's beliefs at this stage of the game will be characterized by a probability distribution over such partial histories, i.e. over its information set. I use the natural solution concept for such a game, namely *Perfect Bayesian Equilibrium* (PBE), which implies, as usual, that each player's strategy maximizes its conditional expected payoff after each partial history, given its beliefs and the other firms' strategies and that the beliefs are consistent with the strategies and with Bayes' rule, where applicable. The term *equilibrium* henceforth refers to this concept. Establishing the existence of equilibria in G is far from straightforward, partly because of the rather wide class of contracts which the firms are allowed to propose, and I do not attempt it. On the other hand, Kreps and Wilson (1982) show that a sequential equilibrium

(and hence a PBE) exists in any finite extensive-form game of perfect recall. G is an extensive-form game of perfect recall and therefore an equilibrium will exist in any game which is a finite approximation to a subgame of G (that is, one in which the players have to select from a finite subset of the contracts and prices available in G which has the property that any price or payment schedule in G is close, in an appropriate metric, to an element of this finite subset). I will construct "equilibria" of G by specifying particular strategies for some histories and ascribing arbitrary equilibrium strategies to all subgames other than those explicitly discussed, which leaves open the question of whether such subgames actually have equilibrium strategies. It should be clear though that the strategies described will in fact form equilibria in any finite approximation to G in which they are legal, if not in G itself. Furthermore, all the propositions are valid for any such finite approximation. The justification for this procedure is that it is notationally cumbersome to analyze explicitly such a finite approximation.

Let $\Pi^m := \max_p (p - \theta) D(p)$ and let $p_m := \arg \max_p (p - \theta) D(p)$ be, respectively, monopoly profit and monopoly price for a vertically integrated firm. $\Pi_1^D (\hat{\tau}, p_1, p_2)$ is defined to be D_1's maximum payoff if D_1 has the contract $\hat{\tau}$ (and no other contract; it will be clear from the context who the other party to the contract is) and D_1 and D_2 charge prices p_1 and p_2 respectively. The maximum profit which D_1 can earn in this circumstance is $\Pi_1^D(\hat{\tau}, p_2) := \max_{p_1} \Pi_1^D (\hat{\tau}, p_1, \hat{\tau}, p_2)$. This maximum will exist in any finite approximation as described in the previous paragraph. Equivalent notation applies to the other firms.

I am interested in outcomes in which one or more firms effectively monopolize the market. An equilibrium or outcome of G is described as *collusive* if the only price charged in the downstream market is p^m, so that the sum of the payoffs is equal to the monopoly profit Π^m. An outcome is described as a *downstream cartel* if it is collusive and the upstream firms both make zero profit.

A two-part tariff payment schedule with per-unit cost c and franchise fee F is referred to as (c, F). In other words the payment schedule for the

contract (c,F) is $F+cx$ where x is the quantity supplied by the upstream firm. The same contract with a price ceiling of p is referred to as $(c,F;p)$.

3. Results

. I begin with some simple but useful Lemmas. The first concerns the Separate Supplier games. Suppose that after the contract proposal and acceptance stages each upstream firm has a contract with a different downstream firm (and only one contract). Then the possibility of renegotiation will ensure that each vertical structure will act as if it were a single firm: i.e., it will charge marginal cost in the downstream market and make zero profits. This is stated formally and proved in Lemma 1. Of course it is possible in principle, if not in an equilibrium of the whole game, that one half of a vertical structure makes negative profit and the other makes positive profit: the distribution of profit between the two firms depends on the contract agreed at stage 2, since this sets the reservation payoffs for the renegotiation stage.

Lemma 1. *In any equilibrium of the Separate Supplier game, with any contracts (τ_1,τ_2) D_1 and D_2 both charge θ and the equilibrium payoffs $\hat{\Pi}_1^D$, $\hat{\Pi}_2^D$, $\hat{\Pi}_1^U$ and $\hat{\Pi}_2^U$ satisfy $\hat{\Pi}_1^D = \hat{\Pi}_1^D(\tau_1,\theta) = -\hat{\Pi}_1^U$ and $\hat{\Pi}_2^D = \hat{\Pi}_2^D(\tau_2,\theta) = -\hat{\Pi}_2^U$*

Proof. The equilibrium strategies of U_2 and U_2 determine a probability distribution over p_2. Let $\tilde{\Pi} := \max_{p_1} E(p_1-\theta)$ $s_1(p_1, p_2)$ where the expectation is taken with respect to this probability distribution. This is the maximum possible expected joint profit of D_1 and U_1. Suppose that the equilibrium strategies of D_1 and U_1 do not maximize their joint profit, given the equilibrium strategies of D_2 and U_2. Let $\tilde{\Pi} - \hat{\Pi}_1^D - \hat{\Pi}_1^U = \varepsilon$. Then $\varepsilon > 0$. Suppose now that U_1 offers the exclusive two-part tariff contract $(\theta, \tilde{\Pi} - \hat{\Pi}_1^D - \varepsilon/2)$. If D_1 accepts, it will then choose its price so as to maximize the expected profit of the vertical structure (because its marginal cost is then θ) and its expected profit will therefore be $\tilde{\Pi} - (\tilde{\Pi} - \hat{\Pi}_1^D - \varepsilon/2) = \hat{\Pi}_1^D + \varepsilon/2$. U_1's expected profit will be equal to the franchise fee, i.e., $\tilde{\Pi} - \hat{\Pi}_1^D - \varepsilon/2) = \hat{\Pi}_1^U + \varepsilon/2$. If D_1 rejects the renegotiation offer, its continuation expected payoff will be $\max_{p_1} E\Pi_1^D(\tau_1,p_1,p_2)$ where the expectation is taken with respect to the same distribution as before because the actions of D_2 and U_2 will be unaffected by U_1's renegotiation

offer. But $\hat{\Pi}_1^D \geq \max_{p_1} E\Pi_1^D (\tau_1, p_1, p_2)$ because D_1 could, after an equilibrium renegotiation offer by U_1, obtain the latter payoff by rejecting the offer. Therefore D_1 will accept the deviant offer. This in turn implies that the deviation is profitable for U_1. This shows that in equilibrium U_1 and D_1 will maximize their joint profit. The same argument applies to U_2 and D_2. Therefore the game reduces to a Bertrand game between two firms and that game has a unique equilibrium in which both charge marginal cost and make zero profit. This shows that $\hat{\Pi}_1^D + \hat{\Pi}_1^U = \hat{\Pi}_2^D + \hat{\Pi}_2^U = 0$. $\hat{\Pi}_1^D \geq \Pi_1^D(\tau_1, \theta)$ because D_1 can obtain the latter payoff by rejecting any renegotiation offer by U_1. Moreover, if U_1 offers $(\theta, -z)$ where z is slightly more than $\Pi_1^D(\tau_1, \theta)$ D_1 will accept and U_1's payoff will be z; this shows that $\hat{\Pi}_1^U \geq -\Pi_1^D(\tau_1, \theta)$. Since $\hat{\Pi}_1^D + \hat{\Pi}_1^U = 0$, we conclude that $\hat{\Pi}_1^D = \Pi_1^D(\tau_1, \theta)$. ∎

The main results in the paper are derived from the fact that if the common supplier game begins with two-part tariff contracts with price ceiling and unit price both equal to the monopoly price, there is a unique equilibrium payoff. This is proved as Lemma 3; first, a proposition which puts a lower bound on a downstream firm's continuation payoff if at stage 1 it has been offered a two-part tariff contract.

Lemma 2. *Suppose that at the end of stage 2 D_i has agreed only one contract: either a two-part tariff contract $(c,F;p)$ where $p \geq c$ or a two-part tariff contract (c,F) with no price ceiling; then, in any continuation equilibrium, D_i's payoff is at least $-F$.*

Proof. Suppose that D_i adopts the following strategy: reject any offer of renegotiation by U_j, the other party to the contract, set price c and order whatever is demanded, i.e., set $x_{ji} = s_i (c,p_1)$ where p_1 is the price set by the other downstream firm. Then D_i's payoff will be $cs_i(c,p_l)-(F+cx_{ji})$, which is equal to $-F$. Therefore D_i can guarantee itself a payoff of $-F$ and so its equilibrium payoff must be at least $-F$. ∎

Lemma 3. *In any equilibrium of the Common Supplier game with contracts $((p''', -\Pi_1;p'''), (p''', -\Pi_1;p'''))$, where $\Pi_1 \geq 0$, $\Pi_2 \geq 0$ and $\Pi_1 + \Pi_2 \leq \Pi'''$, D_1's payoff is Π_1, D_2's payoff is Π_2 and U's payoff is $\Pi''' - \Pi_1 - \Pi_2$.*

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Proof. Fix an equilibrium and denote the equilibrium payoffs by $\hat{\Pi}_1^D$, $\hat{\Pi}_2^D$ and $\hat{\Pi}^U$. Lemma 2 implies that $\hat{\Pi}_1^D \geq \Pi_1$ and $\hat{\Pi}_2^D \geq \Pi_2$. Suppose now that U proposes no renegotiation. Because of the price ceilings each firm's price can be no higher than p^m and so total demand must be at least $D(p^m)$. Therefore U's payoff must be at least $D(p^m)(p^m - \theta) + (-\Pi_1) + (-\Pi_2) = \Pi^m - \Pi_1 - \Pi_2$. This implies that $\hat{\Pi}^U \geq \Pi^m - \Pi_1 - \Pi_2$ since, otherwise, U would have a profitable deviation. Therefore $\hat{\Pi}_1^D + \hat{\Pi}_2^D + \hat{\Pi}^U \geq \Pi^m$. But, by feasibility, $\hat{\Pi}_1^D + \hat{\Pi}_2^D + \hat{\Pi}^U \leq \Pi^m$. Therefore $\hat{\Pi}_1^D + \hat{\Pi}_2^D + \hat{\Pi}^U = \Pi^m$. Since $\hat{\Pi}_1^D \geq \Pi_1$ and $\hat{\Pi}_2^D \geq \Pi_2$ we deduce that $\hat{\Pi}^U \leq \Pi^m - \Pi_1 - \Pi_2$ and so $\hat{\Pi}\hat{\Pi}^U = \Pi^m - \Pi_1 - \Pi_2$. Similarly $\hat{\Pi}_1^D = \Pi_1$ and $\hat{\Pi}_2^D$. ■

Suppose that $\Pi_1 + \Pi_2 = \Pi^m$. Then Lemma 3 shows that in any equilibrium of the Common Supplier game with contracts $((p^m, -\Pi_1; p^m),$ $(p^m, -\Pi_2; p^m))$ a downstream cartel results: both downstream firms set the monopoly price and they share all the surplus between them. In effect the downstream firms are operating a collusive scheme by paying high prices to a common supplier and, through negative franchise fees, transferring the profit downstream (rather than upstream as is usual in the literature on vertical contractual arrangements).

It might appear that the upstream firm would then have an incentive to renegotiate with, say, D_1, to undercut D_2 and thereby increase its own profit at the expense of D_2. This would then upset the collusive scheme. Something similar to this occurs in Hart and Tirole (1990). They study the motives for vertical integration in a context somewhat similar to the context of this paper. In one version of their model there is one upstream firm (U) and there are two downstream firms (D_1 and D_2) and there is an incentive for U to integrate with, say, D_1 in order to monopolize the downstream market. The argument is that, in the absence of vertical integration, if U's strategy is, for example, to sell the monopoly quantity to D_1, it would then also want to sell an additional amount to D_2, upsetting the collusive arrangement at the expense of D_1 (this assumes that an exclusive dealing contract preventing U from selling to D_2 is not permitted). They refer to this motive for vertical integration as ex post monopolization. This appears to be inconsistent with Lemma 3. How is it that, according to Lemma 3, U internalizes the negative externality imposed on D_1 if U sells an additional quantity to D_2, which it could do

by renegotiating its contract with D_2? The answer is that there is no negative externality: D_1 is indifferent, given its contract, to the quantity which it sells. If it is undercut by D_2 then it still receives the payment of Π_1. The essential difference is that in this paper the downstream firms engage in Bertrand competition whereas in Hart and Tirole they engage in Cournot competition: after the contracts are agreed they each choose a quantity to buy from upstream and place it on the market. Equivalently (see Tirole (1988), chap. 5) they each buy some quantity from upstream, observe each other's quantity and compete in prices, constrained by these quantities. In the current paper, once prices have been chosen and demands realized, the downstream firms can buy as much as they want from the upstream firms. In the former specification D_1 is vulnerable to a deviation by D_2 because, once D_1 has bought some quantity, it will make a loss if it cannot sell it all at the expected price. In the latter specification a downstream firm will only order supplies from upstream if the downstream demand has already materialized. Which model is more appropriate depends on technological considerations in the industry, but it is worth noting that one of the characteristics of modern manufacturing is an increased flexibility of upstream suppliers to downstream demand, involving, for example, a reduced reliance on inventories. What Lemma 3 shows is that co-ordinating on a common supplier can serve as a means of softening the rigours of Bertrand competition, just as capacity constraints, repetition and product differentiation can.

The downstream cartel outcome supported by the contracts $(p''',-\Pi_1;p''')$ and $(p''',-\Pi_2;p''')$ does in fact arise as an equilibrium of the simultaneous-move contract game G_1 (Theorem 3 below). First, however, I consider the sequential-move contract game G, which turns out to have a unique equilibrium outcome. This outcome is collusive and U_1 obtains the entire surplus. In effect this is an entry-deterring equilibrium: the incumbent upstream firm U_1 makes a pair of public contract offers to the two downstream firms which prevents U_2 from then making effective counter-offers even though U_1's contracts would give none of the surplus to the downstream firms. Essentially the idea is the following. U_1 writes an exclusive-dealing, two-part tariff contract with D_1 with a zero franchise fee and a unit price higher than the monopoly

price p'''. With D_2 it writes an exclusive-dealing, two-part tariff contract with the same unit price, a negative franchise fee and a price ceiling of p'''. D_2 sets the monopoly price and sells to the whole market while D_1 sets a higher price. D_2 makes a loss on its sales (it would like to charge more but is not allowed to) which it recoups via the franchise fee. U_1 makes all the profit, but U_2 cannot enter the market by undercutting U_1's contracts. This follows because U_2, to make a positive profit, would need to attract both downstream firms; however, if D_1 were to accept a contract offered by U_2, D_2 would make a large positive profit by accepting U_2's contract because now, possibly after renegotiation, D_1 will charge θ (by Lemma 1) and D_2 will therefore not be obliged to make a loss on its sales. Therefore, in order to attract both downstream firms, the excluded firm would have to offer payoffs too high to allow it to make any profit. The fact that renegotiation will take place between U_2 and D_1 after U_2 enters the market is crucial to the argument.

Given $\varepsilon > 0$, define exclusive-dealing two-part tariff contracts $\alpha_1(\varepsilon)$ and $\alpha_2(\varepsilon)$ as follows.

$$\alpha_1(\varepsilon) := (-\varepsilon, p''' + \Pi'''(D(p'''))^{-1})$$
$$\alpha_2(\varepsilon) := (-\Pi''' - \varepsilon, p''' + \Pi'''(D(p'''))^{-1}; p''').$$

The entry-deterring contracts described above are then $\alpha_1(0)$ and $\alpha_2(0)$.

Proposition 1 *G has a unique equilibrium payoff vector. In equilibrium U_1 earns the monopoly profit Π''' and the other firms all make zero profit.*

Proof. Fix an equilibrium of G. Fix any small $\varepsilon > 0$. Consider a history in which U_1 has offered $\alpha_1(\varepsilon)$ to D_1 and $\alpha_2(\varepsilon)$ to D_2 at the outset (this might involve a deviation by U_1) and in which U_2 has then offered some arbitrary pair (τ_1, τ_2) which is in the support of U_2's strategy, conditional on this offer pair of U_1. Since $\alpha_1(\varepsilon)$ and $\alpha_2(\varepsilon)$ are exclusive contracts neither downstream firm can accept more than one contract. Let $\Pi_i^D(\tau_1, \alpha_2(\varepsilon))$ and $\Pi_j^U(\tau_1, \alpha_2(\varepsilon))$ be, respectively, the equilibrium expected continuation payoffs of D_i and U_j if, after these four contracts have been

offered at stage 1, D_1 accepts τ_1 and D_2 accepts $\alpha_2(\varepsilon)$. Define $\Pi_i^D(\alpha_1(\varepsilon), \tau_2)$, $\Pi_j^U(\alpha_1(\varepsilon), \tau_2)$, $\Pi_i^D(\alpha_1(\varepsilon), \alpha_2(\varepsilon))$, etc., in an analogous fashion. Let $\Pi_i^D(\alpha_1(\varepsilon))$ and $\Pi_j^U(\alpha_1(\varepsilon))$ be respectively D_i's and U_j's equilibrium expected continuation payoff after D_i accepts $\alpha_1(\varepsilon)$; define $\Pi_i^D(\tau_1)$ and $\Pi_j^U(\tau_1)$ analogously.

Suppose first that D_1's strategy is to accept $\alpha_1(\varepsilon)$ and D_2's strategy is then to accept $\alpha_2(\varepsilon)$. In that case, if U_1 declines to renegotiate, D_2 cannot subsequently charge more than p'''. Therefore total sales will be at least $D(p''')$ and so U_1's profit will be at least

$$D(p''')(p''' + \Pi'''(D(p'''))^{-1} - \theta) + (-\varepsilon) + (-\Pi''' - \varepsilon) = \Pi''' - 2\varepsilon.$$

This would imply that U_1 can obtain at least $\Pi''' - \varepsilon$ by making the offers $(\alpha_1(\varepsilon), \alpha_2(\varepsilon))$, and, since ε is arbitrary, would prove that in this equilibrium the payoffs must be as specified.

Suppose now that D_1's strategy is to accept τ_1 with positive probability. Since, by Lemma 2, $\Pi_1^D(\alpha_1(\varepsilon)) \geq \varepsilon > 0$, this implies that $\Pi_1^D(\tau_1) > 0$. By Lemma 1,

$$\Pi_1^D(\tau_1, \alpha_2(\varepsilon)) + \Pi_2^U(\tau_1, \alpha_2(\varepsilon)) = 0 \qquad (1.1)$$

Using Lemma 1 again, $\Pi_2^D(\tau_1, \alpha_2(\varepsilon)) = \Pi''' + \varepsilon$. This is because D_1 will charge θ, while D_2 can charge more than θ and make no sales, thus getting a payoff equal to the negative of the franchise fee. Therefore, if D_2's strategy after D_1 accepts τ_1 is to accept τ_2 with positive probability then $\Pi_2^D(\tau_1, \tau_2) \geq \Pi''' + \varepsilon$, in which case $\Pi_1^D(\tau_1, \tau_2) + \Pi_2^U(\tau_1, \tau_2) < 0$ since the joint payoff of D_1, D_2 and U_2 given these contracts must be no greater than Π'''. Combining with (1.1), we have $\Pi_1^D(\tau_1) + \Pi_2^U(\tau_1) < 0$. If, instead, D_2's strategy after D_1 accepts τ_1 is to accept $\alpha_2(\varepsilon)$ then, by (1.1), $\Pi_1^D(\tau_1) + \Pi_2^U(\tau_1) = 0$. Hence $\Pi_1^D(\tau_1) + \Pi_2^U(\tau_1) \leq 0$ and so $\Pi_2^U(\tau_1) < 0$ because $\Pi_1^D(\tau_1) > 0$. If D_2 accepts τ_2 with positive probability after D_1 accepts $\alpha_1(\varepsilon)$ then $\Pi_2^D(\alpha_1(\varepsilon), \tau_2) > 0$ since $\Pi_2^D(\alpha_1(\varepsilon), \alpha_2(\varepsilon)) \geq \varepsilon$. The latter is true because if D_2 accepts $\alpha_2(\varepsilon)$, rejects any renegotiation offer and sets price p''', D_2 will get at least

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$$D(p''')(p''' - (p''' + \Pi''' (D(p'''))^{-1}) - (- \Pi''' - \varepsilon) = \varepsilon.$$

Therefore, using Lemma 1, $\Pi_2^U (\alpha_1(\varepsilon),\tau_2) < 0$. Since $\Pi_2^U (\alpha_1(\varepsilon),\alpha_2(\varepsilon)) = 0$, this shows that $\Pi_2^U (\alpha_1(\varepsilon)) \le 0$. U_2's offer of (τ_1, τ_2) therefore gives a strictly negative expected payoff, contradicting the assumption that it belongs to the support of U_2's strategy. We conclude that D_1 accepts τ_1 with zero probability and therefore accepts $\alpha_1(\varepsilon)$ with probability 1 (by Lemma 2 $\Pi_1^D (\alpha_1(\varepsilon)) \ge \varepsilon > 0$ and so it is suboptimal to accept neither contract). Suppose that, after D_1 accepts $\alpha_1(\varepsilon)$, D_2's strategy is to accept τ_2 with positive probability. Then, as argued above, $\Pi_2^D (\alpha_1(\varepsilon),\tau_2) > 0$, and so $\Pi_2^U (\alpha_1(\varepsilon),\tau_2) < 0$ by Lemma 1. Therefore $\Pi_2^U (\alpha_1(\varepsilon)) < 0$ and so U_2's offer of (τ_1,τ_2) is suboptimal, which implies that D_2 rejects τ_2 and accepts $\alpha_2 (\varepsilon)$. This proves that the equilibrium must give the monopoly profit to U_1.

To see that such an equilibrium exists, consider the following strategies. U_1 offers exclusive contracts $\alpha_1(0)$ to D_1 and $\alpha_2(0)$ to D_2 at stage 1. U_2 then offers the two-part tariff contract $(p''', 0; p''')$ to both D_1 and D_2. Given these offers, both downstream firms accept U_1's offer. Assign arbitrary equilibrium strategies to every other subgame. By the arguments above, D_1 and D_2 both get a zero payoff while U_1's payoff is Π'''. It is clear that no pair of contract offers could give U_1 a payoff greater than Π''' since, given U_2's stated offers, each other party can guarantee itself at least zero. Therefore U_1's offers are optimal. If D_1 accepts U_2's offer of $(p''', 0; p''')$ then D_2 will accept U_1's offer of $\alpha_2 (0)$ since that, by the argument above, will give him Π''' (because $\Pi_2^D (\tau_1,\alpha_2(\varepsilon)) = \Pi''' + \varepsilon$ for any τ_1), while U_2's offer will give him zero, by Lemma 3. By Lemma 1, D_1 then gets zero and so D_1's choice of U_1's offer is optimal. For a similar reason, D_2's choice is optimal (once D_1 has accepted U_1's offer D_2's payoff is zero whichever contract he accepts). The argument in the previous paragraph, slightly adapted, shows that, given U_1's strategy, U_2 cannot make any pair of offers which will give him a strictly positive payoff and so U_2's strategy too is optimal. This shows that the specified strategies form an equilibrium.∎

Clearly this entry-deterring collusive equilibrium relies on the upstream firm being allowed to write a contract which in some circumstances

obliges the other party to set a price below its marginal cost. For future reference, I define a *no-dumping two-part tariff contract* as a contract (c,F) or $(c,F;p)$ in which $c \geq \theta$ and $p \geq c$. If the price ceiling $p < c$ then the downstream firm charges below cost, whereas if $c < \theta$ then the upstream firm charges below cost.

Proposition 1 has something in common with the analysis of Aghion and Bolton (1987). They have a model in which an incumbent upstream firm has an exclusive dealing contract with a single downstream firm which has the effect of keeping other upstream firms out of the market. It is assumed that the parties to the contract do not know in advance what the costs of potential entrants will be. The contract has penalties for breach (liquidated damages) which are set in such a way that an efficient potential entrant will find it in his interest to enter and charge the retailer a low price: one sufficiently low that the retailer finds it worthwhile to break the contract and pay the breach penalty to the first manufacturer. In effect, the retailer has to pay an entry fee which is split between the manufacturer and the retailer. My model differs from Aghion and Bolton's in that there is complete information about the entrant's costs, and there are two retailers (it is clearly essential for the result that there are at least two). The implication of the model is also different in that entry is completely blockaded rather than reduced. Both models imply that exclusive dealing contracts can, despite Bork, have anti-competitive foreclosure effects.

One might wonder whether arm's-length contracts such as those described in the proof of Proposition 1 are needed for entry-deterrence or whether, if vertical integration were permitted, an upstream firm might achieve the same end by that route? In other words, does vertical separation have strategic value? The next Proposition shows that it does: in the vertical integration game U_1 monopolizes the market but there is no equilibrium in which U_1 integrates with both downstream firms.

Proposition 2 *In the Vertical Integration Game there is a unique equilibrium vector of payoffs. This is collusive and gives all the surplus to U_1. There is no equilibrium in which U_1 integrates with both downstream firms*

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Proof. The argument is similar to that in the proof of Proposition 1. By offering $(\alpha_1(\varepsilon), \alpha_2(\varepsilon))$ U_1 can guarantee a payoff close to Π^m. This is because any contract pair (including perhaps offers to buy) which U_2 might then offer will give U_2 a negative payoff if either downstream firm prefers to accept. In particular, if D_1 accepts U_2's offer, D_2 will not follow suit unless doing so gives him at least Π^m. For the same reason, the equilibrium offers of Proposition 1 can be supported in an equilibrium of the vertical integration game.

Suppose that there is an equilibrium in which U_1 offers to buy both downstream firms for Π_1 and Π_2 respectively, where $\Pi_1 + \Pi_2 < \Pi^m$. Then U_2 could offer to buy them both for $\Pi_1 + \varepsilon$ and $\Pi_2 + \varepsilon$ (where $\varepsilon > 0$) and they would both accept. For small enough ε this would benefit U_2. This shows that there can be no such equilibrium. ∎

Vertical integration might still take place with one of the downstream firms. It can easily be shown that there is an equilibrium of this game in which U_1 integrates with D_1 (paying zero) but agrees $\alpha_2(0)$ with D_2. The arm's-length contact clearly plays an essential role.

The existence of an entry-deterring collusive equilibrium does not depend on U_1 having first-mover advantage. Consider the game G_1 in which, at stage 1, U_1 and U_2 make their offers simultaneously. In that case entry-deterring collusive equilibria in which U_1 (or, alternatively, U_2) makes the monopoly profit will still exist. One such equilibrium is as follows. U_1 offers exclusive contracts $\alpha_1(0)$ to D_1 and $\alpha_2(0)$ to D_2 at stage 1. U_2 offers the two-part tariff contract $(p^m, 0; p^m)$ to both D_1 and D_2. Given these offers, both downstream firms accept U_1's offer. Assign arbitrary equilibrium strategies to every other subgame. The arguments in the proof of Proposition 1 show that these strategies do in fact form an equilibrium. But there are also equilibria in which a downstream cartel forms, as the next Proposition shows.

Proposition 3 *Given any Π such that $\Pi > 0$ and $\Pi < \Pi^m$ there exists a collusive equilibrium of G_1 in which D_1's profit is Π, D_2's is $\Pi^m - \Pi$ and both upstream firms have zero profit.*

Proof. Consider the following strategies. U_1 offers the exclusive-dealing two-part tariff contracts $\hat{\tau}_1 := (p''', -\Pi; p''')$ (to D_1) and $\hat{\tau}_2 := (p''', \Pi - \Pi'''; p''')$ (to D_2); U_2 does the same. If these offers are made both downstream firms accept U_1's offer. Assign arbitrary equilibrium strategies to every other subgame. By Lemma 3, these strategies lead to the payoffs specified. If, after the above offers, D_1 accepts U_2's offer and so does D_2, D_1's payoff is Π by Lemma 3. If D_1 accepts $\hat{\tau}_2$ from U_2 and D_2 accepts $\hat{\tau}_1$ from U_1, D_1's payoff is $\Pi_1^D(\hat{\tau}_2, \theta)$ by Lemma 1. This too is equal to Π. D_2 must accept one or other contract after the above offers are made. Therefore D_1's expected payoff after accepting $\hat{\tau}_2$ is Π and so it is optimal for D_1 to accept U_1's offer. Similarly, it is optimal for D_2 to accept U_1's offer. Suppose that U_1 were to offer a deviant pair of contracts $(\bar{\tau}_1, \bar{\tau}_2)$ while U_2 were to offer $(\hat{\tau}_1, \hat{\tau}_2)$. U_2's offered contracts are exclusive so that the downstream firms are not allowed to accept two contracts. By Lemma 2 D_1 gets at least $\Pi > 0$ if he accepts $\hat{\tau}_1$ and so he must accept one or other contract. The same applies to D_2. Therefore there are four subgames to consider after this history. Let the equilibrium payoffs in the common supplier subgame which results if D_1 accepts $\bar{\tau}_1$ and D_2 accepts $\bar{\tau}_2$ be $\hat{\Pi}_1^U(\bar{\tau}_1, \bar{\tau}_2)$, $\hat{\Pi}_1^D(\bar{\tau}_1, \bar{\tau}_2)$ and $\hat{\Pi}_2^D(\bar{\tau}_1, \bar{\tau}_2)$. Define $\hat{\Pi}_i^D(\hat{\tau}_1, \bar{\tau}_2)$, $\hat{\Pi}_j^U(\hat{\tau}_1, \bar{\tau}_2)$, etc. in an analogous way. Suppose that the postulated deviation gives U_1 a strictly positive expected payoff. If D_1 rejects $\bar{\tau}_1$ then D_2 will accept $\bar{\tau}_2$ only if $\hat{\Pi}_2^D(\hat{\tau}_1, \bar{\tau}_2) \geq \Pi''' - \Pi > 0$. But, by Lemma 1, $\hat{\Pi}_2^D(\hat{\tau}_1, \bar{\tau}_2) + \hat{\Pi}_1^U(\hat{\tau}_1, \bar{\tau}_2) = 0$ and so $\hat{\Pi}_1^U(\hat{\tau}_1, \bar{\tau}_2) < 0$. Therefore D_1 must accept $\bar{\tau}_1$ with positive probability, which implies that

$$a\hat{\Pi}_1^D(\bar{\tau}_1, \bar{\tau}_2) + (1 - a)\,\hat{\Pi}_1^D(\bar{\tau}_1, \hat{\tau}_2) \geq \Pi \tag{3.1}$$

where a is the probability that D_2 will accept $\bar{\tau}_2$ after D_1 has accepted $\bar{\tau}_1$. U_1's payoff conditional on D_1's acceptance of $\bar{\tau}_1$ must be strictly positive, i.e.

$$a\hat{\Pi}_1^U(\bar{\tau}_1, \bar{\tau}_2) + (1 - a)\,\hat{\Pi}_1^U(\bar{\tau}_1, \hat{\tau}_2) > 0.$$

Using Lemma 1:

$$a\hat{\Pi}_1^U(\bar{\tau}_1, \bar{\tau}_2) + (1 - a)(-\hat{\Pi}_1^U(\bar{\tau}_1, \hat{\tau}_2)) > 0 \tag{3.2}$$

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Adding (3.1) and (3.2) gives a $(\hat{\Pi}_1^D(\bar{\tau}_1, \bar{\tau}_2) + \hat{\Pi}_1^U(\bar{\tau}_1, \bar{\tau}_2)) > \Pi$, which implies that

$$\hat{\Pi}_1^D(\bar{\tau}_1, \bar{\tau}_2) + \hat{\Pi}_1^U(\bar{\tau}_1, \bar{\tau}_2)) > \Pi \tag{3.3}$$

and also that $a > 0$. However, the maximum feasible joint profit is Π''', i.e. $\hat{\Pi}_1^D(\bar{\tau}_1, \bar{\tau}_2) + \hat{\Pi}_1^U(\bar{\tau}_1, \bar{\tau}_2) + \hat{\Pi}_2^D(\bar{\tau}_1, \bar{\tau}_2) \le \Pi'''$ which gives $\hat{\Pi}_2^D(\bar{\tau}_1, \bar{\tau}_2) < \Pi'''$ $-\Pi$ by (3.3). This in turn implies that $\hat{\Pi}_2^D(\bar{\tau}_1, \hat{\tau}_2) < \hat{\Pi}_2^D(\bar{\tau}_1, \hat{\tau}_2)$ by Lemma 2 and therefore $a = 0$, which is a contradiction. This shows that U_1 cannot profitably deviate. Given U_1's equilibrium offer, the same arguments show that U_2 cannot profitably deviate either. ∎

The question arises whether G_1 has other equilibria in addition to the two types of collusive equilibria discussed above, in particular non-collusive equilibria and equilibria in which both upstream firms make positive profits. I conjecture that the answer is yes. To see why this is plausible, consider a Common Supplier Game with arbitrary non-collusive contracts. It might be thought that the possibility of renegotiation will force a unique equilibrium continuation payoff because the upstream firm will offer a collusive pair of contracts which gives each downstream firm its reservation payoff as determined by the *status quo* pair of contracts. There may, however, be an equilibrium in which no renegotiation is offered, supported by off-equilibrium-path beliefs of the downstream firms in the event of renegotiation being offered. Suppose that U offers some renegotiation to D_1. After this deviation, D_1 might believe that U has made some deviant offer to D_2 and that D_2 will then set an off-equilibrium-path price. The downstream firms' reservation payoffs are therefore not necessarily unique because they depend on off-equilibrium-path beliefs and, furthermore, these beliefs may cause them to react to renegotiation offers in ways which deter the upstream firm from offering them. This potentially could give rise to a multiplicity of equilibria which leads to a multiplicity of equilibria in the game as a whole. On the other hand, it seems to be difficult to construct examples of such equilibria. This would require specifying reactions to every conceivable renegotiation offer in various Common Supplier subgames and showing that no pair of offers can improve the upstream firm's payoff. Because the upstream firm can select from a wide class of contracts this is a complicated task.

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Nevertheless, it is possible to narrow down the set of equilibria of G_1. Suppose we confine ourselves to equilibria in strategies which are pure in stages 1 and 2 (i.e., in the original contract offers and acceptance decisions) and *stationary* in the sense that, from the beginning of stage 3, they depend only on the contracts in force at the end of stage 2 (i.e., actions after stage 2 do not depend on contract offers which were made and rejected in the first two stages). Stationarity seems to be a reasonable refinement, in the spirit of similar notions which have been proposed in other game-theoretic contexts. The restriction to strategies which are pure in the first stages is perhaps not essential to what follows, but simplifies the analysis. The next Proposition shows that any such equilibrium which involves exclusive-dealing two-part tariff no-dumping contracts gives rise to a downstream cartel. This result, together with Proposition 1, suggests the implication that exclusive contracts have a collusive motivation whether they involve dumping (i.e., charging below marginal cost) or not. In the former case they are associated with an upstream firm monopolizing the market (at least in the case where that firm has some incumbency advantage) and in the latter they are associated with the downstream firms monopolizing the market.

Proposition 4 *Suppose that, in some equilibrium of G_1 in which the strategies are (a) pure in stages 1 and 2 and (b) stationary, both upstream firms offer no-dumping two-part tariff contracts. Then if the contracts offered in this equilibrium by at least one upstream firm are exclusive, the equilibrium is collusive. If the contracts offered by both upstream firms are exclusive, the equilibrium outcome is a downstream cartel.*

Proof. Take an equilibrium satisfying (a) and (b) and let the contracts offered in this equilibrium, (τ_{11}, τ_{12}) and τ_{21}, τ_{22}, be no-dumping two-part tariff contracts with payment schedules $(c_{11}, F_{11}), (c_{12}, F_{12})$, etc. Let the equilibrium payoffs be $\hat{\Pi}_1^D$, $\hat{\Pi}_2^D$, $\hat{\Pi}_1^U$ and $\hat{\Pi}_2^U$. Suppose that U_2's equilibrium offers are exclusive contracts. Suppose also that $\hat{\Pi}_1^D + \hat{\Pi}_2^D + \hat{\Pi}_1^U = \Pi^m - 3\varepsilon$ where $\varepsilon > 0$. Consider a history $\bar{h}$ in which U_1 offers exclusive contracts $\tilde{\tau}_1 := (p^m, -\hat{\Pi}_1^D - \varepsilon; p^m)$ to D_1 and $\tilde{\tau}_2 := (p^m, \hat{\Pi}_2^D - \varepsilon; p^m)$ to D_2 while U_2 offers the equilibrium contracts. Let $\Pi_1^D (\tilde{\tau}_1, \tau_{22})$ be defined as D_1's equilibrium continuation payoff if D_1 accepts $\tilde{\tau}_1$ and D_2

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accepts τ_{22} after this history. Define $\Pi_i^D(\tilde{\tau}_1, \tilde{\tau}_2)$, $\Pi_j^U(\tau_{21}, \tau_{22})$, etc., analogously. Since the contracts are exclusive, the downstream firms can only accept at most one contract each. Lemma 3 shows that $\Pi_1^D(\tilde{\tau}_1, \tilde{\tau}_2) = \hat{\Pi}_1^D + \epsilon$, $\Pi_2^D(\tilde{\tau}_1, \tilde{\tau}_2) = \hat{\Pi}_2^D + \epsilon$ and $\Pi_1^U(\tilde{\tau}_1, \tilde{\tau}_2) = \Pi^m - \hat{\Pi}_1^D - \hat{\Pi}_2^D - 2\epsilon = \hat{\Pi}_1^U + \epsilon$. Therefore, if the strategies of D_1 and D_2 imply that they both accept U_1's offer, U_1 has a profitable deviation. This contradiction would show that $\hat{\Pi}_1^D + \hat{\Pi}_2^D + \hat{\Pi}_1^U \geq \Pi^m$, which, by feasibility and the fact that $\hat{\Pi}_2^U \geq 0$, would imply that the equilibrium is collusive and that $\hat{\Pi}_2^U = 0$. We will show that D_1 and D_2 will in fact both accept U_1's offer of $(\tilde{\tau}_1, \tilde{\tau}_2)$. A symmetrical argument shows that if U_1 also offers exclusive contracts in equilibrium then U_2 could offer $(\tilde{\tau}_1, \tilde{\tau}_2)$ and both downstream firms would accept, implying that $\hat{\Pi}_1^D = 0$. This then shows that the outcome is a downstream cartel equilibrium.

Suppose that after $\tilde{h}$ the equilibrium strategy of D_1 is to accept $\tilde{\tau}_1$. Then D_2 either accepts $\tilde{\tau}_2$ and gets $\hat{\Pi}_2^D + \epsilon$ or accepts τ_{22}. By Lemma 1, $\Pi_2^D (\tilde{\tau}_1, \tau_{22}) = \Pi_2^D (\tau_{22}, \theta)$. Since $c_{22} \geq \theta$, $\Pi_2^D (\tilde{\tau}_1, \tau_{22}) = -F_{22}$. But, by Lemma 2, $\hat{\Pi}_2^D \geq -F_{22}$ since D_2 has the option in equilibrium of accepting τ_{22}. Therefore D_2 must accept $\tilde{\tau}_2$ and the theorem is proved. Suppose then that D_1's equilibrium strategy is to accept τ_{21} after $\tilde{h}$ (D_1 must accept a contract because accepting $\tilde{\tau}_1$ would give a payoff of at least $\hat{\Pi}_1^D + \epsilon > 0$ by Lemma 2). By Lemma 1, $\Pi_1^D (\tau_{21}, \tilde{\tau}_2) = -F_{21}$ and by Lemma 2 $\hat{\Pi}_1^D \geq -F_{21}$ since in equilibrium D_1 has the option of accepting τ_{21}. Therefore D_2's response to D_1's choice of τ_{21} must be τ_{22} because otherwise D_1 gets strictly less than $\hat{\Pi}_1^D + \epsilon$, which he could have achieved by accepting $\tilde{\tau}_1$ (D_2 will certainly accept a contract). Since D_2 can in this situation get $\hat{\Pi}_2^D + \epsilon$ by accepting $\tilde{\tau}_2$, this implies that

$$\Pi_2^D (\tau_{21}, \tau_{22}) \geq \hat{\Pi}_2^D + \epsilon. \tag{4.1}$$

Similarly $\Pi_1^D (\tau_{21}, \tau_{22}) \geq \hat{\Pi}_1^D + \epsilon$. That is, both downstream firms get more than their equilibrium payoffs if they both accept U_2's equilibrium offer. Now consider an equilibrium history up to the start of stage 2. Suppose that D_1 accepts τ_{21}. By stationarity, if D_2 follows suit and accepts τ_{22}, D_1's payoff is $\Pi_1^D (\tau_{21}, \tau_{22}) > \hat{\Pi}_1^D$ and D_1 has a profitable deviation. This means that D_2's strategy must be to accept τ_{12} instead (since τ_{22} is exclusive he cannot accept both) and therefore that $\Pi_2^D (\tau_{21},$

$\tau_{12}) \geq \hat{\Pi}_2^D (\tau_{21}, \tau_{22}) > \hat{\Pi}_2^D$ by (4.1). By Lemma 1, $\Pi_2^D (\tau_{21}, \tau_{12}) = -F_{12}$, and so $-F_{12} > \hat{\Pi}_2^D$, which contradicts Lemma 2 since D_2 can in equilibrium accept τ_{12}. This proves the theorem.∎

An equilibrium in strategies which are pure in the first two stages is guaranteed to exist because of the fact that the downstream firms move sequentially at stage 2. One example of such an equilibrium is as follows. U_1 and U_2 both offer the exclusive-dealing contract $(p^m, -\Pi/2; p^m)$ to both downstream firms at stage 1. After these offers D_1 and D_2 both accept U_1's offer. Assign arbitrary equilibrium strategies to every subgame starting at stage 3. Given any history consisting of offers at stage 1 and a choice by D_1 and involving some deviation, select an arbitrary optimal non-random choice by D_2 (D_2's continuation payoff after any choice is well defined). Given any history consisting of offers at stage 1, at least one of which is a deviation, select an arbitrary optimal non-random choice by D_1. It is easy to see that this is an equilibrium, using the arguments in the proof of Proposition 3.

It is essential for the above results that exclusive dealing is allowed. If U_1's strategy is to offer a contract as described above, but without the exclusive dealing clause, to D_1 then U_2 has an incentive to offer a contract undercutting U_1's price of p^m and D_1 has an incentive to accept both contracts. U_1 then makes a loss on the franchise fee element. The negative franchise fee may seem an unrealistic feature of the collusive contract. However, it may be that such contracts are in fact observed in disguised form. It could be, for example, that a supplier has a linear exclusive dealing contract with a downstream buyer and at the same time makes a lump-sum payment to that buyer, perhaps in the form of a subsidy for capital equipment. Such an arrangement would be equivalent to the contract $(p^m, -\Pi)$.

In the model of this paper it is essential that the upstream firm signs an exclusive dealing contract with both downstream firms (i.e., with the whole market); otherwise the logic of Lemma 1 applies and all firms will charge the competitive price. It may be objected that such an arrangement is bound to fall foul of competition laws. On the other hand, take a model similar to the present one but with differentiated products

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and more than two downstream firms. Suppose that exclusive dealing contracts are legal as long as they cover no more than a certain fraction of the downstream market. In that case there will be an equilibrium in which upstream firms each supply exclusively an equal fraction of the market. The contracts are similar to those of this section and the final price charged is higher than the competitive price but lower than the monopoly price. As in the equilibrium of Proposition 3, the upstream firms soften downstream competition (but not completely) by charging high prices and transfer the profit downstream through lump-sum payments. As in Proposition 3, the upstream firms earn zero profits because they compete the surplus away by bidding against each other. This shows that exclusive dealing contracts may have anti-competitive effects even if each covers only a relatively small share of the market.

Other Renegotiation Protocols

In the games analyzed here only the upstream firms are able to make renegotiation offers and an upstream firm cannot make an offer to a downstream firm at stage 3 unless the two of them have already agreed a contract at stage 2. It is natural to ask if these features are essential to the results. Suppose that the renegotiation offer at stage 3 is made by the downstream rather than the upstream firm, the rest of the game being as above. Lemmas 2 and 3 will clearly still be valid; indeed they will be valid for any procedure in which renegotiation takes place only if both parties agree. Propositions 1-4 will be valid if Lemmas 1, 2 and 3 are. Lemma 1, however, does not apply in this case. Given certain contracts, there exist equilibria of the Separate Supplier Game in which total profits are strictly positive. For example, suppose that U_1 and D_1 have a contract with payment schedule $\phi := xD^{-1}(x)$ for all $x \geq 0$. U_2 and D_2 have the same contract. Neither upstream firm offers any renegotiation; after this D_1 sets a price $p_1 = p''' + 2\varepsilon$ and D_2 sets $p''' + \varepsilon$ for some small positive ε. If D_i offers U_i some renegotiation and U_i rejects, D_i then sets a price p''' $(i = 1, 2)$. All players get zero except for U_2, who gets slightly less than Π'''. Given D_1's existing contract and D_2's price any price p below $p''' + \varepsilon$ will give D_1 a payoff of $pD(p) - D(p)D^{-1}(D(p)) = 0$. (Assuming that $xD^{-1}(x)$ is increasing in x D_1 cannot do better by buying more than $D(p)$ and throwing the excess away). In particular D_1 is indifferent between setting p_1 and setting p'''. Similarly, D_2 is indifferent between p_2 and p'''.

It is rational for the downstream firms not to offer any renegotiation because the upstream firm will reject it (unless it offers Π'''); this rejection is rational because it leads to the monopoly profit. The asymmetry between the two specifications of the renegotiation process arises because the joint profit is determined by the price, which only the downstream firm controls. On the other hand, this equilibrium is very implausible. U_1 has a strong incentive to make a renegotiation offer and the equilibrium relies on the fact that he is not allowed to. If the upstream firms are able to make counter-offers after the downstream firms' offers then the logic of Lemma 1 must apply.

Suppose that U_j is allowed to make an offer to D_i at stage 3 even if they have not previously agreed a contract, the rest of the game being as set out in Section 2. Assume, as seems reasonable, that if the other upstream firm has already agreed an exclusive-dealing contract with D_i then D_i will not be able to accept U_j's contract. In this case the argument in the proof of Proposition 1 does not go through. For example, after U_1 has offered $(\alpha_1(\varepsilon), \alpha_2(\varepsilon))$, D_1 has accepted some non-exclusive offer τ_1 from U_2, and D_2 has accepted $\alpha_2(\varepsilon)$ the continuation is not equivalent to a Separate Supplier game because U_1 has the option of making another private offer to D_1. The analysis of such a subgame is complicated for the reasons mentioned in the discussion following Proposition 3 but in principle such a subgame might have equilibria which are not competitive, supported by off-equilibrium-path beliefs of each downstream firm about the other downstream firm's prices. At all events, the collusive equilibria of G and G_1 will still exist and Propositions 3 and 4 will still be valid because the crucial arguments concern subgames at which both upstream firms have made exclusive offers.

Relation to Other Literature

A number of recent papers have examined questions related to those discussed here. Bernheim and Whinston (1985) show that a common marketing agency can act as a collusive device. In their model there are two firms producing similar but differentiated products and a number of marketing agents. The firms offer contracts to the agents which consist

of a price for the firm's product (which final consumers pay) and an incentive scheme for the agent. The agents choose which contracts to accept and each firm then selects an agent from among those who accept its terms. They show that there exists an equilibrium in which all the variables (the prices and the marketing intensities, which are delegated to the agents) are set at their cooperative levels. In this equilibrium both firms sell through a common agent, the agent earns zero profit and the incentive scheme is commission-based rather than fee-for-service. The idea is that the agent pays a franchise fee to the firms and in return is rewarded with all the profit. It pays the firms to set the cooperative prices because then they can charge higher franchise fees (each firm can charge the agent an amount equal to the joint profit of the two firms less whatever he is required to pay the other firm). At first sight this model appears to be quite different from the model of the present paper because it has firms coordinating on a common downstream (marketing) agency rather than on an upstream supplier. But upstream and downstream are conventional terms: a marketing agent can be regarded as a supplier of marketing services to the two producing firms. Therefore the Bernheim-Whinston analysis has something in common with the analysis above. On the other hand there is an important difference. The contracts in Bernheim-Whinston are sell-out contracts: in effect the firms sell their profits to the marketing agents in return for a lump-sum consideration. In this paper, by contrast, the contracts are straightforward price contracts; the suppliers are paid for their goods or services rather than on a commission basis. The Bernheim-Whinston equilibrium is somewhat similar, in the context of this paper, to an arrangement whereby one upstream firm integrates vertically with both downstream firms, which would almost certainly be illegal. What Proposition 3 shows is that a collusive outcome can result even if firms are restricted to using apparently innocuous arm's length (though exclusive-dealing) contracts.

Bernheim and Whinston have also studied exclusive dealing directly (Bernheim and Whinston, 1992). In the simplest model of that paper there are two upstream manufacturers and one downstream retailer. The manufacturers each offer the retailer two contracts, one exclusive, i.e. conditional on not carrying any of the other manufacturer's stock, and one common. A contract specifies a payment as a function of purchases

from both manufacturers. The question is whether there is any advantage to be gained from offering an exclusive contract. The answer is that in the equilibrium which is Pareto-dominant for the manufacturers both offer common (i.e. non-exclusionary) contracts. In this equilibrium each manufacturer offers a sell-out contract whereby the retailer has all the profit in return for a payment equal to the marginal contribution of that manufacturer's products to the overall profit of the vertical structure; the retailer chooses levels of sales which maximize the latter profit. Since the products are imperfect substitutes it may be that the retailer will want to carry both products; if he does not (because it is efficient not to do so), then this can be achieved without an exclusive dealing contract. This result tends to support the contention of Bork (1978) that manufacturers cannot increase their profit via exclusive dealing contracts because they would have to compensate the retailer for the loss of profit resulting from having less variety and therefore that exclusive dealing contracts, when they exist, exist for efficiency reasons. The differences between Bernheim and Whinston's analysis and the analysis of this paper are that in Bernheim-Whinston the downstream market is monopolized from the outset and that, as in their earlier paper, the equilibrium involves sell-out contracts.

Concluding Remarks

This paper has shown that if exclusive dealing is allowed then simple two-part tariff contracts can have collusive effects and that there are reasons to expect such contracts to arise even if there is *ex ante* competitive bidding for contracts. These contracts have commitment value despite (in some cases, precisely because of) the possibility of private renegotiation. They may work either to the benefit of the downstream firms or to that of a single upstream firm, which can use them to foreclose entry. These contracts involve negative franchise fees and so one obvious implication for competition policy suggests itself: that competition authorities ought to be suspicious of exclusive dealing arrangements in which transfers, whether direct or indirect, are made by upstream to downstream firms.

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