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Please Hold Me UP: Why Firms Grant Exclusive-Dealing Contracts

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Abstract

Why do irreplaceable Þrms with a choice of suppliers or customers deliberately expose themselves to the threat of hold up by contracting ex ante to deal with only one of them? Our explanation revolves around the multiple equilibria intrinsic to situations of unveriÞable investment and many traders. Exclusive dealing eliminates inecient equilibria in which too many Þrms invest too little. The enhanced ex post bargaining power of the chosen Þrm is beneÞcial for incentives whilst the distributional impact is more than oset in the ex ante negotiations over which this Þrm obtains the access privelege.

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1 Introduction

A burgeoning literature examines how to mitigate hold-up problems. Less attention has been paid, however, to why some firms deliberately expose themselves to hold up. That after all is the consequence of exclusive-dealing contracts so frequently adopted when legal. In this paper we try to explain the use of such arrangements to sharpen incentives in a world of incomplete contracts.

Exclusive-dealing contracts have been usually considered by courts and antitrust commentators as part of the menu of vertical restraints such as exclusive territories and resale price maintenance. For instance, Marvel (1982) defines exclusive dealing as "a contractual requirement by which retailers or distributors promise a supplier that they will not handle the goods of competing producers". But more broadly, any clause that explicitly prohibits one of the contracting parties from dealing with non-contracting counterparts can be considered as intrinsically exclusive. Hence, exclusivity is also applicable to situations in which a manufacturer of an (intermediate) input promises a potential downstream buyer not to trade the input with competing buyers, and this case represents the leading example of this paper.[1]

Some early papers have claimed (rather informally) that exclusive-dealing contracts may enhance incentives to make specific investments, because they curb certain free-rider problems and hence provide safeguards against *ex post* opportunism. This body of literature has focused on situations in which an agent's investment exhibits external or *cross-effects*, in the sense that it affects the potential revenue a trading partner can generate when he or she deals with other parties. Marvel (1982) argues for example that exclusive contracts protect a manufacturer's investments (e.g., in promotional effort) from the opportunistic behaviour of the dealers, who can opportunistically switch their customers to more profitable brands once they are in the store. So, the argument goes, in the absence of an exclusive relationship dealers may free ride on the manufacturer's effort and hence undermine the latter's incentives. A similar conjecture is given by Masten and Snyder (1993), who argue that the system of exclusive leases used by United Shoe Machinery Co. in the US was intended to foster United's investments that otherwise might have been profitably used by its customers in conjunction with competitors' equipment. Once again, the main argument is that shoemakers had strong incentives to free ride on United's investments in nonpatentable innovations and general know-how.

Other authors have argued instead, also informally, that exclusivity might foster relation-specific investments even in the absence of *cross-effects*. A famous example is given by Klein, Crawford and Alchian (1978). They study the vertical relationship between General Motors and Fisher Car Body and conclude that the exclusive-dealing clause included in the trade agreement signed in 1919 between both parties was intended to encourage Fisher Body to make specific investments in production capacity, because it eliminated GM's threat to purchase bodies elsewhere after those investments had been sunk.[2] Klein (1988) and Frasco (1991) provide additional evidence along these lines.[3]

[1] The case of a manufacturer signing an agreement to buy all its supplies from one of a number of upstream firms is analytically identical.

[2] Suppose that Fisher can sink investment of \$95M to design a car body worth \$200 to GM. Existing bodies worth \$100M to GM are available at a competitive price of \$80M. The Fisher body thus creates gross surplus of \$180M but if the *ex post* bargaining splits the quasi-rent equally with GM it is not in Fisher's interest to invest. Now suppose Fisher has an exclusive contract. In effect it is as if the competitive alternative does not exist. Ex post agreement with Fisher now creates a *gross* surplus of \$200 which, if shared equally, makes it profitable for Fisher to invest. The benefits of marginal improvements in the design are though shared equally whether or not there is an exclusive-dealing contract. So, on this perspective, exclusivity only has a role when there are indivisibilities in investment.

[3] Klein, Crawford and Alchian (1978), Williamson (1975) and Hart (1995) also argue that the takeover of Fisher

Of particular relevance to our analysis is Holmström and Roberts (1998), which examines vertical structures that are closely related to our setup. To be more precise, they mention the case of Nucor, an extremely successful American steel maker that decided to make David J. Joseph Company its sole supplier of scrap. Holmström and Roberts then conclude that notwithstanding potential hold-up problems, this vertical relationship based on an exclusive-dealing contract worked satisfactorily for many years and actually stimulated a similar behaviour by Co. Steel in England, which opted to rely on a sole supplier to make ready-to-use charges.

The particular setting we analyse involves an input monopolist dealing with two downstream customers that use the input to produce final goods. These downstream firms make relation-specific investments that (stochastically) increase the surplus they can generate when they are allowed to use this input. To avoid inessential modelling complications, we assume throughout that downstream buyers sell their goods in independent markets. In addition, the seller may write *ex ante* an enforceable exclusive-dealing contract with one of the buyers that prohibits the former from dealing with any firm other than the exclusive-rightholder.[4] An alternative way of interpreting exclusivity in this context is to imagine that it specifies a prohibitive compensation that the monopolist must pay to the exclusive buyer in case it trades the input with some other firm. That is, the penalty for breach of contract is so high that if it must be paid it precludes any possible trade between the seller and the nonexclusive buyer.

Following Segal and Whinston (2000), we assume that the exclusive contract can be renegotiated as new information emerges so as to achieve *ex post* efficiency. We make use of their three-player bargaining framework to model this process.

In a setup rather similar to theirs we discover, contrary to one of the main conclusions of that paper, that *in our model exclusivity matters even though noncontractible investments do not exhibit cross-effects or spillovers whatsoever.*[5] *Moreover, our analysis suggests that exclusive-dealing contracts are relevant for investment incentives whenever downstream firms' payoffs are responsive to internal values; that is, whenever a buyer's payoff depends positively on its valuation of the input even in realisations in which it is the lowest-valuing buyer.*[6] Hence, enforceable exclusive trade agreements can encourage the protected firm to make unverifiable specific investments even absent the free-rider considerations that have been stressed in some of the previous literature.

This novel result stems from the fact that the exclusive contract has a negative impact on the unprotected firm's investment incentives, because under exclusivity this firm has zero marginal incentives to invest in the coalition in which it is only matched with the seller (from now on the terms protected/unprotected, exclusive/nonexclusive and contracted/uncontracted will be used indiscriminately to refer to the exclusive-rightholder and the other buyer respectively). As the unprotected buyer invests less, the protected buyer expands (i.e., invests more in equilibrium) because investments are strategic substitutes in this setup, and therefore exclusivity affects the

by GM, completed by 1926, was to mitigate hold-up problems. This has recently been disputed by Casadesus-Masanell and Spulber (2000), Coase (2000) and Freeland (2000) who cite transaction cost savings and coordination benefits. The picture is mixed though. Coase reports that prior to 1926 many plants were owned by GM and leased to Fisher. This suggests that hold-up may have been an issue. In addition, the merger was prompted by the concern of GM that Fisher Brothers "...paid less attention to the needs of General Motors than General Motors would have liked" (Coase, p.23). This indicates that the ownership change was designed to alter incentives.

[4] As pointed out by Hart and Tirole (1990), exclusive dealing may sometimes be unenforceable for either informational or legal reasons. In these cases vertical integration might be preferred to exclusivity. However, the analysis of changes in ownership structures lies outside the scope of this paper.

[5] Recall that in this context investments exhibit *cross-effects* when the surplus generated by the seller and one of the downstream customers is sensitive to the investment level of the other buyer.

[6] It's worth mentioning that although this condition is not innocuous, it is satisfied for instance in many of the standard cooperative bargaining solutions that have been previously used in the literature.

equilibrium investment levels of both downstream buyers. This conclusion challenges some of Segal and Whinston's findings. Indeed, the case of both buyers having investment opportunities, although entirely reasonable, is not directly dealt with in Segal and Whinston's paper, which in drawing conclusions focuses on situations in which only one party makes specific investments.

We also find that under plausible circumstances exclusivity can be efficiency-enhancing and thus represent a welfare improvement with respect to the benchmark nonexclusive solution. In other words, our study indicates that in general exclusive-dealing regimes achieve second-best allocations and are both privately and socially beneficial even when they result in complete foreclosure of the unprotected buyer. This mechanism operates is a subtle way though, because the protected firm will typically be exposed to hold-up in equilibrium. However, when in the alternative nonexclusive equilibria of the game we have that many buyers invest too little, a social planner might strictly prefer allocations in which only one downstream customer invests at a reasonable high level to the alternative less efficient outcomes in which both customers invest at intermediate levels. As the only equilibrium that may survive exclusivity is an asymmetric outcome in which only one customer is active, e.g., invests at a high level, exclusive dealing may be considered as an efficiency-enhancing device in many reasonable cases. We therefore provide a theoretical justification for real world situations such as those mentioned by Holmström and Roberts (1998), which can be considered as a source of puzzlement according to the existing literature on hold up problems.[7]

Rajan and Zingales (1998) is also related to our work. They conclude that when managers' investments are perfect substitutes, granting a single specialised manager access to an input essential for production is more efficient than having two managers working together. Granting access to a single agent is a form of exclusivity, so our conclusion is in some ways similar. The model is though substantially different. First, notice that even though access is also allocated *ex ante,* the concept of *ex post* renegotiation is meaningless in Rajan and Zingales' context; their exclusive contracting directly eliminates one of the managers from the *ex post* bargaining process. Within a firm it is often plausible that a manager must have contact with the firm's assets to make productive investments and access can be credibly denied. This is not so obvious though. When trade is between firms the assumption is less reasonable. Firms are often self contained production units and there is no way a supplier of an input can hamper the technical productivity of a user's investment.[8] With this in mind, we follow Segal and Whinston (2000) in supposing that exclusivity is a purely contractual arrangement that does not impinge in technical productivity. This feature is a key ingredient of our framework, and we discover that in this context exclusive-dealing relationships not only can replicate the equilibrium incentives provided by restricted access, but achieve more efficient allocations when firms' investments are imperfect substitutes. This point is further illustrated in the next sections of the paper and other related issues are discussed in the Conclusion. Secondly, in Rajan and Zingales' case of perfect substitutes, restricting access to a single manager achieves always a second-best outcome because it avoids replication of investment costs. We find to the contrary that when exclusivity matters for investment incentives the protected firm ends up investing more whilst exclusive agreements cannot be characterised as unambiguous efficiency-enhancing mechanisms.

The paper is structured in the following way. Section 2 illustrates the main message of our paper by means of an example. We discuss there some technicalities of our model and describe how

[7] In a rather different setup, McAffe and Schwartz (1994) also find that in multilateral contexts exclusivity can protect customers from *ex post* opportunism. However, their result depends delicately on the fact that downstream firms produce substitute products (perfect or imperfect). We assume instead that these firms don't compete on the product market.

[8] This suggests a theory of the firm; exclusive dealing is a step towards full integration. Our analysis isolates the extra benefits asset ownership makes possible.

exclusive-dealing contracts can both foster noncontractible investments and achieve more efficient equilibria. We also analyse private incentives to create exclusive relationships. Section 3 presents a more general and realistic framework. It establishes the potential existence of multiple Nash equilibria in our setup and characterises the benchmark nonexclusive and first-best outcomes. Then, Section 4 studies the impact of an exclusive-dealing contract on downstream firms' investment incentives and evaluates its potential implications in terms of aggregate welfare. A key Proposition, identified as the "relevance result", points out under which particular circumstances exclusivity matters in our model. This section also includes a brief analysis of exclusive clauses that stipulate penalties for breach of contracts that confirms our previous results, and shows that full exclusivity emerges as a special case of this general formulation. Finally, Section 5 highlights some conclusions.

2 Exclusivity in a simple setting

The purpose of this section is to convey the main messages of the paper in a relatively simple setup; a richer theoretical model is subsequently analysed.

Let us assume that there exists a vertical relationship consisting of an upstream firm, called U, that produces a single unit of an indivisible input at (for simplicity) zero cost, and two downstream firms denoted by D_1 and D_2. The intermediate input is transformed into final goods by the downstream firms on a one-for-one basis at zero marginal cost, and for simplicity we also suppose that final goods are sold in independent markets. Put differently, D_1 and D_2 compete for the provision of the essential input but do not compete on the product markets. All agents are risk-neutral.

The value that a downstream firm generates when it is allowed to use the input is denoted by V_j, $j = 1, 2$, and it depends stochastically on the level of noncontractible specific investment I_j. Both buyers are *ex ante* symmetric. In this simple example investments are discrete and may be either I^H or I^L, where superscripts stand for "high" and "low" respectively. When a firm doesn't invest at all its valuation is zero. In addition, investments can either succeed or fail with probability $\frac{1}{2}$, and to simplify the algebra we further assume that when both firms invest they cannot succeed simultaneously, i.e., successes are mutually exclusive events.[9] So, think for example that downstream firms make investments in order to develop product innovations that increase the value of their respective final products. These innovations though use different technological principles, maybe due to asymmetries in the physical nature of the final goods, and therefore once the best technological trajectory is realised only one of the investments ends up being successful. We assume nevertheless that a high investment level guarantees a minimal improvement in the quality of the final product, in the sense that when a buyer invests at a high level it always exhibits a positive valuation.

More formally, we assume that when a firm invests I^L its possible valuations are either V^L if the investment succeeds or 0 otherwise. In addition, when it invests I^H the possible outcomes are either V^H if the investment succeeds or V^L in case of failure. $V^H \geq V^L > 0$, and the monetary cost of investments are c^H and c^L, with $c^H > c^L > 0$.

The sequence of events is exhibited in Figure 1. At date 1 both downstream firms invest, then the state of the world is revealed and afterwards the three parties bargain over the allocation of the input and the price to be paid. Notice that the seller might write *ex ante,* at date 0, an exclusive-dealing contract with one of the buyers, D_1 say, giving this downstream firm exclusive rights over trade with U. We suppose that this contract is "incomplete" though, in the sense that it cannot specify in advance a positive trade between these two parties, e.g., the nature of this

[9] The results do not require this extreme assumption.

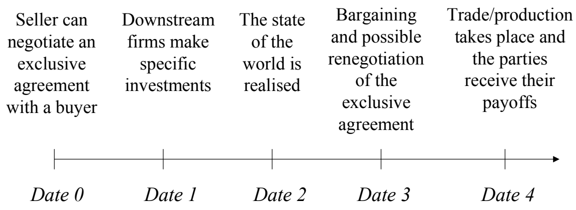

Figure 1: Sequence of events

trade is too complex to be specified in an enforceable contract. This exclusive relationship may nevertheless be renegotiated after the state of the world is realised if it turns out that D_2 is the highest-valuing buyer and hence trading with D_2 is efficient. All relevant variables are observed by the agents.

For illustrative purposes, we shall adopt here the *Shapley* value as the solution concept of the three-player bargaining process. In fact, this solution emerges as a special case of the more general framework discussed in the next section. Recall that the *Shapley* value of a player is his expected contribution to all the possible coalitions he can join. So, let us denote by $\Omega = [\{U, D_1\}, \{U, D_2\}, \{D_1, D_2\}, \{U, D_1, D_2\}]$ the set of possible coalitions with at least two players that can be formed in this game. We further assume that if the agents do not reach an agreement on trade then all payoffs are zero.

Clearly, this simple model presents hold-up problems. However, we abstract from these considerations for the moment in order to focus our attention on other implications of this example that will resurface repeatedly throughout the paper. Since exclusivity is contractible, the upstream firm cares about *ex ante* efficiency. Therefore, we first restrict ourselves to the analysis of downstream firms' investment incentives, and in the next subsection we shall investigate the seller's incentives to sign an exclusive trade agreement.

We start by analysing the outcome in the absence of an exclusive-dealing contract. Letting Π_Ω stand for the *gross* surplus achieved through an efficient trade among the members of coalition Ω, and noticing that $\Pi_{D_1 D_2} = 0$, we have that the parties' payoffs are in this case given by

$$\pi_U = \frac{1}{3}\Pi_{UD_1D_2} + \frac{1}{6}\Pi_{UD_1} + \frac{1}{6}\Pi_{UD_2} \quad (1)$$

$$\pi_1 = \frac{1}{3}\left[\Pi_{UD_1D_2} - \Pi_{UD_2}\right] + \frac{1}{6}\Pi_{UD_1} \quad (2)$$

$$\pi_2 = \frac{1}{3}\left[\Pi_{UD_1D_2} - \Pi_{UD_1}\right] + \frac{1}{6}\Pi_{UD_2} \quad (3)$$

for the upstream firm, D_1 and D_2 respectively. It is worth explaining briefly how these payoffs arise, because the more general bargaining solution considered in subsequent sections rests on analogous principles. As an illustration, consider investments (I^H, I^L). In this case, the possible valuations are either $(V^H, 0)$, when D_1's investment succeeds and D_2's fails, or (V^L, V^L) when D_1's investment fails and D_2's succeeds. Each of these possible outcomes occurs with probability $\frac{1}{2}$. Hence, using equations (2) and (3) , we can write downstream firms' expected payoffs as

$$\begin{aligned}
\pi_1(I^H, I^L) &= \frac{1}{2}\left[\frac{1}{3}V^H + \frac{1}{6}V^H\right] + \frac{1}{2}\left[\frac{1}{6}V^L\right] = \frac{1}{2}\left[\frac{V^H}{2} + \frac{V^L}{6}\right] \\
\pi_2(I^H, I^L) &= \frac{1}{2}\left[\frac{V^L}{6}\right] = \frac{V^L}{12}
\end{aligned}$$

The same methodology may be used to derive downstream buyers' payoffs for the other possible investment levels.

If U writes *ex ante* an exclusive-dealing contract with D_1, the members of any possible coalition may only agree to a positive trade if D_1 is a member. In other words, $\Pi_\Omega = 0$ whenever $D_1 \notin \Omega$. Therefore, the parties' payoffs are now:

$$\pi_U^e = \frac{1}{3}\Pi_{UD_1D_2} + \frac{1}{6}\Pi_{UD_1} \tag{4}$$

$$\pi_1^e = \frac{1}{3}\Pi_{UD_1D_2} + \frac{1}{6}\Pi_{UD_1} \tag{5}$$

$$\pi_2^e = \frac{1}{3}\left[\Pi_{UD_1D_2} - \Pi_{UD_1}\right] \tag{6}$$

We proceed now to evaluate the effects of exclusivity on investment incentives. As usual, a downstream firm's investment decision consists on choosing I_j, $j = 1, 2$, to maximise $\pi_j - c$ and $\pi_j^e - c$ in the absence and in the presence of an exclusive-dealing contract respectively.

This simple investment game can generally give rise to multiple Nash equilibria (in pure-strategy). To illustrate this point and make our case more clear, we focus throughout on situations in which both the symmetric allocation (I^L, I^L) and the asymmetric allocations $(I^H, 0)/(0, I^H)$ represent nonexclusive Nash equilibria of the game; Figure 2 provides the equilibrium constraints for these two cases.

Clearly, these equilibrium configurations will in general differ in terms of total welfare. It might well be the case that *net* aggregate surplus is maximised in the (asymmetric) allocations in which a single buyer is active, i.e., invests at a high level. This is actually what happens when the additional conditions $\frac{V^H+V^L}{2} > c^H > \frac{V^H-V^L}{2}$ and $c^H - 2c^L < \frac{V^H-V^L}{2}$ hold. Therefore, an exclusive-dealing contract, if it affects investment incentives at all, might have the desirable property of eliminating less efficient equilibria in which both buyers invest at low levels, thus enabling more beneficial realisations to potentially emerge. For example, if the first-best outcome is achieved at investment levels $(I^H, 0)$ but the vertical structure can potentially be stuck in the "bad" equilibrium (I^L, I^L), the existence of an exclusive trade agreement might affect downstream firms' investment incentives in such a way that only the more efficient allocation survives exclusivity. In these cases, exclusive regimes achieve efficiency improvements with respect to the benchmark nonexclusive solutions. As will be shown in subsequent sections, this simple and intuitive message of our paper transfers to more sophisticated models.

To clinch the point we provide a numerical example. In particular, suppose that $V^H = 15$, $V^L = 12$, $c^H = 6.2$ and $c^L = 2.5$. As $13.5 > c^H > 1.5$ and $c^H - 2c^L = 1.2 < 1.5$, the asymmetric solution $(I^H, 0)$ achieves the first-best outcome. Using the equilibrium constraints given in Figure

Potential Nash equilibrium	Equilibrium constraints when there isn't an exclusive-dealing contract	Equilibrium constraints when there is an exclusive-dealing contract
$I_1 = I_2 = I^L$	$c^L < \frac{V^L}{4}$ $c^H - c^L > \frac{V^H}{2} - \frac{V^L}{3}$	$c^L < \frac{V^L}{6}$ $c^H - c^L > \frac{1}{2}\left(\frac{V^H}{2} - \frac{V^L}{3}\right)$
$I_1 = I^H, I_2 = 0$ $I_1 = 0, I_2 = I^H$	$c^L > \frac{V^L}{12}$ $\frac{1}{4}\left(V^H + V^L\right) > c^H > \frac{1}{2}\left(\frac{V^H}{2} - \frac{V^L}{6}\right)$ $c^H - c^L < \frac{V^H}{4}$	$c^L > 0$ $\frac{1}{4}\left(V^H + V^L\right) > c^H > \frac{1}{6}\left(V^H - V^L\right)$ $c^H - c^L < \frac{V^H}{4}$

Figure 2: Nash equilibria in a simple investment game

2, we may conclude that both (I^L, I^L) and $(I^H, 0)/(0, I^H)$ are nonexclusive equilibria of this game. However, the first-best allocation $(I^H, 0)$ is the only equilibrium that survives the creation of an exclusive relationship between U and D_1.[10] This is due to the fact once we take exclusivity on board, it is no longer profitable for the uncontracted buyer to invest I^L, and the expansion of the contracted buyer means the nonexclusive firm finds now profitable to directly stop investing.[11] Therefore, an exclusive-dealing contract encourages the contracted firm's specific investments and, at the same time, achieves the first-best outcome.

The achievement of the first-best allocation depends heavily on the assumed discreteness in investment choices. What we want to emphasise is the more general result that exclusivity may eliminate inefficient equilibria in which too many firms invest too little when it would be more efficient if only one firm invests at a reasonable high level. This is a desirable property of exclusive-dealing contracts that is not recognised in the existing literature.

2.1 Private incentives to create exclusive trade agreements

The foregoing analysis implicitly assumes that if exclusivity augments aggregate surplus, it will be adopted. Here it is made more precise why this is plausible.

We briefly analyse a simple mechanism by which the exclusive-dealing contract may be sold at date 0 as well as the seller's incentives to enter into an exclusive trade agreement with one of the downstream buyers. We discover in this context that exclusivity creates an additional instrument which allows the seller easily to capture surplus generated by the vertical relationship.

[10] Since $c^L > \frac{V^L}{6} = 2$, the allocation $\left(I^L, I^L\right)$ is no longer an exclusive equilibrium of the game.

[11] Notice that the creation of an exclusive-dealing relationship discourages entry, as in Aghion and Bolton (1987), but in our model this is desirable.

For simplicity, we continue supposing throughout this subsection that both the symmetric allocation (I^L, I^L) and the asymmetric allocations $(I^H, 0)/(0, I^H)$ are nonexclusive Nash equilibria of the game, but that only the asymmetric outcomes survive exclusivity.

In order to proceed, let us assume that the seller organises an English auction in which downstream firms are allowed to publicly "bid" for the exclusive right over trade with him.[12] Even though one can of course imagine other ways in which the contract might be sold, the proposed mechanism is a simple and natural formulation. In equilibrium, we must hence have that:

$$\pi_1^e(I^H, 0) - c^H - p_1^e = \pi_2^e(0, I^H) - c^H - p_2^e = 0$$

where p_j^e is D_j's equilibrium bid. This condition simply says that the potentially exclusive buyers bid exactly the expected *net* revenue of the protected firm in the unique exclusive equilibrium of the game, because otherwise one of the buyers could slightly increase his bid and thus get the exclusive-dealing contract. By symmetry, we have that the equilibrium price of the exclusive contract is given by $p^e (= p_1^e = p_2^e) = \pi_1^e(I^H, 0) - c^H$, and therefore the expected net revenue of both the protected and unprotected firm is zero. Let's assume, without loss of generality, that D_1 gets the exclusive rights over trade with U.

Without further assumptions, it is difficult to say when an exclusive regime will actually arise. However, notice that the upstream firm will be interested in selling an exclusive-dealing contract only if:

$$p^e + \pi_U^e(I^H, 0) = \pi_1^e(I^H, 0) + \pi_U^e(I^H, 0) - c^H \geq \min\left[\pi_U(I^L, I^L),\ \pi_U(I^H, 0)\right]$$

In words, this means that U will never consider entering into an exclusive trade agreement with one of the buyers unless its expected payoff when doing so is at least equal to its lowest payoff among the possible nonexclusive equilibria of the game. This is only a necessary condition for exclusivity to emerge in this setting. Under our previous assumptions, a sufficient condition is given by:

$$p^e + \pi_U^e(I^H, 0) = \pi_1^e(I^H, 0) + \pi_U^e(I^H, 0) - c^H \geq \max\left[\pi_U(I^L, I^L),\ \pi_U(I^H, 0)\right]$$

Notice therefore that by selling an exclusive contract the upstream firm is able to appropriate the entire *net* surplus generated in the asymmetric exclusive equilibrium. It follows from this property that whenever aggregate surplus is maximised at the allocation $(I^H, 0)$, the seller will choose to write an exclusive-dealing contract with one of the buyers and exclusivity will achieve the first-best outcome. The converse is not true however. Since by signing an exclusive agreement the seller is able to extract additional rents from the buyers, these distributional effects make the contract attractive even absent the efficiency-enhancing effects of exclusivity.[13]

3 A more general model

In this section we generalise the simple setup discussed before in order to study the effects of exclusivity when the investment function of downstream firms is continuous. We also consider a richer bargaining framework.

[12] Bernheim and Whinston (1998) consider related issues. In that paper, two manufacturers simultaneously bid for representation by a retailer. There are no specific investments in the model. Additionally, in their exclusive equilibrium there are asymmetries between both manufacturers and the retailer ends up serving only the most efficient one. In our model, there is an exclusive equilibrium even though downstream firms are *ex ante* symmetric.

[13] Aghion and Bolton (1987) also note that the seller might have socially excessive incentives to use exclusive trade agreements.

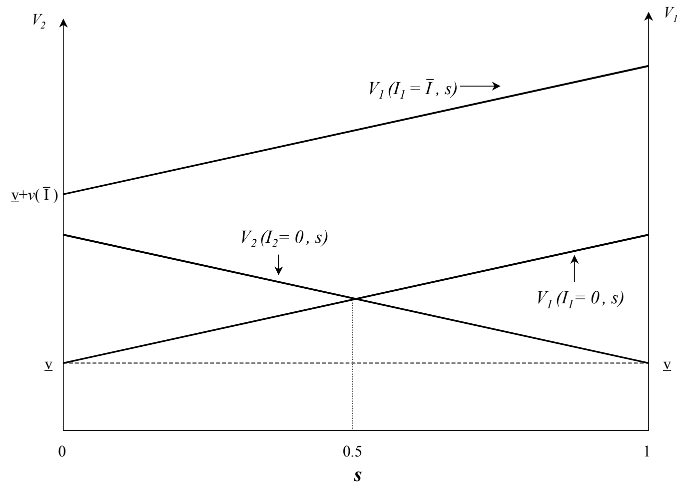

Figure 3: Relationship between downstream firms' valuations

Each final consumer desires at most one unit of D_j's output and has an observable net valuation of the good that is randomly related to the level of D_j's relation-specific investment, according to the following functional forms:

$$V_1(I_1, s) = \underline{v} + v(I_1) + s \quad (7)$$

$$V_2(I_2, s) = \underline{v} + v(I_2) + (1 - s) \quad (8)$$

where $I_j \in [0, \bar{I}]$, $\bar{I} < +\infty$, is the (noncontractible) effort level, $v(\cdot)$ is an increasing strictly concave function, $\underline{v} \geq 0$ and $s \sim U[0, 1]$ is a continuous random variable with probability density function given by $f(s)$. This formulation, which is a special case of Bolton and Whinston (1993), involves perfect negative correlation between both downstream firms' valuations (see Figure 3). Perhaps D_1 is an indoor restaurant and D_2 an outdoor restaurant, and s is the weather. As in the example of the previous section, investment by U is unproductive. Note in addition that V_j depends only on D_j's investment choice; so, in this framework investments have no cross-effects or spillovers. The monetary equivalent cost of the effort level exerted by D_j is given by the increasing strictly convex function $c(I_j)$. We further assume that $c(0) = v(0) = 0$ and $0 < c'(0) < v'(0)$.

In the absence of an exclusive-dealing contract, the sequence of events is that downstream firms make simultaneous observable but noncontractible investment choices, then the state of the world is revealed and afterwards the three firms bargain over whether D_1 or D_2 gets the input and the price to be paid (see Figure 1). There are no liquidity constraints and all firms are risk-neutral. We adopt Segal and Whinston's (2000) (hereinafter SW) three-party bargaining solution. This guarantees efficiency, so the highest-valuing buyer always receives the input. In addition, each player captures *ex post* a payoff that is a linear function of that player's marginal contributions to the various possible coalitions of which he can be a member. One of the appealing features of their cooperative model is that it encompasses as special cases both cooperative and noncooperative bargaining solutions that have been previously used in the literature. Later on, we shall see that in our setting this bargaining solution does give rise to some peculiar implications.

The possible coalitions Ω containing at least two players that can be formed in this game are $\{U, D_1\}$, $\{U, D_2\}$, $\{D_1, D_2\}$ and $\{U, D_1, D_2\}$. Let's simplify things by assuming that if the agents do not reach an agreement on trade then each of them ends up with zero. Then, let Π_Ω define the surplus that can be achieved *ex post* through an efficient trade agreement among the members of coalition Ω, noticing that $\Pi_{D_1 D_2} = 0$ because the buyers cannot produce unless U, the owner of this input, is a member of a coalition. We denote by $M_j^\Omega = \Pi_{\Omega \cup j} - \Pi_\Omega$, $j \in \{U, D_1, D_2\}$, agent $j's$ marginal contribution to coalition Ω and, following the definition in SW, we assume that agent $j's$ bargaining payoff is a nonnegatively weighted linear combination of his marginal contributions M_j^Ω to the different coalitions that can potentially be formed.

Letting π_j stand for agent j's expected payoff, and bearing in mind that $\Pi_\Omega = \Pi_j = 0$ for all $j \in \{U, D_1, D_2\}$ and $\Omega = \{D_1, D_2\}$, we have that

$$\begin{aligned}
\pi_U &= \alpha_U^{D_1 D_2} M_U^{D_1 D_2} + \alpha_U^{D_1} M_U^{D_1} + \alpha_U^{D_2} M_U^{D_2} = \alpha_U^{D_1 D_2} \Pi_{U D_1 D_2} + \alpha_U^{D_1} \Pi_{U D_1} + \alpha_U^{D_2} \Pi_{U D_2} &(9)\\
\pi_1 &= \alpha_{D_1}^{U D_2} M_{D_1}^{U D_2} + \alpha_{D_1}^{U} M_{D_1}^{U} + \alpha_{D_1}^{D_2} M_{D_1}^{D_2} = \alpha_{D_1}^{U D_2} [\Pi_{U D_1 D_2} - \Pi_{U D_2}] + \alpha_{D_1}^{U} \Pi_{U D_1} &(10)\\
\pi_2 &= \alpha_{D_2}^{U D_1} M_{D_2}^{U D_1} + \alpha_{D_2}^{U} M_{D_2}^{U} + \alpha_{D_2}^{D_1} M_{D_2}^{D_1} = \alpha_{D_2}^{U D_1} [\Pi_{U D_1 D_2} - \Pi_{U D_1}] + \alpha_{D_2}^{U} \Pi_{U D_2} &(11)
\end{aligned}$$

for the upstream firm, D_1 and D_2 respectively. The constants α_j^Ω are the agent j's weighting parameters that determine his bargaining power. As mentioned above, the *Shapley* values used in the previous section emerge as special cases of this more general formulation, i.e., $\alpha_{D_1}^{UD_2} = \alpha_{D_2}^{UD_1} = \frac{1}{3}$ and $\alpha_{D_1}^{U} = \alpha_{D_2}^{U} = \frac{1}{6}$. Since aggregate payoffs should equal $\Pi_{UD_1D_2}$, the surplus generated by the grand coalition of all agents, the parameters α_j^Ω must also satisfy the following adding-up restrictions:

$$\alpha_U^{D_1 D_2} + \alpha_{D_1}^{U D_2} + \alpha_{D_2}^{U D_1} = 1, \qquad \alpha_U^{D_1} + \alpha_{D_1}^{U} = \alpha_{D_2}^{U D_1}, \text{ and } \qquad \alpha_U^{D_2} + \alpha_{D_2}^{U} = \alpha_{D_1}^{U D_2} \qquad (12)$$

In order to calculate the surplus generated by every possible coalition that may be formed in this game, we first define the states of the world in which D_1 is the high-value buyer given investments $I_1 \times I_2$. The probability of D_1 being the high-value buyer is given by

$$\begin{aligned}
\omega &= \Pr[V_1 \geq V_2] = \Pr[\underline{v} + v(I_1) + s \geq \underline{v} + v(I_2) + 1 - s]\\
&= \Pr\left\{ s \geq \frac{1}{2}[v(I_2) - v(I_1) + 1] \right\} &(13)
\end{aligned}$$

Hence, D_1 will be the favoured buyer in those realisations of s that belong to the subset $s_1 = \left\{s : s \geq \frac{1}{2}[v(I_2) - v(I_1) + 1]\right\}$. Notice that this set might be empty. For notational convenience, let us define $\rho = v(I_2) - v(I_1) + 1$. Expression (13) and our definition of the random variable s imply that we need to consider three possible cases. First, when $\rho \leq 0$ we have that $\Pi_{UD_1D_2} = \Pi_{UD_1}$ always, because V_1 is greater than or equal to V_2 in all possible states of the world. Secondly, when $\rho \geq 2$ we have instead that $\Pi_{UD_1D_2} = \Pi_{UD_2}$, because now V_2 is greater than or equal to V_1 in all the possible realisations, that is, the subset s_1 is empty. Finally, when $0 < \rho < 2$, V_1 is greater than or equal to V_2 in some states of the world and V_1 is smaller than V_2 in others. More precisely, in the states of nature $s \in \left[0, \frac{\rho}{2}\right]$ the condition $\Pi_{UD_1D_2} = \Pi_{UD_2}$ holds, whereas in the realisations $s \in \left[\frac{\rho}{2}, 1\right]$ we have $\Pi_{UD_1D_2} = \Pi_{UD_1}$.

The previous conditions, together with equations (7) and (8), allow us to write downstream firms' expected payoffs in the following way

$$\begin{aligned}
\pi_1 &= \int_0^{\frac{\rho}{2}} \alpha_{D_1}^{U} V_1 f(s)ds + \int_{\frac{\rho}{2}}^{1} \left[\alpha_{D_1}^{UD_2}(V_1 - V_2) + \alpha_{D_1}^{U} V_1\right] f(s)ds && (14)\\
&= \alpha_{D_1}^{U}\left[\underline{v} + v(I_1) + \frac{1}{2}\right] + \alpha_{D_1}^{UD_2}\left[v(I_1) - v(I_2) + \frac{\rho^2}{4}\right] \qquad if\ 0 < \rho < 2 && (15)\\
&= \alpha_{D_1}^{U}\left[\underline{v} + v(I_1) + \frac{1}{2}\right] + \alpha_{D_1}^{UD_2}\left[v(I_1) - v(I_2)\right] \qquad if\ \rho \leq 0 && (16)\\
&= \alpha_{D_1}^{U}\left[\underline{v} + v(I_1)\right] \qquad otherwise && (17)
\end{aligned}$$

$$\begin{aligned}
\pi_2 &= \int_0^{\frac{\rho}{2}} \left[\alpha_{D_2}^{UD_1}(V_2 - V_1) + \alpha_{D_2}^{U} V_2\right] f(s)ds + \int_{\frac{\rho}{2}}^{1} \alpha_{D_2}^{U} V_2\ f(s)ds && (18)\\
&= \alpha_{D_2}^{U}\left[\underline{v} + v(I_2) + \frac{1}{2}\right] + \alpha_{D_2}^{UD_1}\frac{\rho^2}{4} \qquad if\ 0 < \rho < 2 && (19)\\
&= \alpha_{D_2}^{U}\left[\underline{v} + v(I_2)\right] \qquad if\ \rho \leq 0 && (20)\\
&= \alpha_{D_2}^{U}\left[\underline{v} + v(I_2) + \frac{1}{2}\right] + \alpha_{D_2}^{UD_1}\left[v(I_2) - v(I_1)\right] \qquad otherwise && (21)
\end{aligned}$$

Notice that these payoffs present a discontinuity at $\rho = 2$ and $\rho = 0$ respectively. As equations (14) and (18)are clearly symmetric, we shall briefly explain how it was constructed for D_1 only. The first term in equation (14) stems from the fact that in the subset $s \in \left[0, \frac{\rho}{2}\right]$ D_2 is the highest-valuing buyer (i.e., $\Pi_{UD_1D_2} = \Pi_{UD_2}$) and therefore, according to (10), D_1 only receives a share $\alpha_{D_1}^{U}$ of its own valuation in the bargaining process. In respect to the second term, we have that in the remaining states of the world, that is in the subset $s \in \left[\frac{\rho}{2}, 1\right]$, D_1 is the high-value buyer (i.e., $\Pi_{UD_1D_2} = \Pi_{UD_1}$) and now this firm receives a share $\left(\alpha_{D_1}^{UD_2} + \alpha_{D_1}^{U}\right)$ of V_1 but also looses $\alpha_{D_1}^{UD_2} V_2$ in the *ex post* bargaining. Similar arguments apply for D_2's payoff.

Given the *ex ante* symmetry of the buyers, it seems reasonable to make the following assumptions regarding the weighting parameters of the payoff functions.

Assumption 1. $\alpha_U^{D_1} = \alpha_U^{D_2} = \alpha_U^{D} \geq 0$, $\alpha_{D_1}^{U} = \alpha_{D_2}^{U} = \alpha_D^{U} \geq 0$ and $\alpha_U^{D} + \alpha_D^{U} > 0$.

Assumption 1 thus implies that the seller's share of its marginal contribution when paired with a downstream buyer is independent of the identity of the latter, and that downstream firms' receive similar shares of their respective marginal contributions when paired with U. Our assumption also implies that $\alpha_{D_1}^{UD_2} > 0$ and $\alpha_{D_2}^{UD_1} > 0$. After introducing these restrictions into equation (12), we may deduce the following:

$$\alpha_{D_2}^{UD_1} = \alpha_{D_1}^{UD_2} > 0, \qquad \alpha_U^{D_1D_2} = 1 - 2\alpha_{D_2}^{UD_1}, \qquad 2\alpha_U^{D} + 2\alpha_D^{U} = 1 - \alpha_U^{D_1D_2} \leq 1 \tag{22}$$

Next, we use equations (14)-(21) to analyse D_j's *ex ante* investment incentives. We provide them in detail only for D_1 because the case of D_2 is symmetric and will therefore be omitted. At date 1, each risk-neutral buyer chooses his or her investment level to maximise expected profits, $E\Pi_j = \pi_j - c(I_j)$, taking as given the investment level of the rival. In equilibrium, D_1 will equalise $c'(I_1)$ to

$$\begin{aligned} \frac{v'(I_1)}{2}\left\{\left(\alpha_U^D+\alpha_D^U\right)[v(I_1)-v(I_2)+1]+2\alpha_D^U\right\} \quad & if\ 0 < \rho < 2 & (23)\\ v'(I_1)\left(\alpha_U^D+2\alpha_D^U\right) \quad & if\ \rho \leq 0 & (24)\\ v'(I_1)\alpha_D^U \quad & if\ \rho \geq 2 & (25)\end{aligned}$$

depending on the value of $\rho = v(I_2) - v(I_1) + 1$. Assume that second-order conditions are satisfied.

Then we claim that, as in the example of the previous section, this more general investment game can in general give rise to multiple Nash equilibria. To explain in the simplest setting why this may happen we shall focus on pure-strategy equilibria.

First, we partition the space of feasible investments $I_1 \times I_2$ into two regions, which we call

$$\begin{aligned} B_1 &= \{I_1, I_2 : \rho \leq 0\}\\ B_2 &= \{I_1, I_2 : \rho \geq 2\}\end{aligned}$$

Hence, region B_j, $j = 1, 2$, corresponds to the one where D_j is the high-value buyer in all the possible realisations of s and therefore always ends up using the input. On the other hand, in the space between regions B_1 and B_2 either firm may receive the input in some nonempty subset $s_j \subset s$.

Using the payoffs derived above, i.e., equations 14-21, we then proceed to study D_1's optimal investment choice (a similar argument applies for D_2). In Figures 4 and 5, $b_j(I_i)$ denotes buyer j's best response function to investment level I_i. For example, inside regions B_1 and B_2, D_1's best response functions are given by

$$\begin{aligned} I_1^{B_1} &\equiv \arg\max_{I_1}\left\{\alpha_D^U\left[\underline{v}+v(I_1)+\frac{1}{2}\right]+\alpha_{D_1}^{UD_2}[v(I_1)-v(I_2)]-c(I_1)\right\}\\ I_1^{B_2} &\equiv \arg\max_{I_1}\left\{\alpha_D^U\left[\underline{v}+v(I_1)\right]\right\}\end{aligned}$$

respectively. Notice that these best response functions do not depend on I_2. In addition, between those two regions, that is where $0 < \rho < 2$, D_1's best response function takes the form

$$I_1^i(I_2) \equiv \arg\max_{I_1}\left\{\alpha_D^U\left[\underline{v}+v(I_1)+\frac{1}{2}\right]+\alpha_{D_1}^{UD_2}\left[v(I_1)-v(I_2)+\frac{\rho^2}{4}\right]-c(I_1)\right\} \quad (26)$$

where the superscript i stands for "interior". Since Assumption 1 implies that $\alpha_{D_1}^{UD_2} > 0$, $I_1^i(I_2)$ does depend on I_2.

We can now start our characterisation of the possible Nash equilibria of this game. First, let I^i denote the optimal investment choice of a downstream firm in any interior equilibrium of the game in which both buyers invest positive amounts. Using equation (26), we may conclude that this investment level satisfies the condition $\frac{v'(I^i)}{2}\left(3\alpha_D^U+\alpha_U^D\right) - c'(I^i) = 0$[14], which implies that both

[14] Notice that given our previous assumptions regarding the functions $v(\cdot)$ and $c(\cdot)$, second-order conditions are automatically satisfied.

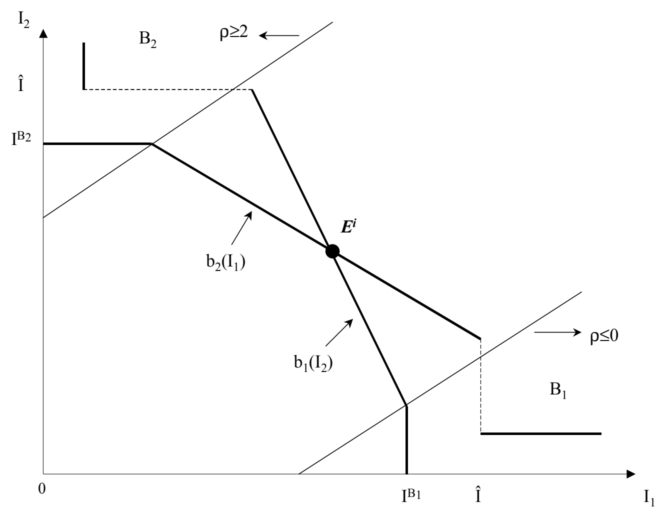

Figure 4: Unique interior equilibrium in the absence of exclusive dealing

buyers expect to receive the input in the same number of states and that their expected profits are given by $E\Pi_j = \alpha_D^U \left[\underline{v} + v(I^i) + \frac{1}{2}\right] + \frac{(\alpha_D^U + \alpha_U^D)}{4} - c(I^i)$.

Secondly, notice that in the space between regions B_1 and B_2, the best response function $b_j(I_i)$ might present a discontinuity at some investment level $\hat{I}_i$ of D_j's rival (see Figures 4 and 5).[15] More formally, investment levels $\hat{I}_i$, $i = 1, 2$, solve the following equations

$$\alpha_D^U \left\{ v\left[I_1^i(\hat{I}_2)\right] + \frac{1}{2} \right\} + \alpha_{D_1}^{UD_2} \left\{ v\left[I_1^i(\hat{I}_2)\right] - v(\hat{I}_2) + \frac{\left[\rho(I_1^i, \hat{I}_2)\right]^2}{4} \right\} - c\left[I_1^i(\hat{I}_2)\right] = \alpha_D^U \left[v(I_1^{B_2})\right] - c(I_1^{B_2}),$$

$$\alpha_D^U \left\{ v\left[I_2^i(\hat{I}_1)\right] + \frac{1}{2} \right\} + \alpha_{D_1}^{UD_2} \frac{\left[\rho(\hat{I}_1, I_2^i)\right]^2}{4} - c\left[I_2^i(\hat{I}_1)\right] = \alpha_D^U \left[v(I_2^{B_1})\right] - c(I_2^{B_1})$$

for D_1 and D_2 respectively. In other words, when D_2 invests $\hat{I}_2$, D_1 is indifferent between investing $I_1^i(\hat{I}_2)$ and $I_1^{B_2}$ because both investment levels generate similar profits given D_2's strategy. Without loss of generality, we shall assume that in this case D_1 chooses $I_1^i(\hat{I}_2)$.

It should be clear from our previous discussion and Figures 4 and 5 that two equilibrium configurations may typically arise in the case under consideration. In particular, the potential existence of both *interior* and *corner-type* equilibria in this investment game will delicately depend upon the relative locations of investment levels $\hat{I}$ and $I_j^{B_j}$. When $\hat{I} \geq I_j^{B_j}$, as in Figure 4, best response

[15] This value may not exist, in which case the game will only have, if any, an interior equilibrium.

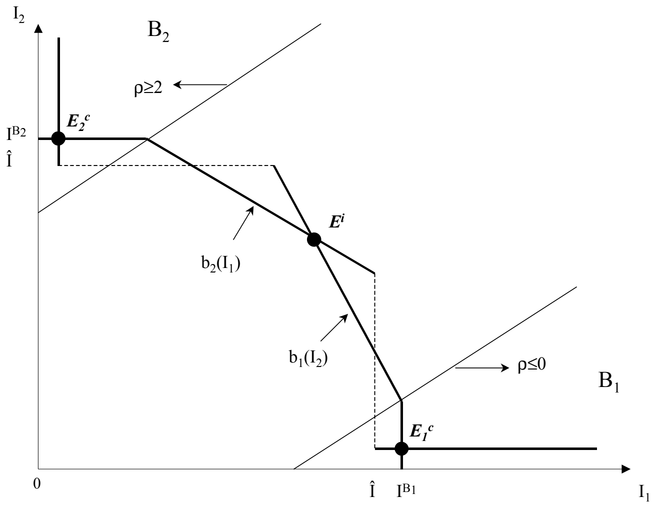

Figure 5: Multiple equilibria in the absence of exclusive dealing

functions don't cross inside regions B_j and therefore only an interior (symmetric) equilibrium E^i may exist. However, when $\hat{I} < I_j^{B_j}$, as in Figure 5, best response functions may in general cross not only in the space between regions B_1 and B_2 but also inside those two regions, and the game gives rise to an interior (symmetric) and two corner-type (asymmetric) equilibria. These three possible equilibria are denoted by E^i and E_j^c, $j = 1, 2$, respectively in Figure 5.

The next proposition summarises our previous discussion, where w.l.o.g. we again focus on D_1 only.

Proposition 1 *(Existence of multiple Nash equilibria) Suppose that there exists at least one pure-strategy Nash equilibrium in the game. Then, if*

$$\begin{aligned} & \alpha_D^U \left\{ v\left[I_1^i(I_2^{B_2})\right] + \frac{1}{2} \right\} + \alpha_{D_1}^{UD_2} \left\{ v\left[I_1^i(I_2^{B_2})\right] - v(I_2^{B_2}) + \frac{\left[\rho(I_1^i, I_2^{B_2})\right]^2}{4} \right\} - c\left[I_1^i(I_2^{B_2})\right] \\ \geq \; & \alpha_D^U \left[v(I_1^{B_2})\right] - c(I_1^{B_2}) \end{aligned}$$

only an interior Nash equilibrium may exist in which both downstream firms invest at the same level I^i. However, if

$$\begin{aligned} & \alpha_D^U \left\{ v\left[I_1^i(I_2^{B_2})\right] + \frac{1}{2} \right\} + \alpha_{D_1}^{UD_2} \left\{ v\left[I_1^i(I_2^{B_2})\right] - v(I_2^{B_2}) + \frac{\left[\rho(I_1^i, I_2^{B_2})\right]^2}{4} \right\} - c\left[I_1^i(I_2^{B_2})\right] \\ < \; & \alpha_D^U \left[v(I_1^{B_2})\right] - c(I_1^{B_2}) \end{aligned}$$

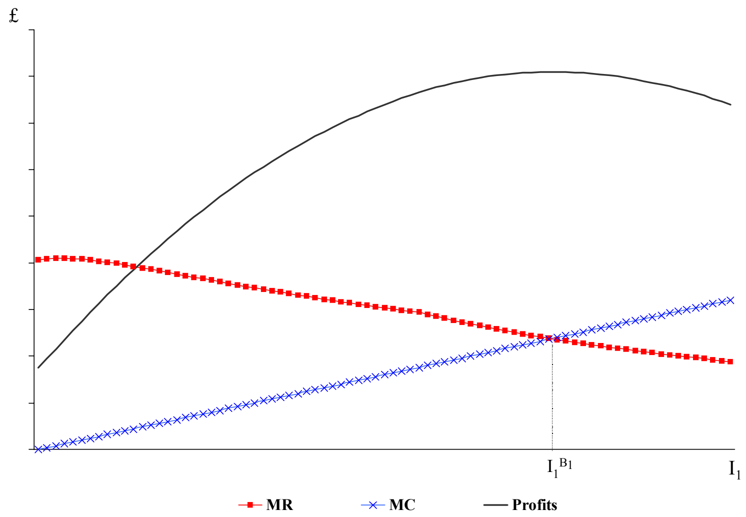

Figure 6: D_1's optimal reply given $I_2^{B_1}$.

the game may have an interior (symmetric) and two corner-type (asymmetric) Nash equilibria.

Proof. Suppose that the first inequality holds. Then, by continuity of the best response functions in the space between areas B_1 and B_2 and up to $\hat{I}$, we have that $\hat{I}_2 \geq I_2^{B_2}$ and therefore best response functions can cross only once. This crossing point determines a unique interior (symmetric) Nash equilibrium. On the other hand, when the second inequality holds we have that $\hat{I}_2 < I_2^{B_2}$ and, by similar arguments, best response functions may cross at most three times. These three crossing points determine an interior (symmetric) and two corner-type (asymmetric) equilibria of the game. ■

Figures 6 and 7 illustrate more intuitively the buyers' optimal investment choices in a hypothetical corner-type equilibrium E_1^c. In the former Figure we see that, given D_2's equilibrium strategy, D_1 maximises profits investing $I_1^{B_1}$. Then, according to Figure 7, D_2 is also adopting an optimal reply. Given that D_1 invests $I_1^{B_1}$, D_2 maximises profits by investing exactly $I_2^{B_1}$.[16] So, we conclude that the potential multiplicity of equilibria already identified in the simple example of Section 2 carries over to this extended and richer formulation of the model.

3.1 First-best allocations

In this subsection we turn to the analysis of aggregate surplus with the aim of determining whether the possible equilibria identified in the previous subsection can be ranked in terms of global efficiency. We therefore replicate the problem of a social planner that picks investment levels (I_1, I_2)

[16] The slight jump in D_2's profits stems from the discontinuity in its payoff function referred to above.

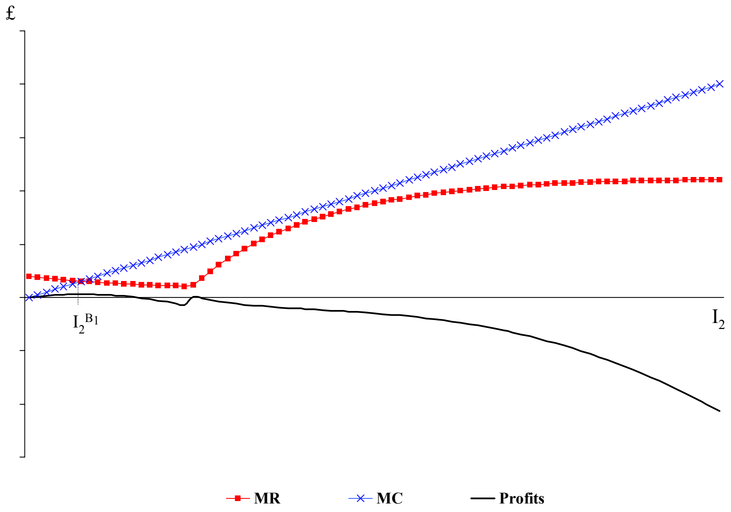

Figure 7: D_2's optimal reply given $I_1^{B_1}$.

to maximise *net* aggregate welfare subject to some constraints. That is, the social planner solves the following problem

$$\begin{aligned} \max_{I_1, I_2} W &= \int_0^{\frac{\varrho}{2}} V_2 f(s) ds + \int_{\frac{\varrho}{2}}^1 V_1 f(s) ds - \sum_{j=1,2} c(I_j) \\ \text{subject to } I_j &\geq 0, \ j = 1, 2 \end{aligned} \tag{27}$$

After writing the respective Kuhn-Tucker Lagrangian, the first-order conditions of this problem are given by

$$\int_0^{\frac{\varrho}{2}} v'(I_2) f(s) ds - c'(I_2) \leq 0 \tag{28}$$

$$\int_{\frac{\varrho}{2}}^1 v'(I_1) f(s) ds - c'(I_1) \leq 0 \tag{29}$$

$$\left[\int_0^{\frac{\varrho}{2}} v'(I_2) f(s) ds - c'(I_2) \right] I_2 = 0 \tag{30}$$

$$\left[\int_{\frac{\varrho}{2}}^1 v'(I_1) f(s) ds - c'(I_1) \right] I_1 = 0 \tag{31}$$

Assume that the Hessian matrix of second derivatives is negative definite at the optimal investment choices. It is worth pointing out that the first terms on the left-hand sides of equations (28) and (29) give the *gross* marginal change in social welfare from a marginal change in I_j, $j = 1, 2$. Clearly, if a global maximum occurs when both downstream buyers invest, then those two terms are similar and equal the respective marginal costs, i.e., equalities hold in equations 28 and 29. This situation characterises an interior (symmetric) first-best solution. However, a global maximum may also occur at a corner solution in which a single downstream firm invests at a high level, in which case one of the inequality constraints of equation (27) must be binding, that is, $I_j^* > 0$ and $I_i^* = 0$, $i, j = 1, 2$, $i \neq j$. Put differently, if for example *net* aggregate welfare is maximised at investment choices $I_1^* > 0$ and $I_2^* = 0$, then equations (28) and (29) will at the optimum be satisfied with strict inequality and equality respectively.

Summing up, aggregate welfare may be maximised at either interior or corner allocations, and which particular solution arises depends upon the properties of the functions $v(\cdot)$ and $c(\cdot)$. So let $E^{i,fb}$ denote an interior solution, and $E_j^{c,fb}$ stand for a corner first-best outcome in which only D_j invests. For notational convenience, let us also define the first-best allocations

$$\begin{aligned} I^{i,fb} &= \left(I_1^{i,fb}, I_2^{i,fb}\right) \equiv \arg\max_{I_1, I_2 > 0} \int_0^{\frac{\rho}{2}} V_2 f(s) ds + \int_{\frac{\rho}{2}}^1 V_1 f(s) ds - \sum_{j=1,2} c(I_j) \\ I^{c,fb} &= \left(I_j^{c,fb}, 0\right) \equiv \arg\max_{I_j} \int_0^1 V_j f(s) ds - c(I_j) \end{aligned}$$

for an interior and a corner solution respectively. Then, from the first-order conditions of these two problems we have that:

$$\frac{v'(I_j^{i,fb})}{2} = c'(I_j^{i,fb}) \qquad j = 1, 2 \tag{32}$$

$$v'(I_j^{c,fb}) = c'(I_j^{c,fb}) \qquad \textit{when } I_j^{fb} > 0 \text{ and } I_i^{fb} = 0,\ j \neq i \tag{33}$$

Comparison of expressions (33) and (23)-(25) allows us to establish the following result.

Proposition 2 *If aggregate surplus is maximised at a corner solution, a nonexclusive equilibrium is suboptimal.*

Proof. In the first-best allocation $I^{c,fb}$, D_j invests $I_j^{c,fb} > 0$ and $I_i^{c,fb} = 0$. However, using equations (24) and (25) we may conclude that in a corner-type nonexclusive equilibrium, $v'(I_j)\left(\alpha_U^D + 2\alpha_D^U\right) = c'(I_j)$ and $v'(I_i)\alpha_D^U = c'(I_i)$, $j, i = 1, 2$, $j \neq i$. Then, taking into account (22) and the properties of $v(\cdot)$ and $c(\cdot)$, in general D_j under-invests and D_i over-invests with respect to the first-best outcome. Obviously, in this context a nonexclusive interior equilibrium cannot achieve the first-best outcome either. ■

This proposition is unsurprising. It says that in our setting private incentives to invest are distorted in such a way that there are no feasible values of the bargaining parameters α_U^D and α_D^U such that a first-best corner allocation is potentially achieved. Any nonexclusive interior equilibrium is clearly inefficient because both downstream firms are active, i.e., both buyers invest at inefficiently low levels. Regarding the corner-type equilibrium E_j^c, the source of inefficiency in this case is that D_j faces hold-up problems, whereas D_i overinvests. D_j is the high-value buyer in all possible realisations and captures *ex post* a fraction $\alpha_U^D + 2\alpha_D^U \leq 1$ of the marginal increases in V_j, but has to pay the full investment costs. So D_j undervalues its investments from a social point of view and ends up investing at less than the socially optimal level. Regarding D_i, we have that even though this buyer never receives the input in equilibrium and so the increases in V_i do not generate surplus, its investment raises its *ex post* bargaining power and hence create positive private returns. So, D_i inefficiently overinvests. Notice that inefficiency is the result of two factors. Exclusive-dealing contracts may in some cases eliminate one of these sources of inefficiency (namely, D_i's overinvestment), and hence exclusivity provisions achieve second-best equilibrium allocations that Pareto dominate the alternative nonexclusive equilibria of the game.

Rather different results apply when the first-best solution is interior. Now the counterintuitive conclusion applies that *both* buyers might overinvest in equilibrium despite the presence of potential hold-up problems. The reason for this peculiar result resembles that indicated above; in Segal and Whinston's bargaining framework a downstream firm may inefficiently receive positive returns to its investments even when it is the low-value customer. This mechanism, which is be difficult to justify from a noncooperative perspective, distorts private incentives to invest and in certain cases this extra boost might outweigh hold-up problems. If this is the case, then firms may end up investing at exactly the first-best levels or even overinvesting in equilibrium.

Proposition 3 *Suppose that the socially optimal outcome of the investment game occurs at an interior solution. Then,*
(i) if $\alpha_U^D + 3\alpha_D^U < 1$, *in the interior equilibrium* E^i *both firms suboptimally underinvest*
(ii) if $\alpha_U^D + 3\alpha_D^U = 1$, *in* E^i *both firms invest at the first-best levels*
(iii) if $\alpha_U^D + 3\alpha_D^U > 1$, *in* E^i *both firms suboptimally overinvest.*

Proof. According to (23), in the nonexclusive interior equilibrium E^i investment levels are characterised by $\frac{v'(I_j)}{2}\left[\alpha_U^D + 3\alpha_D^U\right] = c'(I_j)$, $j = 1, 2$. However, using (32) we know that in the first-best allocation the condition $\frac{v'(I_j)}{2} = c'(I_j)$, $j = 1, 2$, holds The results identified in the proposition then follow directly from the comparison of these two expressions. ■

Since our following results regarding the relevance of exclusivity for investment incentives do not depend on any of the conditions identified in the last proposition, for convenience the rest of the paper assumes that $\alpha_U^D + 3\alpha_D^U < 1$.

This concludes our study of the main features of this extended model. Having established the benchmark nonexclusive and first-best solutions, in the next section we turn to the analysis of the effects of exclusivity on downstream firms' investment incentives, and we also discuss some implications for welfare analysis of exclusive-dealing contracts.

4 The effects of exclusive-dealing contracts

This section establishes when an exclusive contract signed between U and one of the downstream firms, D_1 say, impacts on the level of noncontractible investments and on global efficiency. The set up is that an exclusive-dealing contract can be signed that prohibits U from selling the input to a firm other than D_1 (see Figure 1). Put differently, D_1 has now exclusive rights over trade with U. We also suppose that this contract presents, however, some degree of *incompleteness*, in the sense that it cannot specify *ex ante* a positive trade between U and D_1 because the nature of this trade is unverifiable. Thus, and following the "incomplete contracts" literature [e.g., Hart and Moore (1990), Hart (1995)], we assume that the terms of future trade cannot be specified in advance and so the only feasible clause that can be included in the contract is the exclusivity provision. Although not always applicable, verifiability of trading partners is frequently possible.

We further assume that exclusivity can be renegotiated *ex post* if trade with the uncontracted buyer is efficient (see Figure 1). Thus, this bargaining process always results in efficient trade. This also seems a reasonable assumption, because in realisations in which the unprotected firm is the more efficient buyer, renegotiation of the exclusive contract can generate extra surplus to be divided between the three parties. Hence, we follow Segal and Whinston in supposing that exclusivity is a purely contractual arrangement that has no effect on technical productivities. Notice that the existence of an exclusivity clause affects nonetheless the disagreement point for renegotiation and therefore the allocation of aggregate surplus among the agents.

Our analytical framework is therefore similar that in SW, although they focus instead on a vertical structure in which there is a single buyer and two possible sellers. In their basic setup the sellers make investments in cost reduction and the buyer writes the exclusive-dealing contract with one of the suppliers. Clearly, our model can be easily modified to encompass their type of vertical relationship as well.

When the seller writes an exclusive contract with D_1 that prohibits the former from selling the input to D_2 (or, alternatively, the compensation that U should pay to D_1 in case the seller wanted to trade the input with the nonexclusive buyer is *prohibitive;* we will say more about stipulated damages later on), the members of coalitions $\{U, D_1\}$, $\{U, D_2\}$ and $\{U, D_1, D_2\}$ can agree upon a positive trade level if and only if any particular coalition includes D_1 as one of its members. Hence, in the presence of exclusivity we have that $\Pi_{UD_2} = 0$ in equations $(9) - (11)$. In other words, since D_1 has exclusive rights over trade with U but that agent is not a member of coalition $\Omega = \{U, D_2\}$, the seller and the unprotected buyer cannot trade with each other and therefore they generate zero surplus together.

Hence, in the presence of an exclusive-dealing contract, the parties' expected payoffs reduce to

$$\pi_U^e = \alpha_U^{D_1 D_2} \Pi_{UD_1 D_2} + \alpha_U^D \Pi_{UD_1} \tag{34}$$

$$\pi_1^e = \alpha_{D_1}^{UD_2} \Pi_{UD_1 D_2} + \alpha_D^U \Pi_{UD_1} \tag{35}$$

$$\pi_2^e = \alpha_{D_2}^{UD_1} \left[\Pi_{UD_1 D_2} - \Pi_{UD_1} \right] \tag{36}$$

We of course maintain the adding-up restrictions given in equation (22). Using equations (7), (8), (35) and (36), we can write downstream firms' payoffs in the presence of an exclusive relationship between U and D_1 as

$$\pi_1^e = \int_0^{\frac{\rho}{2}} \left[\alpha_{D_1}^{UD_2} V_2 + \alpha_D^U V_1 \right] f(s) ds + \int_{\frac{\rho}{2}}^1 \left(\alpha_{D_1}^{UD_2} + \alpha_D^U \right) V_1 \; f(s) ds \tag{37}$$

$$= (\alpha_D^U + \alpha_{D_1}^{UD_2}) \left[\underline{v} + v(I_1) + \frac{1}{2} \right] + \alpha_{D_1}^{UD_2} \frac{\rho^2}{4} \qquad if\ 0 < \rho < 2 \tag{38}$$

$$= (\alpha_D^U + \alpha_{D_1}^{UD_2}) \left[\underline{v} + v(I_1) + \frac{1}{2} \right] \qquad if\ \rho \leq 0 \tag{39}$$

$$= (\alpha_D^U + \alpha_{D_1}^{UD_2}) \underline{v} + \alpha_D^U v(I_1) + \alpha_{D_1}^{UD_2} v(I_2) + \frac{1}{2} (\alpha_D^U + \alpha_{D_1}^{UD_2}) \quad otherwise \tag{40}$$

$$
\begin{aligned}
\pi_2^e &= \int_0^{\frac{\rho}{2}} \alpha_{D_2}^{UD_1}(V_2 - V_1) f(s) ds && (41)\\
&= \alpha_{D_2}^{UD_1} \frac{\rho^2}{4} && if\ 0 < \rho < 2 \quad (42)\\
&= 0 && if\ \rho \leq 0 \quad (43)\\
&= \alpha_{D_2}^{UD_1} [v(I_2) - v(I_1)] && otherwise \quad (44)
\end{aligned}
$$

for D_1 and D_2 respectively. After comparing these expected payoffs with those given in the previous section (equations 14 through 21), we may conclude that D_1, the protected buyer, receives a greater share of the aggregate surplus generated by the grand coalition of all members, whereas D_2 experiences a decrease in its expected payoff; that is, $\pi_1^e > \pi_1$ and $\pi_2^e < \pi_2$. Not surprisingly, the exclusive trade agreement enhances D_1's bargaining power, because now U cannot trade the input with D_2 unless the protected buyer is compensated for giving away his exclusive right. But exclusivity also hurts the nonexclusive buyer.

Regarding downstream firms' investment incentives, we know that their decisions are to choose investment levels to maximise $\pi_j^e - c(I_j)$, $j \in \{D_1,\ D_2\}$. For the case of D_1, we find out that the first-order conditions of this problem are identical to those arising in the absence of an exclusive-dealing contract. So, in this model the contracted buyer's marginal investment incentives are not altered at all by the existence of exclusivity, that is, $b_1^e(I_2) = b_1(I_2)$. This is due to the fact that D_1 receives the additional expected payoff $\int_0^1 \alpha_{D_1}^{UD_2} V_2 f(s) ds$ when he writes an exclusive contract with U and this expression doesn't depend whatsoever upon I_1. The intuition is that nothing changes in any coalition of which the exclusive buyer is already a member, whereas the additional payoff this buyer receives due to exclusivity doesn't depend on D_1's investment because of the assumed absence of cross-effects. Additionally, notice that since $\alpha_{D_1}^{UD_2} \geq \alpha_U^D$ the contracted buyer receives an additional expected transfer that is at least equal to the decrease in the seller's payoff. As we discussed in Section 2, this distributional effect of exclusivity can be profitably offset by the seller in the *ex ante* negotiations that determine which buyer obtains the access privilege.

Investment incentives in the presence of an exclusive contract may however be rather different for D_2, who now equalises $c'(I_2)$ to

$$
\begin{aligned}
\frac{v'(I_2)}{2}\left(\alpha_U^D + \alpha_D^U\right)\rho \quad & if\ 0 < \rho < 2 && (45)\\
0 \quad & if\ \rho \leq 0 && (46)\\
v'(I_2)(\alpha_U^D + \alpha_D^U) \quad & if\ \rho \geq 2 && (47)
\end{aligned}
$$

In this case, $b_2^e(I_1)$ may differ from $b_2(I_1)$ and therefore the presence of an exclusive-dealing contract will in general change the equilibrium investment levels of both downstream firms. The route is that the uncontracted buyer now has zero marginal incentives to invest in the coalition in which he is matched with the seller, because recall that now $\Pi_{UD_2} = 0$. The decrease in D_2's investment induces the contracted firm to expand. Hence, the uncontracted firm's best response function may shift in the presence of exclusivity whereas the contracted firm moves along its unchanged reaction curve.

For notational convenience, let $I_j^{i,e}$ denote buyer j's equilibrium investment choice in an exclusive interior equilibrium $E^{i,e}$ of the game. Similarly, let $I_j^{B_i,e}$, $i, j = 1, 2$, denote buyer j's equilibrium investment level in an exclusive corner-type equilibrium $E_j^{c,e}$. Then, we can state the following general result regarding the equilibrium investment choices of downstream buyers in the presence of an exclusive-dealing contract, which we label "The relevance result".

Proposition 4 ***(The relevance result)*** *If $\alpha_D^U > 0$, then $E^{i,e} \neq E^i$ and $E_j^{c,e} \neq E_j^c$, $j = 1, 2$. Therefore, in this case both downstream firms' equilibrium investment levels are affected by the presence of an exclusive-dealing contract.*

Proof. We know from the arguments given in the text that D_1's best response function is not altered whatsoever when this firm writes an exclusive contract with U. In respect to D_2, we can conveniently re-write equation (41) as

$$\pi_2^e = \pi_2 - \int_0^1 \alpha_D^U V_2 f(s) ds$$

which implies that, as long as $\alpha_D^U > 0$, the nonexclusive buyer's marginal investment incentives are affected under an exclusive regime and therefore the equilibria of this game differ from those identified under a nonexclusive regime. ■

This result stands in contrast to Propositions 1 and 2 of SW, which establish the main conclusions of that paper regarding the irrelevance of exclusivity for investment incentives. Recall that SW claim that in their setup exclusivity only matters when specific investments exhibit cross-effects and in addition the parties' payoffs are responsive to "external" value, namely, $\alpha_j^{\{UD_i\}/j} > 0$. *Within our framework, D_j's investment does not affect either D_i's valuation of the input or the surplus U derives from trading this input with the other downstream buyer. In other words, buyer j's investment has no impact whatsoever on the value of coalition $\{U, D_i\}$ and therefore, using SW's terminology, in this model investments have no effects on external value, e.g., we abstract from cross-effects. Nevertheless, we find to the contrary of SW that when both buyers make specific investments exclusivity is relevant for marginal investment incentives whenever the parties' payoffs are just responsive to internal value; that is, whenever a buyer receives in the ex post bargaining a positive share of its valuation even in realisations in which it is the low-value customer (i.e., $\alpha_D^U > 0$).*

It is useful to further point out how this result relates to the simple model discussed in Section 2 of SW. In that example, the external firm receives no surplus at all in the bargaining process because it is part of a competitive industry. This in fact means that, according to our terminology, the unprotected firm's payoff is not responsive to internal value and therefore it's not surprising that in this context exclusive contracts don't have any effects on investment incentives. But recall that in our example of Section 2, where both buyers had investment opportunities and the parties' payoffs were responsive to internal value, we discovered that exclusivity did matter for investment incentives. Hence, Proposition 4 generalises our previous findings to the case of continuous stochastic effects and noncontractible investments.

Exclusivity matters whenever downstream firms' payoffs are responsive to internal value (e.g., $\alpha_D^U > 0$) because it affects D_2's marginal incentives to invest in the coalition in which this firm is matched with the seller only, and therefore exclusive dealing impacts on the equilibrium investment choices of both buyers. In addition, our analysis suggests that exclusivity might in fact be *irrelevant* for investment incentives even when downstream firms' payoffs are responsive to "both internal and external" values, that is, $\alpha_{D_j}^{UD_i} > 0$. It seems relevant then to separate the concept of responsiveness to "strictly internal" value from the idea of responsiveness to "both internal and external" values, because within our framework these two concepts have very different implications in terms of the relevance of exclusivity for investment incentives. The next definition formalises our terminology.

Definition. Downstream firms' payoffs are responsive to *strictly internal* value if $\alpha_D^U > 0$. In addition, downstream firms' payoffs are responsive to *both internal and external* values if $\alpha_{D_j}^{UD_i} > 0$.

According to equation (22), in this setting payoffs are responsive to both internal and external values. Notice, in addition, that responsiveness to strictly internal value is a sufficient but not necessary condition for the existence of responsiveness to both internal and external values.

We shall assume from now on that the buyers' payoffs are responsive to *strictly internal* value. Our next proposition shows that in this context any exclusive interior equilibrium outcome is now asymmetric and therefore socially inefficient.

Proposition 5 *If downstream firms' payoffs are responsive to strictly internal value and the sets* $\left\{I_1^i \times I_2^i\right\}$ *and* $\left\{I_1^{i,e} \times I_2^{i,e}\right\}$ *are non-empty, then* $I_1^i < I_1^{i,e}$ *and* $I_2^i > I_2^{i,e}$*, i.e.,* $I_1^{i,e} > I_2^{i,e}$*. Therefore, exclusive interior equilibria can never achieve first-best solutions.*

Proof. From the comparison of equations (45) and (23) we can directly deduce that, as long as $\alpha_D^U > 0$, the condition $I_2^i > I_2^{i,e}$ holds. But then equation (23) implies that D_1 expands and hence $I_1^i < I_1^{i,e}$. Since $I_1^i = I_2^i$, we may conclude that $I_1^{i,e} > I_2^{i,e}$. ■

The next subsection analyses further implications of exclusivity on aggregate surplus in the context of corner first-best solutions. We show there that an exclusive regime may, under some conditions, be efficiency-improving and hence increase aggregate surplus.

4.1 Exclusivity as a surplus-enhancing device

In this subsection we look in particular at the efficiency levels of nonexclusive and exclusive corner-type equilibria. In order to address these additional features of our model it is convenient to focus the discussion on situations in which first-best outcomes occur at corner solutions. This assumption makes sense, because it is precisely under these circumstances that exclusivity enables more efficient allocations to potentially emerge and is also more valuable for the seller. In this context, exclusivity provisions can be seen as contractual devices that might drive vertical relationships towards second-best and hence efficiency-improving allocations.

For simplicity, we shall also assume throughout this subsection that a corner-type equilibrium outcome achieves a higher level of efficiency than an interior allocation under a nonexclusive regime; put differently, we suppose that a corner-type allocation, if it exists at all, is the most efficient allocation in the absence of exclusivity.

More explicitly,

Proposition 6 *Suppose that aggregate surplus is maximised at a corner solution. Then, the exclusive corner-type equilibrium* $E_1^{c,e}$ *achieves a second-best allocation and is therefore socially preferred to any nonexclusive equilibrium of the game.*

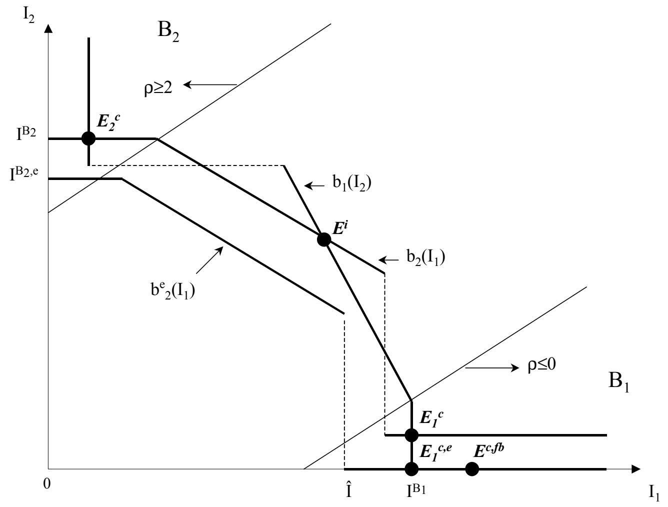

Figure 8: Welfare-improving equilibrium outcome in the presence of exclusive dealing

Proof. We know that at the optimal solution $E_1^{c,fb}$, the conditions $v'(I_1^{c,fb}) - c'(I_1^{c,fb}) = 0$ and $I_2^{c,fb} = 0$ hold. From Proposition 2 we have that in the nonexclusive corner-type equilibrium E_1^c, D_1 underinvests and D_2 overinvests with respect to the first-best levels. But at $E_1^{c,e}$ firm D_1 invests $I_1^{B_1,e} = I_1^{B_1}$ whilst D_2 invests zero (see equation 46). Hence, the exclusive corner-type equilibrium $E_1^{c,e}$ must represent a net gain and therefore achieves a second-best allocation. ■

This proposition says that when exclusivity matters for investment incentives and a first-best outcome occurs at a corner solution, in which a single buyer invests at a relatively high level, there might exist potential efficiency gains derived from moving from any nonexclusive equilibrium to an exclusive corner-type equilibrium outcome. In particular, exclusive dealing may be valuable from a social perspective because it exhibits the desirable property of eliminating less efficient equilibria in which too many firms invest too little. Therefore, exclusive corner-type equilibrium outcomes may actually achieve second-best allocations, and moreover exclusive regimes may be more efficient than the benchmark nonexclusive solutions even though they potentially result in complete vertical foreclosure of the unprotected buyer.

We illustrate this result in Figure 8. It is relatively straightforward to construct numerical examples in which only the corner-type equilibrium $E_1^{c,e}$ exists after U writes an exclusive-dealing contract with D_1. That figure illustrates a plausible situation in which an interior (E^i) and a corner-type equilibrium (E_1^c) exist in the nonexclusive benchmark. The first-best allocation is given however by the corner solution $E^{c,fb}$ in which a single buyer, D_1 say, invests. According to our previous assumption, we have that E_1^c is nevertheless more efficient that E^i. According to our last proposition, if only the corner-type equilibrium $E_1^{c,e}$ survives exclusivity, then exclusive dealing represents an unambiguous Pareto improvement. This conclusion provides some positive social roles for emerge of exclusive trade agreements and may in principle explain as well the pervasiveness of exclusive-dealing contracts in a world of incomplete contracts.

4.2 Finite stipulated damages for breach of contract

Up to now we have analysed the effects on investment incentives of exclusive contracts that completely block any potential trade between U and D_2. In this final subsection we relax this assumption, and briefly discuss whether our previous results change when the exclusive-dealing contract only includes a clause that specifies a finite penalty that U must pay to D_1 in case the former sells the input to D_2. Notice that we don't need to relax any of our previous informational assumptions in order to deal with this situation. This enquiry allows us to conclude that full exclusivity actually arises as a special case of this more general formulation, and so the case of finite stipulated damages combines analytical features already explored in previous sections of this paper.

To begin with, suppose that V_2 is greater than or equal to a certain stipulated damage P for all possible investment levels and realisations, e.g., $\underline{v} \geq P$. Under these circumstances, we have that $\Pi_{UD_2} = V_2 - P \geq 0$ and therefore exclusivity, even though it still has distributional effects, doesn't have any impact on the buyers' marginal investment incentives. To show this, we focus on D_2's expected payoff, which in this case is given by

$$\begin{aligned}\pi_2 &= \int_0^{\frac{\rho}{2}} \left[\alpha_{D_2}^{UD_1}(V_2 - V_1) + \alpha_{D_2}^{U}(V_2 - P)\right] f(s)ds + \int_{\frac{\rho}{2}}^{1} \alpha_{D_2}^{U}(V_2 - P)\ f(s)ds \\ &= \left\{\int_0^{\frac{\rho}{2}} \left[\alpha_{D_2}^{UD_1}(V_2 - V_1) + \alpha_{D_2}^{U} V_2\right] f(s)ds + \int_{\frac{\rho}{2}}^{1} \alpha_{D_2}^{U} V_2\ f(s)ds\right\} - \alpha_{D_2}^{U} P\end{aligned}$$

Notice that the expression in braces is exactly similar to that given in equation (18). Thus it is immediate that liquidated damages cannot have any impact on marginal incentives.

Matters change when V_2 may potentially be smaller than P in some nonempty subset of states of nature, because the penalty that U has to pay to D_1 for breach of contract in realisations in which D_2 is the high value buyer is so high that if it must be paid it precludes any potential trade between U and and the nonexclusive buyer. This was in fact the situation discussed in previous sections of the paper. The subset of states of the world in which $V_2 \leq P$ is given by

$$s^p = \{s : s \geq \underline{v} - P + v(I_2) + 1\}$$

Notice that $\Pi_{UD_2} = 0$ whenever $s \in s^p$. After defining $s^* = \underline{v} - P + v(I_2) + 1$, we may write the buyers' payoffs in the presence of an exclusive-dealing contract between U and D_1 that includes liquidated damages P as

$$\pi_1^p = \int_0^{s^*} \alpha_{D_1}^{UD_2} P f(s)ds + \int_{s^*}^{\frac{\rho}{2}} \alpha_{D_1}^{UD_2} V_2 f(s)ds + \int_0^1 \alpha_D^U V_1 f(s)ds + \int_{\frac{\rho}{2}}^1 \alpha_{D_1}^{UD_2} V_1 f(s)ds \quad (48)$$

$$\pi_2^p = \int_0^{s^*} \alpha_D^U (V_2 - P) f(s)ds + \int_0^{\frac{\rho}{2}} \alpha_{D_2}^{UD_1} (V_2 - V_1) f(s)ds \quad (49)$$

When $s^* \leq 0$ for all I_2, equations (48) and (49) collapse to expressions (37) and (41) respectively and therefore a full exclusive relationship emerges as a special case of this formulation. Since s^* doesn't depend upon I_1, equations (48) and (49) confirm our previous finding that exclusivity has no effect whatsoever on D_1's marginal investment incentives, whereas it impacts negatively on D_2's marginal incentives. In addition, when $s^* \geq 1$ for all I_2, downstream firms' marginal incentives coincide with those given in equations (23)-(25). Hence, the inclusion of stipulated damages for breach of contract in the model confirms our previous findings regarding the effects of exclusivity provisions on the equilibrium investment levels of both buyers.

5 Conclusion

Exclusive-dealing contracts encourage relationship-specific investments by allowing *ex post* hold up by the investing party. This reasoning appears to be straightforward, but the literature has struggled to make the story cohere. There are several reasons. First, the focus has been on the marginal return to investment. In some cases these are unaffected by exclusive contracts, but this is not enough to conclude that investment is unaffected. Exclusivity nearly always boosts total returns and this makes all the difference when, as is often true, there are investment indivisibilities.

Next, existing models of exclusive dealing assume cooperative bargaining over the division of the surplus follows non-cooperative investment decisions. Cooperative bargaining has the property that, even in the absence of an exclusive contract, a firm that does not trade shares in the surplus created by those that do. An exclusive contract eliminates the surplus otherwise created by a coalition of the seller and the uncontracted buyer but if neither has investment opportunities the contracted buyer's marginal investment incentive is unchanged. The implication is that the investment equilibrium in the absence of exclusivity remains so in its presence. This is the basis for Segal and Whinston's irrelevance of exclusivity result. The case of both buyers having investment opportunities is though entirely reasonable and Segal and Whinston do not examine the desirability of exclusive dealing in this case. In an otherwise similar set up to theirs, we show that multiple equilibria are intrinsic in this situation. Buyer investments are strategic substitutes and are also substitutes as far as the creation of aggregate surplus is concerned. It is therefore possible that both buyers invest at a low level but it would be more efficient if only one firm invests at a high level. Exclusive dealing enables this beneficial rationalisation to emerge. The route is not that the contracted firm's marginal return to investment is enhanced (nothing changes in any coalition of which it is a member). Rather the unprotected buyer now has zero marginal incentive to invest in the coalition in which it is matched with the seller. The uncontracted firm's publicly observed lower investment incentive causes the contracted firm to expand which may be enough to altogether eliminate the uncontracted firm's investment incentive. The only equilibrium that may survive exclusivity is the asymmetric non exclusive outcome. Not only may this be more efficient but the exclusive contract creates an instrument which allows the seller easily to capture the surplus.

Rajan and Zingales (1998) are far more positive than Segal and Whinston concerning the profitability of exclusive dealing. They too assume cooperative bargaining but assume that exclusivity prevents the excluded firm having access to information vital in creating productive investment. So a non-exclusive relationship with two or more firms investing is transformed by an exclusive contract into one in which, without further analysis, only one firm need be considered. When the firm's investments are perfect substitutes it is clearly efficient that only one should invest, as is guaranteed by exclusive dealing. The desirability of exclusivity is thus guaranteed if there is an equilibrium in which in its absence both buyers invest. Wasteful replication is eliminated by exclusivity and, since surplus is only shared amongst two rather than three parties, the under investment due to hold up is reduced. Under non exclusivity and perfect substitutes Rajan and Zingales show that there is a symmetric mixed strategy equilibrium so their case is made.

Our non cooperative analysis does in a way mirror this story but instead of assuming that an exclusive contract makes it technically impossible for the excluded firm to invest, we show that the contract makes it economically unprofitable to do so. Also our model is somewhat richer, so the symmetric non exclusive equilibrium is pure strategy. This part of our analysis combines elements of Rajan and Zingales and Segal and Whinston to make the case for the profitability of exclusive dealing.

Whether exclusivity precludes trade with uncontracted parties may sometimes be a choice variable. Suppose the possibility of developing a use for an input depends on early disclosure of its characteristics by the supplier. One strategy is to make this information freely available to all potential users. This is our analysis with no contract in place. Another possibility is to disclose the information to all but also grant one firm an exclusive contract to buy the input. This preserves some incentive for rivals to develop products using the input, because they have opportunity to negotiate for it with the protected firm. Finally, the supplier could only inform a chosen firm; in effect vertical integration. These arrangements are ordered by the incentives for rivals to invest versus the encouragement given to reap economies of investment scale. For example, the middle arrangement may be best if one firm investing heavily to exploit a particular application of the input is likely to be the best way of exploiting it, but there is also the possibility that other firms could at low cost come up with a radical idea that is much more valuable. So our analysis provides the basis for a theory of joint ventures as a possibly intermediate step between full vertical integration and nonintegration with a downstream industry.

Cooperative bargaining solutions are best justified as incorporating notions of justice. This is not obviously a basis for positive economics. In particular, firms that fail to trade do not in reality usually receive compensatory payments from those that do. Reasonable noncooperative bargaining models do not have this feature and this fundamentally changes the nature of the results. Segal and Whinston briefly look at a noncooperative game that embodies the outside-option principle. Drawing an analogy with Chiu (1998) and de Meza and Lockwood (1998) they conclude that exclusivity diminishes the investment incentive of the protected firm. A simple example in the Appendix challenges this argument. The key is that an exclusive contract provides the protected firm with a return even when it is not the high-value buyer (this would not be true in the absence of exclusivity). The threat to buy and use the good itself is more potent the greater is its value to the buyer. Thus the marginal investment return to the contracted firm is greater under exclusivity. This may, as before, precipitate an asymmetric equilibrium though the direct cause is the stimulus to the protected firm rather than the investment deterrent to the uncontracted firm. Moreover the creation of a positive marginal return when the contracted firm is the low-value buyer may partially offset the underinvestment due to holdup in the asymmetric case.

The overall message is that the case that exclusivity promotes relationship-specific investment is much more robust than earlier analyses suggested. That brings the theory much closer to the evidence.

APPENDIX

An alternative noncooperative story. The basic set up is similar to that discussed in the text. We are interested here in providing some very preliminary intuitions of an alternative noncooperative “solution” in which exclusivity might still matter for investment incentives in a world of incomplete contracts. The three-player bargaining protocol that we are going to apply here is an appealing extension of Rubinstein (1982) introduced in Bolton and Whinston (1993). There are two downstream firms, H and L, that value the input at 12 an 10 respectively. The seller has zero valuation. In negotiating with H, the upstream firm has an outside option of selling the input to L at his reservation price (for the latter can never displace the highest-valuing buyer). Since $10 > \frac{12}{2}$, this outside option is binding and therefore Bolton and Whinston claim that the input will be sold to H for a price of 10. This seems indeed a very reasonable outcome.

Now suppose that the seller has entered into an enforceable exclusive trade agreement with L, that is, L can block the direct sale of the input to H. This means that the upstream firm looses its outside option. A plausible story in this case would be that the seller and L bargain over the transfer price of the input, which is sold to L at 5 $\left(\text{e.g., } \frac{10}{2}\right)$. In the subsequent bilateral bargaining between L and H, the former agent has an outside option of using the input internally, so the input is in the end transferred to H at a price of 10. Hence, final payoffs are 5 for the seller, 5 for L and 2 for H. Of course, this final outcome might be achieved instead in a single step bargain, with L paid 5 to relinquish its exclusive right and H pays 10 for the input. *Notice therefore that when there is an exclusive-dealing contract L, the low-value buyer, receives a positive payoff that directly depends upon his valuation and therefore exclusivity will in general affect his investment incentives.* In fact, this non cooperative bargaining approach seems to extend reasonably to finite breach penalties as well. Therefore, exclusivity may still be relevant for investment incentives even in the context of noncooperative three-player bargaining frameworks.

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