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Exclusive contracts and protection of investments

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THE CENTER FOR THE STUDY
OF INDUSTRIAL ORGANIZATION
AT NORTHWESTERN UNIVERSITY

Working Paper #0005

Exclusive Contracts and Protection of
Investments^{*}

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Abstract

We consider the effect of a renegotiable exclusive contract restricting a buyer to purchase from only one seller on the levels of noncontractible investments undertaken in their relationship. Contrary to some informal claims in the literature, we find that in this setting exclusivity has *no* direct effect on “internal” investments, i.e. those that are specific to the relationship. The direct effect of exclusivity is instead to increase the “external” investments of the seller (those which enhance the value of the buyer’s trade with other sellers) and to reduce those of the buyer. Exclusivity may have an indirect effect on internal investments; the direction of this effect depends on the nature of any complementarities or substitutabilities between external and internal trades and investments. We relate these findings to existing informal discussions of the role of exclusivity in protecting investments. We also examine the effects of exclusivity on aggregate welfare, the private incentives of the buyer-seller coalition to use it, and the resulting externality on other potential suppliers.

1 Introduction

A contract between a buyer and a seller is said to be exclusive if it prohibits one party to the contract from dealing with other agents. Exclusivity provisions are a common feature of contracting in many industries. Although exclusive contracts are relevant to many areas of economics, they have attracted the most attention and controversy in industrial organization and antitrust analysis. A long-standing concern of courts in the antitrust arena, explored formally in a series of recent papers (Aghion and Bolton [1987], Rasmusen, Ramseyer, and Wiley [1991], Bernheim and Whinston [1998], and Segal and Whinston [1996]), is that such contracts can serve anticompetitive purposes. Antitrust commentators often argue, however, that such contracts serve procompetitive, efficiency-enhancing ends, and in particular that they protect the holder of the exclusive right's relationship-specific investments against opportunistic hold-up.

A recent U.S. Department of Justice investigation into contracting practices in the computerized ticketing industry provides an example of this debate. In many major U.S. cities, the leading computerized ticketer, Ticketmaster, had exclusive contracts with concert venues having eighty to ninety-five percent of the available seating capacity. To some observers, this fact raised a concern that these contracts limited competition in computerized ticketing services. Other observers, however, argued that these contracts were adopted instead to protect Ticketmaster's relationship-specific investments both in training a venue's personnel in the use of its computerized system and in tailoring its software to the specific configuration and ticketing needs of a venue.

Surprisingly, the economics literature contains no formal analysis of the role of exclusivity provisions in fostering specific investments. Moreover, the several (quite interesting) informal discussions of the issue that do exist make somewhat differing arguments. Klein [1988] and Frasco [1991] argue that exclusive dealing contracts may be used instead of quantity contracts to protect a seller's relationship-specific investment when specification of quantities is too costly. Klein [1988], for example, attributes the 1919 exclusive contract in which GM promised to buy all of its closed metal bodies from Fisher to the need to protect Fisher's investments in stamping machines and dies that were specific to GM's car designs. (Klein [1988] also discusses the eventual replacement of this contract by vertical integration due to Fisher's hold-up of GM under the contract, a point we shall discuss further below.) In contrast, Marvel [1982] and Masten and Snyder [1993] also argue that exclusivity may be

adopted to protect a seller's investments, but they focus on investments that can be used by the buyer in its dealings with *other* sellers. Masten and Snyder [1993], for example, suggest that the penalty clauses in the United Shoe Machinery Corporation's leases were in part a response to United's concern that its expenditures on educating shoe manufacturers in the efficient production of shoes could be used by these manufacturers in conjunction with competitors' shoe machines.

In this paper, we examine formally the conditions under which exclusive contracts may be privately and/or socially valuable for protecting noncontractible investments. To investigate these claims, we develop a model in which a buyer (B) and a seller (S) initially contract, while facing the possibility that the buyer may later wish to buy from an external source (E).¹ B and S can write an exclusive contract *ex ante*, which prohibits B from buying anything from E . After the contract is signed, but before trade, the parties may undertake noncontractible investments that affect the value of *ex post* trades.² We assume that an exclusive contract can be renegotiated *ex post* whenever trading with E is efficient. The role of exclusivity is therefore to establish the disagreement point for renegotiation. As in Grossman and Hart [1986] and Hart and Moore [1990], the disagreement point is important because it affects the allocation of *ex post* surplus, which in turn determines the parties' investment incentives.

Since the effect of an exclusivity provision may depend on the *other* terms included in B and S 's contract, an important modeling choice concerns the set of feasible contractual terms. In most of the paper we focus on the "incomplete contract" setting in which the terms of future trade cannot be specified in advance (see Hart [1995]). Thus, the *only* possible term in the initial contract, aside from a lump-sum side payment, is the exclusivity provision. In Section 7, however, we argue that many of our results generalize to settings in which more complex contracts are feasible.

We begin in Section 2 by considering a simple example in which the seller may make a noncontractible *ex ante* investment that reduces his cost of serving the buyer *ex post* (along the lines discussed in Klein [1988] and Frasco [1991]). In this context we discover a surprising result: exclusivity provisions have *no effect whatsoever* on the level of relationship-specific investment undertaken by the seller. Although exclusivity does increase the seller's share of

¹Our results apply equally well, with obvious alterations, to the case in which it is the seller who may later wish to sell to alternative buyers.

²Clearly, exclusivity can have a role in protecting only those investments which cannot be directly specified in a contract, i.e. are non-verifiable.

ex post surplus (in accord with the conventional wisdom), it does not increase the sensitivity of the seller's payoff to his investment.

In Section 3, we introduce a far more general model of investments and hold-up. Using this model, we show that the key feature leading to the irrelevance result of Section 2 is that investments in that context were purely *internal*; that is, they affected only the value of trade between B and S . In any such case, exclusivity will have no effect, a finding that we label “the irrelevance result”. For exclusivity to matter for noncontractible investments, these investments must possess some *external* element — they must affect the value of trade between B and E . Thus, the informal arguments of Klein [1988] and Frasco [1991] — in which investments are purely internal — find no support here. The investments envisioned by Marvel [1982] and Masten and Snyder [1993], by contrast, do contain an external element.

In Section 4, we discuss more thoroughly the distinction between internal and external investments, and the issues involved in deriving definitive comparative statics results. We introduce several sets of assumptions for our later analysis of comparative statics. In general, complementarities and substitutabilities between internal and external investments and between S and E 's goods play a central role in determining the effects of exclusivity on investments and welfare. Given the role of complementarities in the theory, the monotone comparative statics tools presented in Milgrom and Roberts [1990] are particularly helpful for our problem, and we rely on them extensively in our analysis.

In Sections 5 and 6 we study the effects of exclusivity on investments and welfare. Section 5 is devoted to the case of complementary internal and external investments, while in Section 6 we study substitutable internal and external investments. Our welfare results consider the effect of exclusivity on social welfare and its private benefits and costs for the players. Here we identify circumstances in which exclusivity is and is not socially optimal, and we identify cases in which the private benefits of signing an exclusive contract for the buyer and seller differ from what is socially optimal. In essence, our results enable us to provide a check-list for evaluating investment-based efficiency claims for exclusive contracts in which the predicted private and social welfare effects of exclusivity depend on the identity of the party making external investments and the complementarity/substitutability of internal and external investments and trades.

In Section 7 we discuss how the possibility of the buyer and seller signing more complex ex ante contracts affects our conclusions.

Section 8 offers concluding remarks including a discussion of related work in other literatures. The issue of exclusivity and investment incentives arises in a number of fields of economics (e.g. labor economics) in which our results may have fruitful applications.

2 A Simple Example

Consider a situation in which a buyer (B) and a seller (S) initially contract, while facing the possibility that the buyer may later wish to buy from an external source (E). At the initial contracting stage, B and S can sign an exclusive contract that prohibits B from trading with E , but cannot specify a positive trade because the nature of the trade is hard to describe in advance. Suppose that B demands up to one unit of the good, which she values at v , that S 's cost of producing the good is c_S , and that E 's cost of producing the good is c_E . While all three values can in general depend on the parties' ex ante investments, we begin by considering only S 's investment in reducing his cost c_S . We denote by $\phi_S(c_S)$ the ex ante investment cost for S of achieving cost level c_S .

According to Frasco [1991] and Klein [1988], the seller's incentive to engage in this kind of specific investment is enhanced by an exclusive contract. The intuition behind their claims is simple: exclusivity enables the seller to extract a greater share of the available surplus in ex post bargaining, and thereby encourages the seller's ex ante investments. In this section, we examine the validity of these claims in a very simple model (we generalize the model substantially in Section 3).

We assume that after E appears, the three parties renegotiate to an ex post efficient outcome.³ In particular, if E turns out to be the more efficient supplier, renegotiation results in B buying from him, even if an exclusive contract was written. However, the original contract is still important, because it affects the distribution of ex post surplus among the parties, which in turn affects ex ante investment incentives.

We assume a very specific formulation of ex post bargaining. First, we suppose that E receives no surplus in the bargaining. This would happen, for example, if there was competition among many identical external suppliers. Second, we assume that B and S split their renegotiation surplus 50/50 over the disagreement point, which is determined by

³There is extensive evidence of renegotiation occurring during the life of long-term contracts. Joskow [1985], for example, notes that in his sample of long-term contracts between mine-mouth electric utilities and coal mines (which nearly always involved some form of exclusivity provision), many were amended during the life of the contract.

the original contract. Let $e = 1$ denote an exclusive contract and $e = 0$ denote a nonexclusive one (or, equivalently, the absence of any contract), and let $U_S^0(c_S, e)$ and $U_B^0(c_S, e)$ denote the two parties' disagreement utilities, which may in general depend on S 's ex post cost c_S and the contract term e . Then the renegotiation surplus can be written as $TS(c_S) - U_S^0(c_S, e) - U_B^0(c_S, e)$, where $TS(c_S) = \max\{v - c_S, v - c_E, 0\}$ is the total available ex post surplus. Ignoring any ex ante side payments (which have no effect on investment incentives), S 's ex post utility can be written as

$$U_S(c_S, e) = U_S^0(c_S, e) + \frac{1}{2}[TS(c_S) - U_S^0(c_S, e) - U_B^0(c_S, e)]. \quad (1)$$

The seller's ex ante investment decision can then be framed as one of choosing c_S to maximize $U_S(c_S, e = 1) - \phi_S(c_S)$ under an exclusive contract, and $U_S(c_S, e = 0) - \phi_S(c_S)$ under a nonexclusive one.

With a nonexclusive contract, the parties' utilities at the disagreement point are $U_S^0(c_S, e = 0) = 0$ and $U_B^0(c_S, e = 0) = \max\{v - c_E, 0\}$ (B can buy from E at price c_E whenever she desires). Observe that these disagreement utilities do not depend on c_S ; hence, the only term in (1) that is sensitive to c_S is $\frac{1}{2}TS(c_S)$. Therefore, S captures only 50% of his investment's contribution to total surplus, which implies that his incentive to invest is socially suboptimal.⁴

Can this underinvestment problem be mitigated with an exclusive contract? Under such a contract, the parties' disagreement utilities are $U_S^0(c_S, e = 1) = U_B^0(c_S, e = 1) = 0$ (B cannot buy from anyone without S 's permission). Substituting these expressions into (1), we can write:

$$U_S(c_S, e = 1) = U_S(c_S, e = 0) + \frac{1}{2} \max\{v - c_E, 0\}. \quad (2)$$

Equation (2) tells us that the functions $U_S(c_S, e = 1)$ and $U_S(c_S, e = 0)$ differ by an amount that is *independent of* c_S . Hence, we see that exclusivity is *irrelevant* for the seller's optimal investment level.⁵ Recall that the claims of Frasco [1991] and Klein [1988] are based on the intuition that exclusivity enables S to extract a higher share of the total surplus in ex

⁴In more general situations in which E captures some of the bargaining surplus, or in which S 's investments differ in their nature, S may over-invest relative to the socially optimal level. We shall encounter such cases when we consider our general model in Sections 3-6.

⁵Our analysis assumes that the seller's ability to enforce exclusivity is independent of his investment. For example, even when S 's production cost is infinite, his payoff with an exclusive equals $\frac{1}{2} \max\{v - c_E, 0\}$ (while his payoff without an exclusive is zero). Conditioning exclusivity on some aspects of S 's investment would presumably require a court to be able to verify these aspects of S 's investment, but in such a case the parties would be able to specify directly these aspects of the investment in their contract.

post bargaining. While this intuition by itself is correct (S 's payoff is indeed larger under an exclusive contract), under our assumptions the additional surplus extracted by S due to exclusivity is not sensitive to his investment, and therefore does not affect his investment incentives.

This simple model, and its result, can be related in an interesting way to the asset ownership model of Hart and Moore [1990]. Imagine a situation in which there is a single asset which B must have access to in order to trade with E . Then, ownership of this asset by S is equivalent to the exclusive contract considered above, while a nonexclusive contract corresponds to ownership of the asset by B or E . In the present example, only S makes an investment, while B is indispensable for trade. It follows from the results of Hart and Moore [1990] that ownership of the asset by either S or B is optimal – that is, that exclusivity is irrelevant. This “asset interpretation” of exclusivity will apply in our general model as well. However, our analysis in later sections will concern environments that fall outside the settings considered by Hart and Moore [1990].⁶

It is natural to wonder precisely what is responsible for the irrelevance of exclusivity for investment incentives in this simple model. We observe first that this irrelevance depends on two assumptions about bargaining. The first of these is that exclusivity may be renegotiated ex post. Suppose, instead, that while B and S are able to negotiate their terms of trade ex post, they cannot renegotiate the exclusivity provision itself. In this case, exclusivity would affect not only B 's disagreement utility – which would still be $U_B^0(c_S, e = 1) = 0$ under an exclusive – but also the total surplus available to the parties, which would now be given by the function $\overline{TS}(c_S) = \max\{v - c_S, 0\}$. This differs from $TS(c_S)$ whenever $c_E < c_S < v$, and in that range of parameters we have $\partial\overline{TS}(c_S)/\partial c_S = -1 < 0 = \partial TS(c_S)/\partial c_S$. As a result, unless trade with S is always efficient (regardless of investments), a nonrenegotiable exclusivity provision may increase S 's cost-reducing investment.⁷ Of course, in the present environment, B and S must negotiate ex post in order to trade. Given this fact, it is

⁶In particular, we will consider more general bargaining solutions, investments that benefit coalitions of which the investing agent is not a member, investments that are multidimensional, and investments that are not complementary with one another.

⁷For example, suppose that S has a discrete investment choice, “invest” or “don't invest”, and that $c_S < c_E < v$ when S invests, and $c_E < c_S < v$ when S does not invest. A nonrenegotiable exclusivity provision reduces ex post total surplus when S does not invest, but has no effect on total surplus when S does invest. Since S receives a share of total surplus, this provision increases S 's incentive to invest. Note that although in this simple example a non-renegotiable exclusive has no cost as long as S decides to invest in equilibrium, in more general models (e.g. with randomness in the realization of c_E) a non-renegotiable exclusivity provision would involve a cost in terms of trade foregone with E in states in which $c_E < c_S < v$.

difficult to see why they would negotiate terms of trade, but forego any opportunities for mutual benefit through procurement from E .⁸

The second assumption is that B and S split the surplus available over their disagreement payoffs in fixed proportions. The leading alternative treatment of bargaining would involve B and S engaging in “outside option bargaining” (see Binmore et al. [1986]). Under outside option bargaining, the parties split total surplus in fixed proportions (say, 50/50) as long as both receive more than their disagreement utilities (outside options); otherwise, one party’s outside option binds and it receives its disagreement utility level while the other party receives the remaining surplus. In the present setting, this means that B receives $U_B(c_S, e) = \max\{\frac{1}{2}TS(c_S), U_B^0(c_S, e)\}$, and S receives $U_S(c_S, e) = TS(c_S) - U_B(c_S, e)$. The fundamental difference between this bargaining outcome and that considered above is that it depends on the disagreement utilities in a nonlinear way. Assume for simplicity that we always have $c_S < c_E < v$, and consequently $TS(c_S) = v - c_S$ and $U_B^0(c_S, e = 0) = v - c_E$. Then we have

$$\frac{\partial U_S(c_S, e = 0)}{\partial c_S} = \begin{cases} -\frac{1}{2} & \text{when } \frac{1}{2}(v - c_S) > (v - c_E), \\ -1 & \text{when } \frac{1}{2}(v - c_S) < (v - c_E). \end{cases}$$

In words, in the absence of an exclusive contract, S extracts 50% of his investment’s marginal contribution to total surplus when B ’s outside option is not binding, and 100% of this contribution when B ’s outside option is binding. The effect of an exclusive contract is to reduce B ’s outside option to zero, in which case S always receives 50% of total surplus: $U_S(c_S, e = 1) = \frac{1}{2}(v - c_S)$. Therefore, with outside option bargaining, even though exclusivity still increases S ’s share of ex post surplus, it actually *discourages* S ’s cost-reducing investment (contrary to the claims of Klein [1988] and Frasco [1991]).⁹

In the remainder of the paper, however, we maintain (in a generalized way) the bargaining structure of the simple example above, and focus on two other dimensions of the contracting environment: the nature of the investments being made and the identities of the investing parties. These two dimensions turn out to have important ramifications for the equilibrium use and efficiency properties of exclusive contracts. We begin in the next section by introducing a substantially more general model, and by using this model to identify the

⁸Note, however, that renegotiation of exclusivity can be prevented if a technological commitment is possible that eliminates the possibility of trade with E .

⁹Similar points are made by de Meza and Lockwood [1998] (who note the reversal of some of Hart and Moore [1990]’s results under outside option bargaining), Che and Hausch [1997] (who discuss the role of competition in encouraging investments in a model with outside option bargaining and cooperative investments), and Bolton and Whinston [1993] (who show that competition for inputs may induce first-best investments by buyers in a model with outside option bargaining).

feature of S 's investment decision that was responsible for the irrelevance result above.

3 The General Model and the Irrelevance Result

3.1 The Model

As before, the model has three parties, B , S , and E . At date 0, B and S sign a contract. We continue to make the “incomplete contracting” assumption that future trades cannot be described in advance.¹⁰ For this reason, B and S cannot specify a positive trade in an ex ante contract. At the same time, we assume that it is possible to describe ex ante and verify ex post the fact that B does not conduct *any* trade with another seller, which makes exclusive contracts possible. Specifically, along with a lump-sum side payment, which has no effect on investment incentives and will thus be ignored throughout the paper, the contract specifies a variable $e \in \{0, 1\}$ that indicates whether S has exclusive rights over trade with B ex post (as before, $e = 1$ indicates an exclusive contract).

At date 1 (ex ante), each party $j \in N = \{B, S, E\}$ makes an investment choice $a_j \in A_j$ that stochastically affects valuations for future trades, at a cost of $\psi_j(a_j)$.

At date 2 (ex post), the state of nature $\theta \in \Theta$ is revealed and negotiations over trade occur. B can potentially purchase both from S and from E . We denote by $q_j \in Q_j$ the quantity B buys from seller $j \in \{S, E\}$. The parties' ex post payoffs are determined by these trades, the ex ante investments, the monetary transfers between the parties, and the realization of uncertainty. Letting t_j denote the monetary payment from B to party $j \in \{S, E\}$, these payoffs are as follows:

- Buyer: $v(q_S, q_E, a_B, a_S, a_E, \theta) - \psi_B(a_B) - t_S - t_E$,
- Seller: $t_S - c_S(q_S, a_B, a_S, \theta) - \psi_S(a_S)$,
- External supplier: $t_E - c_E(q_E, a_B, a_E, \theta) - \psi_E(a_E)$,

Note that we allow for B 's valuation to be affected both by B 's own investments and by the investments of S and E ; likewise, the production cost of seller $j \in \{S, E\}$ may be affected both by j 's own investments and by B 's investments.

At this point, we assume that Q_j and A_j are compact sets in metric spaces, that Θ is finite, and that the functions $v(\cdot)$, $c_j(\cdot)$, and $\psi_j(\cdot)$ are continuous. Let $(0, 0) \in Q =$

¹⁰See Hart [1995] for a discussion of this assumption and Segal [forth.] for a formal justification.

$Q_S \times Q_E$ stand for “no trade”, and assume (for notational convenience) that $v(q_S = 0, q_E = 0, a_B, a_S, a_E, \theta) = c_S(q_S = 0, a_S, a_B, \theta) = c_E(q_E = 0, a_B, a_E, \theta) = 0$. We will make additional assumptions on the nature of these sets and functions as the need arises.

We assume that the ex post allocation $(q_j, t_j)_{j \in \{S, E\}}$ arises from a three-party bargaining process. We model this bargaining using cooperative game theory, by assuming that each player receives an ex post payoff that is a linear function of the player’s marginal contributions to the various possible coalitions of which it can be a member.¹¹ This approach encompasses as special cases a number of bargaining models, both cooperative and noncooperative, that have been used previously in the literature.

Absent an ex post agreement on trade, the default trade and transfer outcome is $q_j = t_j = 0$ for all $j \in \{S, E\}$. Thus, under a nonexclusive contract ($e = 0$) the surplus that can be achieved ex post through an efficient agreement among the members of coalition J given investments a and state of the world θ , denoted by $\widehat{V}_J(a, \theta)$, is

$$\begin{aligned} \widehat{V}_{SE}(a, \theta) &= \widehat{V}_j(a, \theta) = 0 \quad \text{for all } j \in N, \\ \widehat{V}_{BS}(a, \theta) &= \max_{q_S \in Q_S} [v(q_S, q_E = 0, a, \theta) - c_S(q_S, a, \theta)], \\ \widehat{V}_{BE}(a, \theta) &= \max_{q_E \in Q_E} [v(q_S = 0, q_E, a, \theta) - c_E(q_E, a, \theta)], \\ \widehat{V}_{BSE}(a, \theta) &= \max_{(q_S, q_E) \in Q} [v(q_S, q_E, a, \theta) - c_S(q_S, a, \theta) - c_E(q_E, a, \theta)]. \end{aligned} \tag{3}$$

In contrast, under an exclusive contract ($e = 1$), the members of coalition J can agree to a positive trade level if and only if coalition J includes S . Moreover, if S is a member of J , the existence of the exclusive contract in no way limits the set of trades that J ’s members can agree to. Thus, letting $\overline{V}_J(a, \theta)$ denote the surplus achievable by coalition J under an exclusive contract given investments a and state of the world θ , we have $\overline{V}_J(a, \theta) = \widehat{V}_J(a, \theta)$ for $J \neq \{BE\}$, and $\overline{V}_{BE}(a, \theta) = 0$. Note, in particular, that the only difference in achievable surplus occurs for coalition BE , which cannot trade in the presence of an exclusive contract. We can therefore define coalition J ’s value under a contract with exclusivity provision e given investments a and state of the world θ by

$$V_J(a, e, \theta) \equiv (1 - e)\widehat{V}_J(a, \theta) + e\overline{V}_J(a, \theta) = \begin{cases} \widehat{V}_J(a, \theta) & \text{for } J \neq \{BE\}, \\ (1 - e)\widehat{V}_{BE}(a, \theta) & \text{for } J = \{BE\}. \end{cases} \tag{4}$$

¹¹For an introduction to cooperative game theory, see Mas-Colell et al. [1995], Appendix A to Ch. 19.

Define $M_j^J(a, e, \theta) = [V_{J \cup j}(a, e, \theta) - V_J(a, e, \theta)]$ to be agent j 's marginal contribution to coalition J . We assume that that agent j 's bargaining payoff, denoted by $f_j(a, e, \theta)$, is a nonnegatively weighted linear combination of its marginal contributions:

$$f_j(a, e, \theta) = \sum_{J \subset N \setminus j} \alpha_j^J M_j^J(a, e, \theta), \quad (5)$$

where the α_j^J 's are nonnegative parameters satisfying an adding-up restriction (introduced below for our specific model) that the sum of the agents' payoffs always equals $V_{BSE}(a, e, \theta)$.¹² In the present setting, where $V_j(a, \theta, e) = 0$ for all $j \in N$ and $V_{SE}(a, \theta, e) = 0$, the bargaining solution (5) reduces to:

$$\begin{aligned} f_B(a, e, \theta) &= \alpha_B^{SE} V_{BSE}(a, e, \theta) + \alpha_B^S V_{BS}(a, e, \theta) + \alpha_B^E V_{BE}(a, e, \theta), \\ f_S(a, e, \theta) &= \alpha_S^{BE} [V_{BSE}(a, e, \theta) - V_{BE}(a, e, \theta)] + \alpha_S^B V_{BS}(a, e, \theta), \\ f_E(a, e, \theta) &= \alpha_E^{BS} [V_{BSE}(a, e, \theta) - V_{BS}(a, e, \theta)] + \alpha_E^B V_{BE}(a, e, \theta). \end{aligned} \quad (6)$$

Substituting from (4) into (6), we obtain:

$$\begin{aligned} f_B(a, e, \theta) &= \alpha_B^{SE} \widehat{V}_{BSE}(a, \theta) + \alpha_B^S \widehat{V}_{BS}(a, \theta) + \alpha_B^E (1 - e) \widehat{V}_{BE}(a, \theta), \\ f_S(a, e, \theta) &= \alpha_S^{BE} [\widehat{V}_{BSE}(a, \theta) - (1 - e) \widehat{V}_{BE}(a, \theta)] + \alpha_S^B \widehat{V}_{BS}(a, \theta), \\ f_E(a, e, \theta) &= \alpha_E^{BS} [\widehat{V}_{BSE}(a, \theta) - \widehat{V}_{BS}(a, \theta)] + \alpha_E^B (1 - e) \widehat{V}_{BE}(a, \theta). \end{aligned} \quad (7)$$

The adding up restriction then requires that

$$\alpha_B^{SE} + \alpha_S^{BE} + \alpha_E^{BS} = 1, \quad \alpha_B^S + \alpha_S^B = \alpha_E^{BS}, \quad \text{and} \quad \alpha_B^E + \alpha_E^B = \alpha_S^{BE}. \quad (8)$$

As noted above, our primary motivation for taking this approach to bargaining is that it nests a number of bargaining models previously used in the literature, most notably split-the-surplus bargaining with a competitive external source and the Shapley value.¹³ The former solution, used in the simple example of Section 2, arises when $\alpha_E^J = 0$ for all nonempty $J \subset N \setminus E$, and $\alpha_S^B = \alpha_B^S = 0$. Then, using (8), (6) can be rewritten as

$$\begin{aligned} f_B(a, e, \theta) &= (1 - \alpha_S^{BE}) [V_{BSE}(a, e, \theta) - V_{BE}(a, e, \theta)] + V_{BE}(a, e, \theta), \\ f_S(a, e, \theta) &= \alpha_S^{BE} [V_{BSE}(a, e, \theta) - V_{BE}(a, e, \theta)], \\ f_E(a, e, \theta) &= 0. \end{aligned}$$

¹²Weber [1988, Theorem 4] gives an axiomatic foundation for this bargaining solution, using the linearity, dummy, monotonicity, and Pareto optimality axioms.

¹³Note that both of these bargaining outcomes can be implemented in a non-cooperative way without any direct communication between S and E ; thus, our approach to modeling bargaining payoffs in no way requires an agreement be reached among all three parties.

The Shapley value is obtained by imposing the symmetry property that $\alpha_j^{J \setminus j}$ is only a function of $|J|$, and not of the identities of player j or coalition J 's members. Then (8) implies that $\alpha_j^{J \setminus j} = \frac{1}{3}$ if $|J| = 2$, $\frac{1}{6}$ if $|J| = 1$, and $\frac{1}{3}$ if $J = \emptyset$.¹⁴

Let $A^*(e) \subset A = \prod_{j \in N} A_j$ denote the set of Nash equilibria in the game in which each party j 's strategy is its investment choice $a_j \in A_j$, and j 's payoff is $U_j(a, e) = E_\theta(f_j(a, \theta, e)) - \psi_j(a_j)$. Formally, $A^*(e)$ is the set of vectors $a^* = (a_B^*, a_S^*, a_E^*) \in A$ such that

$$a_j^* \in \arg \max_{a_j \in A_j} U_j(a_j, a_{-j}^*, e) \text{ for every } j \in N. \quad (9)$$

In general, this investment game can have multiple Nash equilibria, so that $A^*(e)$ need not be single-valued. Because of this, our comparative statics results will use a notion of monotonicity of a correspondence. Specifically, letting X and Y be two partially ordered sets,¹⁵ we say that:¹⁶

Definition 1 *The correspondence $G : X \rightarrow Y$ is nondecreasing if whenever $x' \sqsubseteq x''$, we have $\max G(x') \sqsubseteq \max G(x'')$ and $\min G(x') \sqsubseteq \min G(x'')$.*

In the case where $G(\cdot)$ is single-valued, this notion corresponds to the usual notion of a nondecreasing function. For a single-valued function, we shall also use the notation $G(\widehat{X}) \equiv \{G(x) : x \in \widehat{X}\}$.

Finally, up to this point, we have restricted attention to either a fully exclusive ($e = 1$) or a fully nonexclusive ($e = 0$) contract. In what follows, we treat exclusivity more continuously by letting $e \in [0, 1]$ denote the *probability* that S has an exclusive right. This reinterpretation of the variable e leads to no change in the specification of our bargaining payoffs in (7).¹⁷ In a model in which many periods of trade follow the parties' investments, one can also interpret this probability in terms of the *duration* of the exclusivity provision.

¹⁴Our bargaining solution also covers some cases of the noncooperative bargaining model of Spier and Whinston [1995].

¹⁵A partial ordering is a transitive, reflexive, and antisymmetric binary relation - see Milgrom and Roberts [1990].

¹⁶The concept is adapted from Milgrom and Roberts [1990]. Note that the definition applied to the correspondence $A^*(e)$ makes sense only when the maximum and minimum points in the equilibrium set exist. In fact, our assumptions will ensure that the set of equilibrium investments is nonempty and has a maximum and minimum point (see Milgrom and Roberts [1990]). When only one party has an investment choice, our comparative statics results can be stated using a stronger notion of monotonicity, called the "strong set order" (see Milgrom and Shannon [1994]).

¹⁷The realization of the randomly determined exclusivity provision occurs before bargaining commences, and our bargaining payoffs correspond to the players' expected payoffs prior to this realization.

3.2 The Irrelevance Result

Given this general model of investment and hold-up, we can now state more general conditions under which the irrelevance result of our simple example (in Section 2) holds:

Proposition 1 (The Irrelevance Result) *If $v(q_S = 0, q_E, a, \theta)$ and $c_E(q_E, a, \theta)$ do not depend on the investments $a = (a_B, a_S, a_E)$, then $A^*(e)$ does not depend on the degree of exclusivity e .*

Proof. Under the stated conditions, $\widehat{V}_{BE}(a, \theta)$ does not depend on a . Given this, and the payoffs in (7), it is immediate that the set of Nash equilibria is unaffected by e . ■

The idea behind the result is simple. Recall that the exclusivity parameter e affects only the value of coalition BE . If investments do not affect the value of BE , then exclusivity does not affect the marginal returns to investment for any of the agents. This was precisely the case in the simple example of Section 2: there, S 's investment lowered S 's production cost, but had no effect on either E 's cost or B 's value from consuming E 's product. Hence, S 's investment in that example had no impact on the value of coalition BE , and consequently exclusivity had no effect on investment incentives. Proposition 1, of course, applies to more cases than just investment by S in cost reduction; we may for example have investment by S that enhances its product or investments by B in learning to more effectively use S 's product. As long as investments do not affect the value of trade between B and E , exclusivity will be irrelevant for investment incentives.

4 Internal and External Investments: Definitions

Proposition 1 tells us that exclusivity is irrelevant for *internal* investments, that is, those that affect only the value of “internal trade” between B and S . According to Proposition 1, for exclusivity to affect ex ante investments, some component of these investments must be *external*, that is, must affect the value of trade between B and E . Formally, it is convenient to separate each party j 's investments a_j into two components, “internal” investments a_j^i , and “external” investments a_j^e , so that internal/external investments affect only internal/external values respectively. Specifically, we suppose that $v(q_S = 0, q_E, a^i, a^e, \theta)$ and $c_E(q_E, a^i, a^e, \theta)$, and therefore $\widehat{V}_{BE}(a, \theta)$, do not depend on a^i , and that $v(q_S, q_E = 0, a^i, a^e, \theta)$

and $c_S(q_S, a^i, a^e, \theta)$, and therefore $\widehat{V}_{BS}(a, \theta)$, do not depend on a^e .¹⁸ We write $A_j = A_j^i \times A_j^e$ for each $j \in N$, where A_j^i and A_j^e are the sets of party j 's internal and external investments respectively, and define $A^i = \prod_{j \in N} A_j^i$ and $A^e = \prod_{j \in N} A_j^e$.

Investments that are specific to trades between B and S have only an internal component. Purely external investments, on the other hand, affect the gains from trade between B and the external supplier E , but have no effect on the gains from trade between B and S when B does not trade with E . For example, a buyer's investment in learning how to use E 's product is external. Another example of a purely external investment is E 's sunk cost of entry: it does not affect the value of B 's trade with S , but does enhance the value of B 's trade with E (possibly from zero).

Many situations of economic interest involve investments with both internal and external components. For example, Marvel [1982] and Masten and Snyder [1993] consider a seller's investments in promotion and training, which a buyer can use with other sellers' products. Klein [1988] discusses the general investments of GM (the buyer in its relationship with Fisher) in the production, distribution, and marketing of automobiles, whose value (presumably) did not depend on the source of GM's automobile bodies. Another example arises in Areeda and Kaplow's [1988] discussion of a retailer's allocation of promotional efforts toward various manufacturers' brands (here the retailer is the buyer).

Notice that these examples differ in two ways: (i) who is making external investments (the seller in Marvel [1982] and Masten and Snyder [1993]; the buyer in Klein [1988] and Areeda and Kaplow [1988]) and (ii) the complementarity/substitutability of internal and external investments (complementarity in Marvel [1982], and Masten and Snyder [1993], and Klein [1988]; substitutability in Areeda and Kaplow [1988]). We will see that these two dimensions are critical determinants of the effects of exclusivity on investments.

Although exclusivity has no direct effect on internal investments (Proposition 1), it does have a direct effect on external investments. This effect can be seen by inspecting the parties' ex post payoffs (7). Exclusivity e increases the share of V_{BE} received by S , and lowers the share of V_{BE} received by B and E . As a result, it increases S 's incentive to make external investments and lowers the incentives of B and E to make such investments.¹⁹ Using the

¹⁸If an investment affects both $\widehat{V}_{BE}(a, \theta)$ and $\widehat{V}_{BS}(a, \theta)$, we formally split it in two, and assume that the investment cost function displays the property of perfect investment cost complementarity between these two investments, as defined below.

¹⁹When only one party invests and its investment is purely external, these increases and decreases in incentives are certain to translate into higher and lower levels of external investments. When more than one party

analogy to asset ownership introduced in Section 2, these findings are related to the idea of Hart and Moore [1990] that asset ownership increases a party’s incentive to invest. Thus, transferring the “exclusivity asset” from B or E to S increases S ’s external investment, but reduces B ’s or E ’s.²⁰

In general, however, a shift in external investments will lead the parties to adjust their internal investments as well. Note that this indirect effect of exclusivity on internal investments is of primary concern in the literature described above. To understand this effect, we need to understand the interactions between internal and external investments in the parties’ payoff functions. There are three potential sources of such interactions:

1. *Interactions in the investment cost functions* $\psi_j(a_j^i, a_j^e)$. This is, perhaps, the most immediate form of interaction between internal and external investments. It arises, for example, when the seller invests in non-appropriable promotion and training, as in Marvel [1982] and Masten and Snyder [1993], or when the buyer makes a general investment, such as GM’s investment discussed in Klein [1988]. In these two cases, internal and external investments can be viewed as complementary in the investing party’s investment cost function. Internal and external investments may also be substitutable in investment cost functions, as in Areeda and Kaplow’s [1988] discussion of a retailer’s allocation of promotional efforts among brands.

The easiest cases to study will be those in which internal investments are *perfect investment cost complements* or *substitutes*. For example, when the seller makes a one-dimensional investment in promotion or training which increases the value of both internal and external trades, we will say that his internal and external investments are perfect investment cost complements. Another example of such complementarity is the buyer’s “general” one-dimensional investment which increases her valuation for both sellers’ products. An example of perfect investment cost substitutability is a situation in which a retailer allocates a fixed one-dimensional resource (attention span, shelf space, etc.) between brands. Formally, these cases can be defined as follows:

makes external investments, however, definitive predictions require assumptions about the complementarity or substitutability of these investments. Throughout the paper we restrict attention to cases in which only one party invests externally.

²⁰Note, however, that in contrast to Hart and Moore [1990], when S is the only investing party, it may be uniquely optimal to give S ownership rights (i.e. have exclusivity) even though B is essential for trade. The reason for this difference is that here there is an agent (S) whose investment affects the value of a coalition (coalition BE) that the agent does not belong to, which is ruled out by Hart and Moore’s assumptions.

Definition 2 *The internal and external investments of party j are perfect investment cost complements if there exist a scalar variable²¹ $r \in R$ and nondecreasing functions $\tilde{a}_j^i : R \rightarrow A_j^i$ and $\tilde{a}_j^e : R \rightarrow A_j^e$ such that $\psi_j(a_j^i, a_j^e)$ takes finite values for all*

$$(a_j^i, a_j^e) \in \bar{A} \equiv \{(\tilde{a}_j^i(r), \tilde{a}_j^e(r)) : r \in R\}$$

and infinite values for all $(a_j^i, a_j^e) \notin \bar{A}$. They are perfect investment cost substitutes if $\tilde{a}_j^i(\cdot)$ is instead a nonincreasing function of r .

With perfect investment cost complements, internal and external investments necessarily move together while with perfect investment cost substitutes, internal and external investments necessarily move in opposite directions. (In both cases the various internal investments necessarily move together, as do the various external investments.)

While the effect of exclusivity on investments will be the easiest to identify in these two cases, they are quite restrictive. Often internal and external investments will be complementary or substitutable, but only imperfectly so. In these situations, other interactions between internal and external investments will prove to be important.²²

2. *Interactions of investments (a^i, a^e) in the buyer's valuation $v(\cdot)$.* This type of interaction can arise in a number of ways. As one example, consider a situation in which a buyer can receive training in the use of both S and E 's products from each of the two different sellers. If training in the use of one product reduces B 's difficulty of learning about the other product, then this introduces a complementarity between these internal and external investments in $v(\cdot)$. On the other hand, B 's disutility of receiving one type of training is increased by having received the other (e.g. the disutility is time-related and B has decreasing marginal benefit for leisure), then these internal and external investments will be substitutes in $v(\cdot)$.

3. *Interactions of trades (q_S, q_E) in the buyer's valuation $v(\cdot)$.* This is the most subtle form of interaction between internal and external investments. Of primary concern in antitrust analysis is the case in which q_S and q_E are substitutes in the buyer's valuation. This gives rise to an indirect substitutability between internal and external investments. For example, suppose again that B is a retailer, and q_S and q_E are her sales of two competing

²¹The variable $r \in R$ is a scalar if the set R is fully ordered (that is, if R is a "chain"; see Milgrom and Roberts [1990]). For example, any subset of the set \mathfrak{R} of real numbers is fully ordered.

²²A reader who is only interested in the cases of perfect investment substitutes and complements can safely skip the rest of this section.

brands. Suppose also internal/external investments are complementary to internal/external trades respectively. Then B 's promotion of the external brand increases the brand's optimal sales q_E , thereby reducing the optimal sales of the internal brand q_S , which in turn reduces B 's marginal benefit of promoting the internal brand.

In general, all three of these types of interaction between internal and external activities will matter. To obtain definitive comparative statics results we need to identify conditions under which these effects do not counteract each other. To do so, we identify cases in which we can represent the investment game as a supermodular game, and apply the monotone comparative statics results of Milgrom and Roberts [1990]. This framework is ideally suited for analyzing the effects of exclusivity, which depend heavily on the complementarity or substitutability between internal and external investments.

In some cases, all three types of interactions will reinforce each other. These are the cases of *full internal/external complementarity* and *substitutability*. Formally:

Definition 3 *We have full internal/external complementarity [substitutability] if*

1. $v(\cdot), -c_S(\cdot), -c_E(\cdot)$ are supermodular in (q, a) [in $(-q_S, q_E, -a^i, a^e)$],
2. all $-\psi_j(\cdot)$ are supermodular in a [in $(-a_j^i, a_j^e)$]

The supermodularity conditions for the case of full complementarity mean that: (i) Internal and external goods are complements for the buyer; (ii) Investments increase the buyer's marginal valuations for trades and reduce the sellers' marginal costs; and (iii) Investments are investment cost complements. The conditions for the case of full substitutability mean that (i) Internal and external goods are substitutes for the buyer; (ii) Internal (external) investments increase the buyer's marginal valuations for internal (external) trades, reduce the buyer's marginal valuation for external (internal) trades, and reduce the sellers' marginal costs of internal (external) trades; and (iii) Internal investments are investment cost substitutes to external investments.

The case of full complementarity corresponds closely to the conditions assumed by Hart and Moore [1990]. This case is of limited interest in antitrust analysis, however, which mainly concerns itself with situations in which the two sellers' goods are substitutes. When investments are complements in investment cost functions, but the goods are substitutes in the buyer's valuation, investment interactions of the third kind may counteract interactions

of the first kind and rule out definitive comparative statics predictions. The case of perfect investment cost complements provides one setting in which internal and external investments must move together regardless of interactions of the third kind. Another such setting arises when the levels of efficient trade for all coalitions are independent of investments:

Definition 4 *Trades are independent of investments if for all $\theta \in \Theta$ there exists a triple $(q^*(\theta), q_S^*(\theta), q_E^*(\theta)) \in Q \times Q_S \times Q_E$ such that for all $a \in A$ we have*

$$\begin{aligned} q^*(\theta) &\in \arg \max_{(q_S, q_E) \in Q} v(q_S, q_E, a, \theta) - c_S(q_S, a^i, \theta) - c_E(q_E, a^e, \theta), \\ q_S^*(\theta) &\in \arg \max_{q_S \in Q_S} v(q_S, 0, a^i, \theta) - c_S(q_S, a^i, \theta), \\ q_E^*(\theta) &\in \arg \max_{q_E \in Q_E} v(0, q_E, a^e, \theta) - c_E(q_E, a^e, \theta). \end{aligned}$$

This condition is encountered, for example, when the buyer wants at most a single indivisible unit of either good and the internal trade is always efficient. This assumption has been made in the models of Holmstrom and Tirole [1991] and Hart [1995, Ch.2]. More generally, whether external or internal trade is efficient may depend on the realization of uncertainty θ , but not on the parties' investments a .

When trades are independent of investments we can obtain definitive comparative statics results with assumptions only on the first two types of interactions between internal and external investments. Formally, we will use the following notions:

Definition 5 *We have internal/external investment complementarity [substitutability] if*

1. $v(\cdot), -c_S(\cdot), -c_E(\cdot)$ are supermodular in a [in $(-a^i, a^e)$],
2. all $-\psi_j(\cdot)$ are supermodular in a [in $(-a_j^i, a_j^e)$].

Finally, our subsequent analysis will make use of the following assumptions:

(A.1) $v(\cdot), -c_S(\cdot), -c_E(\cdot)$ are nondecreasing in a .

(A.2) Q_S, Q_E , and A_j for $j = B, S, E$ are lattices and $\min Q_j = 0$ for $j \in \{S, E\}$.

(A.3) $|A_E^i| = 1$.

Assumption (A.1) says that investments increase the buyer's utility and reduce the sellers' costs. (We have been implicitly making this assumption in the preceding discussion.) Assumption (A.2) is necessary for applying the theory of supermodular games of Milgrom and Roberts [1990], where the formal definition of a lattice can be found. Every compact product set in \mathfrak{R}^k has this property: as one simple example, we could take $q_j \in [0, \bar{q}_j] \subset \mathfrak{R}_+$ for $j \in \{S, E\}$ and $a \in [0, \bar{a}]^k \subset \mathfrak{R}_+^k$ for some k . Alternatively, we might be in the often-studied situation in which quantities are indivisible, so that $q_j \in \{0, 1\}$. Assumption (A.3) says that E has no internal investment decision.

5 Complementary Investments

In this section we study the effects of exclusivity on investments and welfare in the cases of complementarity between internal and external investments. Before formulating general results, it is instructive to consider a very simple case of complementary investments. Specifically, consider a modification of the example of Section 2 in which the investment $a \in \mathfrak{R}_+$ affects not S 's production cost c_S (which is now fixed), but B 's valuation for S 's and E 's goods. Denote B 's valuation by $v(a)$, where $v'(\cdot) > 0$, $v''(\cdot) < 0$. The cost of investment is $\psi(a)$, where $\psi(0) = 0$, $\psi'(0) = 0$, and $\psi''(a) > 0$. Hence, investment in this model is completely general, i.e. internal and external investments are perfect investment cost complements. Suppose in addition that internal trade is always more efficient than external trade, which is in turn more efficient than not trading: $c_S < c_E < v(a)$ for all $a \in \mathfrak{R}_+$. The efficient investment level a° thus satisfies $v'(a^\circ) = \psi'(a^\circ)$.

Suppose first that S is the party making the investment a . S 's ex post payoff (excluding the cost of investment) is given by

$$U_S(a, e) = \frac{1}{2} [(v(a) - c_S) - (1 - e)(v(a) - c_E)].$$

Without an exclusive S receives no ex post return on his investment, hence S will set $a = 0$. With an exclusive contract, S will choose a so that $\frac{1}{2}v'(a) = \psi'(a)$, which will result in a strictly positive, though still socially suboptimal, level of investment. Hence, exclusivity increases S 's investment, and increases welfare in this case.

Suppose instead that it is B who makes the investment a . B 's ex post payoff is

$$U_B(a, e) = (1 - e)(v(a) - c_E) + \frac{1}{2} [(v(a) - c_S) - (1 - e)(v(a) - c_E)].$$

Hence, B chooses a so that $(1 - \frac{e}{2})v'(a) = \psi'(a)$. When $e = 0$, B makes the efficient investment choice, while a contract with $e = 1$ results in a lower level of investment. In this case, exclusivity lowers investment, and reduces welfare.

Using the techniques of monotone comparative statics, these simple observations can be extended to substantially more general settings of complementarity between internal and external investments. For the sake of expositional simplicity, we formulate all of our general results as *weak* comparative statics results (that is, we establish that certain investments are nondecreasing or nonincreasing in exclusivity). As the above examples suggest, however, under weak additional assumptions our comparisons would be strict.²³

5.1 Comparative Statics

Our general comparative statics result for complementary investments is given in the following proposition (the proof of this and subsequent results are given in the Appendix):

Proposition 2 *Suppose that (A.1) – (A.3) hold and that either (i) only one party invests and its internal and external investments are perfect investment cost complements, (ii) we have full internal/external complementarity, or (iii) we have internal/external investment complementarity and efficient trades are independent of investments. Then*

- (a) *If only S has an external investment choice and a_S^e is a scalar, then $A^*(e)$ is nondecreasing in e .*
- (b) *If only B and/or E have external investment choices, then $A^*(e)$ is nonincreasing in e .*

Proposition 2 establishes that in all of the cases of complementarity defined in Section 4, exclusivity moves internal and external investments in the same direction, which is determined by the direct effects of exclusivity on external investments. The results correspond well with the arguments made in the informal literature. As suggested by Marvel [1982] and Masten and Snyder [1993], Proposition 2(a) shows that exclusivity encourages a seller’s general investment. At the same time, Proposition 2(b) tells us that exclusivity discourages a buyer’s general investment. This latter result accords well with Klein [1988]’s observation that the GM-Fisher exclusive contract exposed GM’s (general) investments to hold-up by Fisher.

²³The only additional assumptions required are that the parties’ payoffs are differentiable and equilibrium investments are in the interior of the feasible set (see Edlin and Shannon [forth.]).

5.2 Welfare

In this subsection we evaluate the effects of exclusive contracts on welfare. We examine the effects of exclusive contracts on total welfare, on the joint payoff of B and S (to determine the private incentives to write an exclusive contract), and on E 's payoff (to determine the external effect of an exclusive contract).

The strongest welfare results obtain in the fully complementary case. Letting $U_J(a, e) = \sum_{j \in J} U_j(a, e)$ denote the total ex ante surplus of a coalition $J \subset N$,²⁴ we have:

Proposition 3 *Suppose that assumptions (A.1) – (A.3) hold and that we have full internal/external complementarity. Then:*

- (a) *If only S has an external investment choice and a_S^e is a scalar, then $U_{BSE}(A^*(e))$ and $U_{BS}(A^*(e), e)$ are nondecreasing in e .*
- (b) *If only B and/or E has an external investment choice, then $U_{BSE}(A^*(e))$ and $U_E(A^*(e), e)$ are nonincreasing in e .*

Proposition 3 tells us that with full internal/external complementarity, aggregate welfare U_{BSE} increases with higher levels of exclusivity if and only if S is the party who invests externally. The intuition behind this result is that under the condition of full complementarity, each party's investment increases other parties' marginal contributions to all coalitions, thus raising their ex post bargaining payoffs. Because of this positive externality, all of the parties have socially suboptimal investment incentives. Since exclusivity leads to an increase or decrease in all investments, the sign of the effect on total welfare is unambiguous. (Note that these results are analogous to those of Hart-Moore [1990], who assume that all investments are complementary to each other).

Proposition 3 implies that in the case in which E is competitive, where $U_{BSE} = U_{BS}$, B and S would sign an exclusive contract if and only if S invests externally. With a noncompetitive E , however, B and S may sign a welfare-reducing exclusive contract even when B invests externally because the exclusive helps B and S extract E 's rents (i.e. exclusivity may raise U_{BS} but lower U_{BSE} because of its effect on U_E). This effect parallels that in Aghion

²⁴Observe that the ex ante aggregate social welfare $U_{BSE}(a, e)$ does not depend on e directly: $U_{BSE}(a) = E_\theta \widehat{V}_{BSE}(a, \theta) - \sum_{j \in N} \psi_j(a_j)$.

and Bolton [1987] (although products here are complements rather than substitutes), but does not rely on an absence of renegotiation.²⁵

The case of full complementarity analyzed in Proposition 3 is of limited interest in antitrust analysis, however, which mainly concerns itself with situations in which the two sellers' goods are substitutes. Absent full complementarity, general welfare results become significantly harder to obtain.²⁶ The problem is that investments can now have negative, as well as positive, externalities. For example, when external and internal goods are substitutes, S 's internal investment may reduce E 's marginal contribution to the grand coalition, thus reducing E 's payoff. For cases in which internal and external goods may be substitutes, while internal and external investments are complements, we have the following results (which are weaker than those in Proposition 3):

Proposition 4 *Suppose that (A.1) – (A.3) hold, and that either (i) only one party invests and its internal and external investments are perfect investment cost complements, or (ii) we have internal/external investment complementarity and efficient trades are independent of investments. Then*

- (a) *If only S invests externally and a_S^e is a scalar, then $U_{BS}(A^*(e), e)$ is nondecreasing in e .*
- (b) *If only B invests externally, E is competitive, and $E_\theta \widehat{V}_{BSE}(a_S, a_B, \theta)$ is strictly increasing in a_B , then $U_{BS}(A^*(e), e)$ is nonincreasing in e for e close enough to 1. If, moreover, $[\widehat{V}_{BSE}(a, \theta) - \widehat{V}_{BE}(a, \theta)]$ is nondecreasing in a_B , then $U_{BS}(A^*(e), e)$ is nonincreasing in e for all $e \in [0, 1]$.*

The assumption on $E_\theta \widehat{V}_{BSE}(a_S, a_B, \theta)$ in part (b) is rather weak, since (A.1) implies that $\widehat{V}_{BSE}(a_S, a_B, \theta)$ is always nondecreasing in a_B . The proof of part (b) is based on the fact that under the assumptions, B 's investments have a positive externality on S when e is close to 1. Hence, by reducing these investments, exclusivity reduces B and S 's joint surplus. (The condition leading to the *global* result in part (b) implies that the external effect on S

²⁵This is not the only negative externality that can arise from exclusive contracts; Rasmusen, Ramseyer, and Wiley [1991] and Segal and Whinston [forth.] consider the externality that exclusive contracts have on other buyers (which are absent from our model).

²⁶Rajan and Zingales [1998] independently observe that the welfare results of Hart and Moore [1990] do not go through when their assumptions on complementarity of investments are not satisfied. (In particular, Rajan and Zingales show that welfare may be increased in such cases by taking an asset away from the only investing party.)

is always positive; it is quite special, but applies in the example at the beginning of this section.) In part (a), on the other hand, S 's investments have a positive externality on B ; by raising these investments, exclusivity increases B and S 's joint surplus.

Proposition 4(a) tells us that when S makes complementary internal and external investments (as in Marvel [1982] and Masten and Snyder [1993]), B and S can be expected to sign an exclusive arrangement. When the external supply is competitive, this arrangement is necessarily efficient; when E is not competitive, E 's payoff may decrease as a result of this exclusive, and the arrangement may not be socially efficient.

Proposition 4(b) tells us that when B makes complementary internal and external investments (such as GM's investments in auto production capability in Klein [1988]), B and S will never find it optimal to sign a fully exclusive contract. The result seems consistent with the difficulties, noted by Klein [1988], that arose under the GM-Fisher Body exclusive contract. If, as seems likely, GM was making important general investments, this result provides support for GM's conclusion that its exclusive contract with Fisher was not working to its advantage.^{27,28}

The comparative statics and welfare results of this section are summarized in the upper panel of Table 1. The effects of exclusivity depend on which party makes external investments, with the three columns covering the cases in which it is S , B , and E respectively. Additional assumptions required for specific results are given in footnotes.

6 Substitutable Investments

In this section, we provide comparative statics and welfare results for the case of substitutable investments. Before proceeding to our general result, consider the following simple case of substitutable investments. Modify the example of Section 2 so that B 's valuations for S 's and E 's products are $v(a)$ and $v(1-a)$ respectively, where $a \in [0, 1]$, $v'(\cdot) > 0$ and $v''(\cdot) < 0$. The cost of investment is $\psi(a)$ where $\psi''(\cdot) > 0$ and $\psi'(\frac{1}{2}) = 0$, so that investment costs are

²⁷GM responded to this concerns by vertically integrating with Fisher, a possibility not present in our model. This feature could be incorporated, however, by also introducing some asset of Fisher's that vertical integration might shift to GM's control. The advantage of this shift would be that GM's external investments would no longer be expropriated by Fisher; the disadvantage, presumably, would be some loss of motivation on the part of Fisher's managers (as in Grossman and Hart [1986]).

²⁸Tirole [1988, p.25] makes a related point. He considers a model with one seller and many buyers and shows that the greater the specificity of the seller's cost-reducing investments to a single buyer, the greater the distortion in those investments. Greater specificity in his model therefore has effects like greater exclusivity in ours (adjusting for the reversal of the buyer and seller roles).

minimized at $a = \frac{1}{2}$. Note that in this example internal and external investments are perfect investment cost substitutes. We suppose, again, that internal trade is always more efficient than external trade, which is in turn more efficient than not trading: $c_S < c_E < v(a)$ for all $a \in [0, 1]$. Assuming that $v'(1) < \psi'(1)$, the efficient investment level a° satisfies $v'(a^\circ) = \psi'(a^\circ)$, and in particular $a^\circ \in (\frac{1}{2}, 1)$.

The ex post payoffs of B and S following an investment of a (excluding investment costs) are

$$\begin{aligned} U_B(a, e) &= (1 - e) [v(1 - a) - c_E] + \frac{1}{2} \{ [v(a) - c_S] - (1 - e) [v(1 - a) - c_E] \}, \\ U_S(a, e) &= \frac{1}{2} \{ [v(a) - c_S] - (1 - e) [v(1 - a) - c_E] \}. \end{aligned}$$

Suppose, first, that it is B who makes the investment. For example, the investment may involve deciding how much time to devote to promoting the products of S and E . The amount of time available is 1, and a represents the amount of time devoted to promoting S 's product, with the remainder of B 's available time devoted to promoting E 's product. The shape of the investment cost function $\psi(\cdot)$ reflects an increasing marginal disutility of time spent promoting any one product (in the limit where $\psi(\cdot)$ is a constant, B simply has a fixed amount of time to allocate costlessly). Then B 's optimal choice of a given e satisfies $\frac{1}{2} [v'(a) - (1 - e)v'(1 - a)] = \psi'(a)$. When $e = 0$, B sets $a = \frac{1}{2}$. On the other hand, when $e = 1$, B chooses $a \in (\frac{1}{2}, a^\circ)$. Hence, exclusivity in this example increases B 's internal investment, reduces its external investment, and raises welfare.

Now suppose that it is S who makes the investment a . In this case, we might imagine that S can choose how specifically to train B , with $a = \frac{1}{2}$ being general training and $a = 1$ being training that is fully specific to S 's product. The shape of the investment cost function $\psi(\cdot)$ reflects a situation in which it is more costly for S to train B specifically. In this case, S chooses a so that $\frac{1}{2} [v'(a) + (1 - e)v'(1 - a)] = \psi'(a)$. Here, exclusivity reduces the level of a (i.e. reduces the specificity of S 's investment). Since $a < a^\circ$ when $e = 1$, we can conclude that a small reduction in e below $e = 1$ raises welfare (note that S invests excessively when $e = 0$).

6.1 Comparative Statics

For the case of substitutable investments our general comparative statics result is:

Proposition 5 *Suppose (A.1) – (A.3) hold and that either (i) only one party invests and its internal and external investments are perfect investment cost substitutes, (ii) we have full internal/external substitutability, or (iii) we have internal/external investment substitutability and efficient trades are independent of investments. Define $\bar{A}^*(e) = \{(-a_j^i, a_j^e) : (a_j^i, a_j^e) \in A^*(e)\}$. Then*

- (a) *If only S has an external investment choice and a_S^e is a scalar, then $\bar{A}^*(e)$ is nondecreasing in e .*
- (b) *If only B and/or E have external investment choices, then $\bar{A}^*(e)$ is nonincreasing in e .*

The proposition establishes that when internal and external investments are substitutes, exclusivity moves them in opposite directions. Thus, while exclusivity has the same effect on external investments as in the previous section, its effect on internal investments has the opposite sign: they decrease when S invests externally, and increase when B and/or E invests externally. These effects are described in the lower panel of Table 1, in the panel labeled “Comparative Statics”.

The result for the case in which B makes substitutable internal and external investments is consistent with the “dealer loyalty” motivation for exclusive dealing offered by Areeda-Kaplow [1988]. Namely, by discouraging a retailer’s effort in promoting other manufacturers’ brands, exclusivity indirectly encourages its effort in promoting the “internal” brand. (We are unaware of any discussion in the literature of a case in which S makes substitutable investments.)

6.2 Welfare

For the case of full substitutability, we have the following welfare result:

Proposition 6 *Suppose that (A.1) – (A.3) hold, and that we have full internal/external substitutability. Then*

- (a) *If only B invests externally, and $E_\theta M_S^{BE}(a_S, a_B^i, a_B^e, e = 0, \theta)$ is strictly decreasing in a_B^e , then $U_{BS}(A^*(e), e)$ is nondecreasing in e for e close enough to 0. Moreover, if internal trade is always optimal, then $U_{BS}(A^*(e), e)$ is nondecreasing in e at all $e \in [0, 1]$.*
- (b) *If only B and/or E invests externally, then $U_E(A^*(e), e)$ is nonincreasing in e .*

(c) If only S invests externally and a_S^e is a scalar, E is competitive, internal trade is always optimal, and $\widehat{V}_{BS}(a^i, \theta)$ is strictly increasing in a^i , then $U_{BS}(A^*(e), e)$ is nonincreasing in e for e close enough to 1.

The additional assumption in part (a) is rather mild, since under full substitutability $M_S^{BE}(a_S, a_B^i, a_B^e, e = 0, \theta)$ is always nonincreasing in a_B^e . The proof of part (a) is based on the fact that when e is close enough to zero, B 's internal [external] investments have positive [negative] externalities on S (and this is true at all e if, as in the example above, internal trade is always more efficient ex post). Therefore, by inducing B to raise his internal investments and reduce external ones, exclusivity raises the surplus of the BS coalition. The proof of part (b), on the other hand, is based on the fact that B 's and S 's internal [external] investments have negative [positive] externalities on E .

Proposition 6(a) is consistent with the dealer loyalty motivation for exclusive dealing discussed by Areeda and Kaplow [1988]. It establishes that when B invests externally with full internal/external substitutability, B and S will jointly elect to have at least *some* exclusivity in order to promote B 's internal investments. Moreover, in the special case in which internal trade is always optimal ex post, B and S will sign a fully exclusive contract. When E is competitive, B and S 's decision is also socially optimal, although part (b) tells us that B and S may sign an inefficient exclusive when E is not competitive.

Proposition 6(b) also tells us that when E 's investment is an entry cost, exclusivity will discourage entry, as in Aghion-Bolton [1987]. The social effect of exclusivity in this case is unclear: it may be socially optimal to prevent inefficient entry by E that is motivated by "business stealing" concerns (as in Mankiw and Whinston [1986]). What we do know is that because of the negative externality of exclusivity on E , B and S have a socially excessive incentive to adopt exclusivity, just as in Aghion and Bolton [1987].

Finally, Proposition 6(c) tells us that when S invests externally, E is competitive, and internal trade is always optimal ex post, B and S will not sign a fully exclusive contract.

The welfare effects of exclusivity identified in this section are summarized in the second part of the lower panel of Table 1. In addition, in Table 2 we distill from Table 1 the implications of exclusivity for social welfare in cases with substitute products and a competitive external source.²⁹ Table 2 provides a simple check-list for evaluating the logical consistency

²⁹Specifically, for cases with either perfect investment cost complements/substitutes or with investment cost complements/substitutes and efficient trade independent of investments.

of efficiency-based claims for exclusive contracts when the supply-side of the market is argued to be competitive. To use Table 2 one need only determine the nature of the investments being made by asking: “Is there an external component to the investments being made?”, “Who is making these external investments?”, “Are internal and external investments complements or substitutes?”. Given the answers to these questions, Table 2 indicates whether efficiency concerns would in fact lead to the adoption of an exclusivity provision.

7 More General Contracts

Up to this point we have restricted our attention to an incomplete contracting setting in which B and S could specify only a probability e that external trade is not allowed. In this section, we consider the possibility that B and S might sign more elaborate contracts. In subsection 7.1, we consider how our results are affected if B and S can specify a penalty that B must pay to S if B trades with E . Although we have not considered such terms up to now, they are in fact feasible under our informational assumptions. Then, in subsection 7.2, we suppose that a court can verify trade, so that B and S can include not only an exclusivity provision in their contract, but also a contractually specified trade (or, perhaps, more elaborate options regarding trade).

7.1 Penalties for External Trade

Even when quantities cannot be described in advance, under our assumptions B and S can write a contract in which B must pay S a penalty P in compensation for the right to trade with E . In this case, a fully exclusive contract corresponds to $P = \infty$, while a non-exclusive contract (no contract) corresponds to $P = 0$. It is immediate that such a contract can have no effect on the players’ investment levels in the case in which all investments are internal. To see why, note that given investments a , state of nature θ , and penalty P , B will choose the level of e to maximize $[\alpha_B^E \widehat{V}_{BE}(a, \theta) - P](1 - e)$.³⁰ When investments are purely internal, \widehat{V}_{BE} is independent of a , and therefore B ’s decision of whether to pay the penalty P must also be unaffected by a . Hence, this contract must create exactly the same incentives for investment as one that simply specifies a fixed level of exclusivity. Thus, allowing for such

³⁰Here we have assumed that B must decide on the level of e prior to renegotiation. A similar irrelevance result holds if instead renegotiation occurs prior to B ’s choice of e (in this case, B will choose e in the event of a bargaining breakdown to maximize $[\widehat{V}_{BE}(a, \theta) - P](1 - e)$).

contracts preserves our irrelevance result.^{31,32}

It is worth stressing the difference between this result and results for what may at first appear to be similar models in the literature on stipulated damages for breach of contract (see, for example, Chung [1992] and Spier and Whinston [1995]). In that literature, the level of damages *does* affect players' choices of purely internal investments (such as a seller's investment in cost reduction). The critical difference, however, is that in that literature quantities are verifiable, and so it is possible to specify a price for trade (i.e. the buyer faces an option of whether to trade with the seller or not, with different prices attached to each option). Here, in contrast, the buyer must still bargain with the seller if trade is to occur. We shall say more about this difference in the next subsection.

7.2 When Quantities can be Specified in Advance

We now consider situations in which B and S can specify contractually not only an exclusivity term, but also the terms of trade between them (investments are still non-contractible). We begin by considering the role of exclusivity provisions in specific performance (i.e. fixed-quantity) contracts, and then discuss more general contracts. Although a full analysis is beyond the scope of this paper, here we seek to highlight a number of the issues that arise when contracts can include such provisions.

7.2.1 Specific performance contracts

Suppose that B and S sign a contract that specifies a fixed trade \bar{q}_S between them and a probability $e \in [0, 1]$ that B is not allowed to trade with E (and possibly an up-front monetary transfer). We begin by showing how our irrelevance result generalizes to this setting. When B and S sign a contract (\bar{q}_S, e) , we have the following coalitional values:

$$\begin{aligned} V_B &= v(\bar{q}_S, q_E = 0, a, \theta); & V_S &= V_{SE} = -c_S(\bar{q}_S, q_E = 0, a, \theta); & V_E &= 0 \\ V_{BS} &= \hat{V}_{BS}(a, \theta); & V_{BE} &= V_B + (1 - e) \max_{q_E} [v(\bar{q}_S, q_E, a, \theta) - c_E(q_E, a, \theta) - V_B] \\ V_{BSE} &= \hat{V}_{BSE}(a, \theta). \end{aligned}$$

³¹More generally, a contract can make exclusivity contingent on announcements (messages) made by B and S . Similar logic shows that the irrelevance result also holds with these more general contracts.

³²When investments have external components it is more difficult to get direct extensions of our comparative static and welfare results. It is of course immediate that our results for cases with $e = 0$ and $e = 1$ tell us what happens when $P = \infty$ and $P = 0$ respectively. More generally, in some cases we can use the results of Segal and Whinston [1998] to show that for any contract that specifies a penalty P , there is an equivalent contract that specifies the exclusivity probability $e(P)$, where $e(P)$ is an increasing function. In this case, we can employ our previous comparative statics results directly to analyze the effects of any change in P .

Observe that, as before, exclusivity matters only through its effect on V_{BE} .

To extend our irrelevance result, suppose that it is possible to partition investments into internal investments a^i and external investments a^e , so that S 's costs are affected only by a^i , E 's costs are affected only by a^e , and B 's value function can be written in the following “investment separable” form:

$$v(q_S, q_E, a^i, a^e, \theta) = v^i(q_S, a^i, \theta) + v^e(q_E, a^e, \theta) + \hat{v}(q_S, q_E, \theta).$$

This form obviously holds whenever investments affect only sellers' costs. When investments do affect the buyer's value, this form would arise if, for example, it was never optimal for B to buy from both S and E at the same time (e.g. B might need at most 1 unit of an indivisible good). Alternatively, B could be a retailer who sells q_S and q_E to different markets, but who incurs joint inventory costs (equal to $-\hat{v}(q_S, q_E, \theta)$) that are unaffected by investments. Under investment separability, we have

$$V_{BE} = V_B + (1 - e) \max_{q_E} [v^e(q_E, a^e, \theta) + \hat{v}(\bar{q}_S, q_E, \theta) - c_E(q_E, a^e, \theta) - \hat{v}(\bar{q}_S, q_E = 0, \theta)],$$

and so there is no interaction between a^i and e . Hence, for any given level of \bar{q}_S specified in the contract, exclusivity is irrelevant if investments are purely internal.

To consider the effects of exclusivity in cases in which external investments are present, we focus in the rest of this section on an extension of the simple example in Section 2. Specifically, we suppose that B needs at most one unit, and that B 's valuations of S and E 's products given investments a are given by the (deterministic) functions $v_S(a)$ and $v_E(a)$. We assume also that E is competitive with stochastic cost level \tilde{c}_E . For simplicity we suppose as well that B and S have equal bargaining power. Finally, we assume that trade with E is always more efficient than no trade; i.e. that $\Pr(\tilde{c}_E < v_E(a)) = 1$ for all a . Letting $\bar{q}_S \in [0, 1]$ denote a contractually-specified probability that S must deliver a unit of its good to B ,³³ the expected ex post payoffs for B and S are

$$\begin{aligned} E[f_B(a, e, \tilde{c}_E)] &= \frac{1}{2} E[TS(a, \tilde{c}_E)] + \frac{1}{2} \{ \bar{q}_S (v_S(a) + c_S(a)) + (1 - \bar{q}_S) (1 - e) (v_E(a) - E[\tilde{c}_E]) \} \\ E[f_S(a, e, \tilde{c}_E)] &= \frac{1}{2} E[TS(a, \tilde{c}_E)] - \frac{1}{2} \{ \bar{q}_S (v_S(a) + c_S(a)) + (1 - \bar{q}_S) (1 - e) (v_E(a) - E[\tilde{c}_E]) \} \end{aligned}$$

where $TS(a, c_E) = \max_{q_S \in \{0, 1\}} \{ q_S (v_S(a) - c_S(a)) + (1 - q_S) (v_E(a) - c_E) \}$. Note that this example is “investment separable” in the sense introduced above.

³³Note that we could have described an equivalent model in which B consumes a continuous quantity up to an amount 1 and has utility that is linear in the amount consumed. In this case, \bar{q}_S would be a quantity rather than a probability.

Several points of interest follow from these expressions. First, note that if v_E is independent of a , then exclusivity is irrelevant for ex ante investment incentives; this is just the irrelevance result of the previous paragraph.

Second, in some cases the optimal contract takes the form $\bar{q}_S = 0$, in which case we are back to the incomplete contract setting considered earlier in the paper. Specifically, suppose that only S invests and that his investment a_S is a general investment in B 's value from trade; i.e., $v_S(a_S) = v_E(a_S) \equiv v(a_S)$. Then S 's ex post expected payoff is

$$E[f_S(a_S, \tilde{c}_E)] = \frac{1}{2} \{E[TS(a_S, \tilde{c}_E)] - (\bar{q}_S + (1 - \bar{q}_S)(1 - e))v(a_S) + \bar{q}_S c_S - (1 - \bar{q}_S)(1 - e)E[\tilde{c}_E]\}.$$

This expression implies that S 's optimal choice of a_S is weakly decreasing in \bar{q}_S . Since B 's payoff is increasing in a_S (holding e fixed), it follows that any contractual change that increases a_S increases U_{BS} (since a_S has a positive externality on B ; the formal argument parallels those in Sections 4 and 5). Hence, we conclude that it is optimal for B and S to write a contract that sets $\bar{q}_S = 0$. (This is a simple extension of the result in Che and Hausch [1997].) Given this fact, we can directly apply our earlier results to conclude that B and S optimally set $e = 1$.

Finally, in contrast to the two cases discussed above, in other cases the possibility of including a quantity provision in the contract can materially alter our conclusions about the use of exclusive contracts. To see this, suppose that B 's investment $a_B \in \mathfrak{R}$ affects only $v_S(\cdot)$ and $v_E(\cdot)$, and S 's investment $a_S \in \mathfrak{R}$ affects only $c_S(\cdot)$. Then the efficient investments (a_B°, a_S°) must satisfy the first-order conditions:

$$\begin{aligned} q_S^\circ v'_S(a_B^\circ) + (1 - q_S^\circ)v'_E(a_B^\circ) - \psi'_B(a_B^\circ) &= 0, \\ -q_S^\circ c'_S(a_S^\circ) - \psi'_S(a_S^\circ) &= 0, \end{aligned}$$

where $q_S^\circ \equiv \Pr(v_S(a_B^\circ) - c_S(a_S^\circ) \geq v_E(a_B^\circ) - \tilde{c}_E)$. Observe now that by setting $\bar{q}_S = q_S^\circ$ and $e = 0$, B and S are faced with precisely these first-order conditions. (This is a simple extension of Proposition 6 in Edlin and Reichelstein [1996], which also implies that given the contract, efficient investment choices are *globally* optimal for the parties.) Hence, B and S can implement efficient investment levels without resorting to an exclusivity provision. Thus, while exclusives can serve an efficiency-enhancing purpose in the incomplete contracting setting (for example, when $v'_S(\cdot)$ and $v'_E(\cdot)$ have different signs so that B 's internal and external investments are perfect investment cost substitutes), once B and S can include a quantity provision in their contract, exclusives are no longer needed.

7.2.2 Price contracts

Once quantities can be specified, a wide range of contractual terms can be included in B and S 's contract. As a general matter, we can imagine that the quantity, price, and extent of exclusivity can depend on announcements made by B and S . Here we restrict attention to one relatively simple contractual form, “option-to-buy” contracts, and maintain our focus on the example introduced in the previous subsection. An option to buy contract (p, e) specifies a price p at which B may elect to take delivery of a unit from S , and a probability e that B is allowed to procure from E . The timing is that \tilde{c}_E is first realized, then B decides whether to exercise the option, then the exclusivity realization occurs, and finally B and S can renegotiate with the option exercise decision as the default outcome.

Given a contract (p, e) and realization \tilde{c}_E , B will exercise the option if and only if doing so increases his utility at his default outcome, i.e. if and only if

$$v_S(a) + c_S(a) - p \geq (1 - \tilde{e})[v_E(a) - \tilde{c}_E].$$

Let $\bar{q}_S(a, e, p, \tilde{c}_E)$ denote the realized quantity given B 's optimal exercise decision. Now, B 's and S 's expected ex post payoffs are

$$\begin{aligned} E[f_B(a, e, p, \tilde{c}_E)] &= \frac{1}{2}E[TS(a, \tilde{c}_E)] + W(a, e, p), \\ E[f_S(a, e, p, \tilde{c}_E)] &= \frac{1}{2}E[TS(a, \tilde{c}_E)] - W(a, e, p), \end{aligned}$$

where

$$W(a, e, p) = E\{\bar{q}_S(a, e, p, \tilde{c}_E)(v_S(a) + c_S(a)) + (1 - \bar{q}_S(a, e, p, \tilde{c}_E))(1 - e)(v_E(a) - \tilde{c}_E)\}.$$

Suppose now that $a \in \mathfrak{R}$. Assuming that the distribution of \tilde{c}_E is non-atomic, by the envelope theorem, we have

$$\frac{\partial W(a, e, p)}{\partial a} = E[\bar{q}_S(a, e, p, \tilde{c}_E)]\{v'_S(a) + c'_S(a) - (1 - e)v'_E(a) + (1 - e)v'_E(a)\}.$$

Thus, the option price p affects the equilibrium level of investment through its effect on $E[\bar{q}_S(a, e, p, \tilde{c}_E)]$, the expected quantity exercised by the buyer under the option-to-buy clause (this is precisely the effect identified in the literature on stipulated damages). Now, let $\hat{q}_S = E[\bar{q}_S(a^*, e, p, \tilde{c}_E)]$, where a^* is the equilibrium investment level under the contract. Then it is simple to see that the first-order condition for a would be unchanged if instead B and S wrote the specific performance contract (\hat{q}_S, e) . Thus, with one-dimensional investment,

we can always find a specific performance contract that is equivalent to any option-to-buy contract as long as second-order conditions are satisfied.³⁴ This implies that the effects of exclusivity when the parties optimally adjust price in option-to-buy contracts are the same as when the parties optimally adjust quantity in specific performance contracts. In particular, the “irrelevance result” continues to hold here: if investments are purely internal, banning exclusives would have no effect on investments when the parties can optimally adjust contractual price.

This conclusion stands in contrast to results presented in Gilbert and Shapiro [1997], who also study the effects of exclusivity on investments in settings in which price terms can be included in contracts. Gilbert and Shapiro argue that exclusives do increase the level of the seller’s cost-reducing investment (which is purely internal). The difference in results is due to the fact that Gilbert and Shapiro identify the results of changing e *holding all other contract terms fixed*. However, in response to a change in the level of exclusivity, B and S can be expected to *alter* these other terms. In the case of a seller investing in cost reduction, what we have shown is that by altering the price term appropriately (specifically, by keeping the expected contractual trade $E[\bar{q}_S(a, e, p, \tilde{c}_E)]$ unchanged), B and S can achieve the same outcome regardless of the level of e .³⁵

8 Conclusion

The foregoing analysis provides a number of results regarding the effects of exclusivity on noncontractible investments and welfare. On a very practical level, these results can be used to evaluate claims about the use of exclusive contracts to protect investments. For example, consider the investments of Ticketmaster in personnel training and software configuration described in the Introduction. Because of the proprietary nature of Ticketmaster’s system, these investments could not be used by the buyer in conjunction with other systems, so they were purely internal in our terminology. Our Irrelevance Result therefore casts doubt on the claimed efficiency motivation for Ticketmaster’s exclusive contracts. More generally, for cases in which investments have an external component, our analysis identifies cases in which

³⁴Segal and Whinston [1998] establish this fact for arbitrary message-contingent contracts, of which option-to-buy contracts are just one example.

³⁵Moreover, the result of Edlin and Reichelstein [1996] discussed in the previous subsection suggests that, in this case, by ensuring that the expected contractual trade equals the expected efficient trade, the parties can implement efficient cost-reducing investment by S without resorting to an exclusivity provision.

a buyer and seller would and would not wish to sign an exclusive contract, and also indicates when such arrangements are socially efficient. Table 2 in particular provides a check-list for evaluating the logical consistency of efficiency-based claims for exclusive contracts for cases in which the supply-side of the market is argued to be competitive.

Our findings relate to some arguments that have been made in the literatures on transfer pricing, second sourcing, human capital investments, and outsourcing. In their study of transfer pricing, Holmstrom and Tirole [1990] investigate the investment incentives of division managers under various organizational arrangements, including those that prohibit external trade. Their model differs from ours in several respects: first, it considers the effect of imposing exclusivity on both the buyer and seller at once, second, it allows explicit compensation schemes, and third, it is substantially more specialized. Despite these differences, our results are reminiscent of some of the effects identified by Holmstrom and Tirole. For example, they find that prohibiting external trade may be beneficial because it discourages managers' rent-seeking investments in external activities. This parallels our result on the beneficial effect of exclusivity when the buyer's external and internal investments are substitutes (see the southeast cell of Table 2). Holmstrom and Tirole also find that "non-integration" may be good because it encourages general investments by managers, which parallels our result that exclusivity is harmful when B 's internal and external investments are complements (see the northeast cell of Table 2).

The northeast cell of Table 2 also has parallels to cases of second-sourcing (Farrell and Gallini [1988], Shepard [1987]) in which a supplier elects to establish a competitive source of supply to elicit greater levels of general investments by B . The main difference is that in the second-sourcing literature the seller either shares the licensing surplus with the licensee or licenses unilaterally at a zero fee. In order to analyze the optimality of these decisions, we would need to consider the effect of exclusivity (non-licensing) on the ex ante surplus of coalitions SE and S .

In his classic treatise on human capital, Becker [1964] observes that firms have a socially suboptimal incentive to invest in general training of their employees. He also notes that a firm's incentive to make such investment is increased when it has a degree of monopsony over employees (exemplified by an isolated company town).³⁶ Interpreting the firm as a "seller" who competes with other firms ("external sellers") for a worker (the "buyer"), this parallels

³⁶For a recent development of this idea, see Acemoglu and Pischke [1997].

our finding that exclusivity may be good when the seller's internal and external investments are complements (the northwest cell of Table 2).

Another application of this result to labor economics concerns union contracts that restrict outsourcing. While it is common to attribute such restrictions to unions' attempt to maintain their "power", Baron and Kreps [forth.] argue that such contracts enhance efficiency, by encouraging cooperation between workers and the firm. Our analysis suggests another efficiency justification for outsourcing restrictions: it encourages union members to invest in improving the firm's profitability in ways that would be appropriable by the firm absent the restrictions.

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Appendix: Proofs of Propositions in Sections 5,6

We begin with a result providing sufficient conditions on the coalitional value functions for unambiguous comparative statics. These requirements on the coalitional values may be satisfied even when the structural sufficient conditions we identify in the various propositions are not. With a slight abuse of notation, in Lemma 1 we write the arguments of the functions $V_J(\cdot)$ and $\psi_j(\cdot)$ as $(\bar{a}, \bar{e}, \theta)$ and \bar{a}_j to allow later interpretations of \bar{a} as either (a^i, a^e) or $(-a^i, a^e)$ and of \bar{e} as either e or $-e$.

Lemma 1 *Suppose that*

1. (A.1) – (A.3) hold,
2. For all $\theta \in \Theta$ every marginal contribution $M_j^J(\bar{a}, \bar{e}, \theta) = [V_{J \cup j}(\bar{a}, \bar{e}, \theta) - V_J(\bar{a}, \bar{e}, \theta)]$ is continuous in \bar{a} , supermodular in \bar{a}_j , and has increasing differences between \bar{a}_j and (\bar{a}_{-j}, \bar{e}) ,³⁷
3. The investment cost functions have the property that $-\psi_j(\bar{a}_j)$ is supermodular in \bar{a}_j for $j \in \{B, S, E\}$.

Then the set $\bar{A}^(\bar{e})$ of Nash equilibrium investment vectors \bar{a} is nondecreasing in \bar{e} .*

Proof. A nonnegatively weighted sum of functions preserves the properties of continuity, supermodularity, and increasing differences. Each player j 's ex post payoff in state θ given (\bar{a}, \bar{e}) , $U_j(\bar{a}, \bar{e}, \theta)$, is a nonnegatively weighted sum of marginal contributions and the negative of investment costs. In turn, player j 's ex ante payoff given (\bar{a}, \bar{e}) , $U_j(\bar{a}, \bar{e})$, is a nonnegatively weighted sum of the functions $U_j(\bar{a}, \bar{e}, \theta)$. Therefore, the investment game is supermodular and the result follows from the corollary to Theorem 6 in Milgrom and Roberts [1990]. ■

Proof of Proposition 2: For each case, the proof consists of establishing that the conditions of Lemma 1 hold for the appropriately chosen (\bar{a}, \bar{e}) .

Consider part (a) first with full internal/external complementarity (case (ii)). We shall show that the requirements of Lemma 1 are satisfied taking $(\bar{a}, \bar{e}) = (a, e)$. Note that in this case $|A_E| = 1$, so that every marginal contribution of E , $M_E^J(a, e, \theta)$, trivially satisfies the assumptions of Lemma 1.

³⁷See Milgrom and Roberts [1990] for definitions.

Now consider the marginal contributions of B and S . Note first that since $M_S^E(a, e, \theta) = 0$, this marginal contribution trivially satisfies the requirements of Lemma 1. For the remaining marginal contributions, recall that Topkis [1978] establishes that if a function $f : X \times Y \rightarrow \mathfrak{R}$ is supermodular on a sublattice $X \times Y$, then the function $g(x) = \max_{y \in Y} f(x, y)$ is supermodular on X . This tells us that under full internal/external cost complementarity, every coalitional value $\widehat{V}_J(a, \theta)$ is supermodular in a . Since $M_j^J(a, e, \theta) = \widehat{V}_{j \cup J}(a, \theta)$ for $(j, J) \in \{(S, B), (B, SE), (B, S)\}$, these marginal contributions are supermodular in (a, e) and so satisfy the requirements of Lemma 1 (a supermodular function satisfies increasing differences in all pairs of variables). Next, note that in part (a) we have $M_B^E(a, e, \theta) = (1 - e)\widehat{V}_{BE}(a_S^e, \theta)$. Hence, $M_B^E(a, e, \theta)$ also trivially satisfies the conditions of Lemma 1. The final marginal contribution to consider is

$$M_S^{BE}(a, e, \theta) = [\widehat{V}_{BSE}(a_S^i, a_B^i, a_S^e, \theta) - (1 - e)\widehat{V}_{BE}(a_S^e, \theta)].$$

Since a_S^e is a scalar, $-(1 - e)\widehat{V}_{BE}(a_S^e, \theta)$ is trivially supermodular in a . It also has increasing differences in a_S and e . Likewise, $\widehat{V}_{BSE}(a_S^i, a_B^i, a_S^e, \theta)$ is supermodular in a and (trivially) has increasing differences in a_S and e . Since these properties are preserved under addition, this implies that $M_S^{BE}(a, e, \theta)$ has the properties required in Lemma 1. Thus, all of the requirements of Lemma 1 are met taking $(\bar{a}, \bar{e}) = (a, e)$.

The proof of part (b) follows similarly but taking $(\bar{a}, \bar{e}) = (a, -e)$. The proofs for cases (i) and (iii) follow similar lines. ■

Proof of Proposition 3: We begin by establishing that under full internal/external complementarity, every marginal contribution $M_j^J(a, e, \theta)$ is nondecreasing in a_{-j} . To see this, note first that under (A.1) all of the coalitional values $\widehat{V}_J(a, \theta)$ are nondecreasing in a_{-j} . Hence, it is immediate that all marginal contributions other than

$$M_S^{BE}(a, e, \theta) = [\widehat{V}_{BSE}(a, \theta) - (1 - e)\widehat{V}_{BE}(a, \theta)] = [\widehat{V}_{BSE}(a, \theta) - \widehat{V}_{BE}(a, \theta)] + e\widehat{V}_{BE}(a, \theta)$$

and $M_E^{BS}(a, e, \theta) = [\widehat{V}_{BSE}(a, \theta) - \widehat{V}_{BS}(a, \theta)]$ are nondecreasing in a_{-j} . Now consider $M_S^{BE}(a, e, \theta)$.

Letting

$$\phi(q_S, a, \theta) \equiv \max_{q_E \in Q_E} [v(q_S, q_E, a, \theta) - c_S(q_S, a, \theta) - c_E(q_E, a, \theta)]$$

we can write

$$M_S^{BE}(a, e, \theta) = \max_{q_S \in Q_S} [\phi(q_S, a, \theta) - \phi(0, a, \theta)] + e\widehat{V}_{BE}(a, \theta).$$

Since $v(\cdot)$, $-c_S(\cdot)$, and $-c_E(\cdot)$ are supermodular in (q, a) , the function $\phi(\cdot)$ is supermodular in (q_S, a) . But then supermodularity of $\phi(\cdot)$ in (q_S, a) implies that for any $a'' \geq a'$ and any $q_S \in Q_S$ we have $\phi(q_S, a'', \theta) - \phi(0, a'', \theta) \geq \phi(q_S, a', \theta) - \phi(0, a', \theta)$, which implies

$$\max_{q_S \in Q_S} [\phi(q_S, a'', \theta) - \phi(0, a'', \theta)] \geq \max_{q_S \in Q_S} [\phi(q_S, a', \theta) - \phi(0, a', \theta)].$$

Since we also know that $\widehat{V}_{BE}(a, \theta)$ is nondecreasing in a , this implies that $M_S^{BE}(a, e, \theta)$ is nondecreasing in a_{-S} . A similar argument establishes that $M_E^{BS}(a, e, \theta)$ is also nondecreasing in a_{-E} .

Since $U_j(a, e)$ is a nonnegatively weighted sum of the marginal contributions $M_j^J(a, e, \theta)$, we now know that

$$U_j(a, e) \text{ is nondecreasing in } a_{-j} \text{ for every player } j \in N. \quad (10)$$

This implies, in particular, that for every coalition $J \subset N$, $\max U_J(A^*(e), e) = U_J(a^*(e), e)$ and $\min U_J(A^*(e), e) = U_J(a_*(e), e)$, where $a^*(e) = \max A^*(e)$ and $a_*(e) = \min A^*(e)$, and the existence of the two vectors is implied by Theorem 5 of Milgrom and Roberts [1990].

Part (a): Let $e'' > e'$ and let $a'' \geq a'$ denote corresponding (maximum or minimum) equilibrium investment vectors (recall that by Proposition 2(a), $a^*(e'') \geq a^*(e')$ and $a_*(e'') \geq a_*(e')$). Then

$$U_j(a'', e'') \geq U_j(a'_j, a''_{-j}, e'') \geq U_j(a'_j, a'_{-j}, e''), \quad (11)$$

where the first inequality follows from the best-response property (a''_j is a best-response to a''_{-j} under e'') and the second follows from (10). Adding (11) over j we see that

$$U_{BSE}(a'', e'') \equiv \sum_{j \in \{B, S, E\}} U_j(a'', e'') \geq \sum_{j \in \{B, S, E\}} U_j(a', e'') = \sum_{j \in \{B, S, E\}} U_j(a', e') \equiv U_{BSE}(a', e'),$$

where the second-to-last equality follows because changes in e have no effect on the sum of expected payoffs given an investment vector a . Similarly, we have:

$$U_{BS}(a'', e'') \equiv \sum_{j \in \{B, S\}} U_j(a'', e'') \geq \sum_{j \in \{B, S\}} U_j(a', e'') \geq \sum_{j \in \{B, S\}} U_j(a', e') \equiv U_{BS}(a', e'),$$

since $U_{BS}(a, e) = U_{BSE}(a) - U_E(a, e)$ is nondecreasing in e holding a fixed.

Part (b): The argument that total welfare is nonincreasing in e follows along exactly the same lines as above, but here (corresponding to Proposition 2(b)) we take $a'' \square a'$. To see that E is necessarily (weakly) worse off when e increases we note that $U_E(a', e') \geq$

$U_E(a''_E, a'_{-E}, e') \geq U_E(a'', e') \geq U_E(a'', e'')$, where the first inequality follows from the best-response property, the second from (10), and the third from the fact that $U_E(a, e)$ is nonincreasing in e in e holding a fixed. ■

Proof of Proposition 4: Observe that (A.1) implies that $U_B(a, e)$ is nondecreasing in a_{-B} .

Part (a): Proposition 2 tells us that the set $A^*(e)$ is nondecreasing in e . By Theorem 5 of Milgrom-Roberts [1990], $a^*(e) = \max A^*(e)$ and $a_*(e) = \min A^*(e)$ exist. Let $e'' > e'$ and let $a'' \geq a'$ denote corresponding (maximum or minimum) equilibrium investment vectors. Using B 's revealed preference, and the fact that $U_B(a, e)$ is nondecreasing in a_{-B} , we have $U_B(a'', e'') \geq U_B(a'_B, a''_{-B}, e'') \geq U_B(a', e'')$.

As for S 's payoff, we note that when only S has an external investment choice we have $a_{-S} = a^i_B$. From this (and, in particular, the fact that a_{-S} contains no external investments) it follows from (A.1) that $M_S^{BE}(a, e, \theta) = [\widehat{V}_{BSE}(a_S, a^i_B, \theta) - (1-e)\widehat{V}_{BE}(a^e_S, \theta)]$ is nondecreasing in a_{-S} . Hence, as before we have $U_S(a'', e'') \geq U_S(a'_S, a''_{-S}, e'') \geq U_S(a', e'')$. Therefore,

$$U_{BS}(a'', e'') \equiv \sum_{j \in \{B, S\}} U_j(a'', e'') \geq \sum_{j \in \{B, S\}} U_j(a', e'') \geq \sum_{j \in \{B, S\}} U_j(a', e') \equiv U_{BS}(a', e'),$$

since $\sum_{j \in \{B, S\}} U_j(a, e)$ is nondecreasing in e holding a fixed.

Part (b): Proposition 2 tells us that the set $A^*(e)$ is nonincreasing in e . By Theorem 5 of Milgrom-Roberts [1990], $a^*(e) = \max A^*(e)$ and $a_*(e) = \min A^*(e)$ exist. Take $e'' > e'$ with e' close enough to 1, and let $a'' \square a'$ denote corresponding (maximum or minimum) equilibrium investment vectors. Since $U_B(a, e)$ is nondecreasing in a_{-B} , using B 's revealed preference we have $U_B(a', e') \geq U_B(a''_B, a'_{-B}, e') \geq U_B(a'', e')$.

As for S 's payoff, under the stated hypotheses, for e' close enough to 1,

$$M_S^{BE}(a_S, a_B, e', \theta) = [\widehat{V}_{BSE}(a_S, a_B, \theta) - \widehat{V}_{BE}(a_B, \theta)] + e'\widehat{V}_{BE}(a_B, \theta)$$

is nondecreasing in a_B . Hence, $U_S(a', e') \geq U_S(a''_S, a'_B, e') \geq U_S(a'', e')$. Together, this gives

$$\sum_{j=B, S} U_j(a', e') \geq \sum_{j=B, S} U_j(a'', e') = \sum_{j=B, S} U_j(a'', e''),$$

where the final equality follows from the assumption that E is competitive. Finally, note that if $[\widehat{V}_{BSE}(a_S, a_B, \theta) - \widehat{V}_{BE}(a_B, \theta)]$ is nondecreasing in a_B , then $M_S^{BE}(a_S, a_B, e, \theta)$ is nondecreasing in e at all $e \in [0, 1]$, and $\sum_{j=B, S} U_j(a', e') \geq \sum_{j=B, S} U_j(a'', e'')$ for any e' . This completes the argument. ■

Proof of Proposition 5: The proposition is proven in essentially the same way as Proposition 2. The requirements of Lemma 1 are satisfied taking $\bar{a} = (-a^i, a^e)$, and taking $\bar{e} = e$ for part (a), or $\bar{e} = -e$ for part (b). ■

Proof of Proposition 6: Define $\bar{a} = (-a^i, a^e)$. Similar arguments to those in the proof of Proposition 3 establish that under the condition of full internal/external substitutability $M_E^{BS}(\bar{a}, e, \theta)$ is nondecreasing in $\bar{a}_{-E} = (-a_{-E}^i, a_{-E}^e)$, and that $M_S^{BE}(\bar{a}, e = 0, \theta)$ is nonincreasing in $\bar{a}_{-S} = (-a_{-S}^i, a_{-S}^e)$.

Part (b): Using the findings above, we can see that $U_E(\bar{a}, e)$ is nondecreasing in \bar{a}_{-E} . Therefore, we can write $\max U_E(\bar{A}^*(e), e) = U_E(\bar{a}^*(e), e)$ and $\min U_E(\bar{A}^*(e), e) = U_E(\bar{a}_*(e), e)$, where $\bar{a}^*(e) = \max \bar{A}^*(e)$ and $\bar{a}_*(e) = \min \bar{A}^*(e)$, and the two vectors exist by Theorem 5 of Milgrom-Roberts [1990], and are nonincreasing in e by Proposition 5. Let $e'' > e'$, and let $\bar{a}'' \square \bar{a}'$ be two corresponding (maximum or minimum) equilibria. Then we can write $U_E(\bar{a}', e') \geq U_E(\bar{a}''_E, \bar{a}'_{-E}, e') \geq U_E(\bar{a}'', e') \geq U_E(\bar{a}'', e'')$, where the first inequality follows from the best-response property, the second follows from the fact that E 's payoff is nondecreasing in \bar{a}_{-E} , and the third follows from the fact that E 's payoff is nonincreasing in e .

Part (a): If $E_\theta M_S^{BE}(a, e, \theta)$ is strictly decreasing in \bar{a}_{-S} for $e = 0$, then the same must be true for e close enough to 0. For such values of e , we have $U_j(\bar{a}, e)$ nonincreasing in \bar{a}_{-j} for $j \in \{B, S\}$ (for $j = B$, recall that $\bar{a}_{-B} = -a_S^i$), which implies that

$$\max_{\bar{a} \in \bar{A}^*(e)} U_j(\bar{a}, e) = U_j(\bar{a}_*(e), e) \text{ and } \min_{\bar{a} \in \bar{A}^*(e)} U_j(\bar{a}, e) = U_j(\bar{a}^*(e), e) \text{ for } j \in \{B, S\},$$

where the two vectors exist by Theorem 5 of Milgrom-Roberts [1990], and are nonincreasing in e by Proposition 5. Let $e' \geq e''$ be two values that are close enough to zero, and let \bar{a}' and \bar{a}'' denote corresponding (maximum or minimum) equilibrium investment vectors, with the property that $\bar{a}' \square \bar{a}''$. Then we have $U_S(\bar{a}', e') \geq U_S(\bar{a}''_S, \bar{a}'_{-S}, e') \geq U_S(\bar{a}'', e')$, where the first inequality follows by revealed preference, and the second follows from the fact that $U_S(\bar{a}, e)$ is nonincreasing in \bar{a}_{-S} when $E_\theta M_S^{BE}(a, e, \theta)$ is. In addition, we have $U_B(\bar{a}', e') \geq U_B(\bar{a}'_B, \bar{a}'_{-B}, e') \geq U_B(\bar{a}'', e')$, since $U_B(\bar{a}, e)$ is nonincreasing in \bar{a}_{-B} . Summing these inequalities we get

$$\sum_{j \in \{B, S\}} U_j(\bar{a}', e') \geq \sum_{j \in \{B, S\}} U_j(\bar{a}'', e') \geq \sum_{j \in \{B, S\}} U_j(\bar{a}'', e''),$$

where the last inequality follows from the fact that, holding a fixed, $\sum_{j \in \{B, S\}} U_j(\bar{a}, e)$ is nondecreasing in e . Finally, note that if internal trade is always efficient, then $M_S^{BE}(a, e, \theta) =$

$[\widehat{V}_{BS}(a^i, \theta) - (1 - e)\widehat{V}_{BE}(a^e, \theta)]$, and so $M_S^{BE}(a, e, \theta)$ (and therefore $U_S(\bar{a}, e)$) is nonincreasing in \bar{a}_{-S} for all $e \in [0, 1]$, and so the result follows globally.

Part (c): If internal trade is always optimal, then (as above) $U_S(\bar{a}, e)$ is nonincreasing in \bar{a}_{-S} for all $e \in [0, 1]$. If, in addition, $\widehat{V}_{BS}(a^i, \theta)$ is strictly increasing in a^i , then $U_B(a, e)$ is nonincreasing in \bar{a}_{-B} for e close enough to 1. Using Proposition 5(a), the result follows in a manner similar to those above. ■

External Inv. by:	S	B	E
COMPLEMENTARITY			
Comparative Statics			
a^i	↑	↓	↓
a^e	↑	↓	↓
Welfare			
U_{BSE}	↑*	↓*	↓*
U_{BS}	↑	↓†	?
U_E	?	↓*	↓*
Story:	General Investment (Marvel, Masten-Snyder)	General Investment (Klein, 2nd Sourcing)	
SUBSTITUTABILITY			
Comparative Statics			
a^i	↓	↑	↑
a^e	↑	↓	↓
Welfare‡			
U_{BSE}	?	?	?
U_{BS}	↓§	↑¶	?
U_E	?	↓	↓
Story:		Dealer Loyalty (Areeda-Kaplow)	Entry Deterrence (Aghion-Bolton)

Table 1: The Effects of Exclusivity

External investment by:	S	B
Complementary Investments	Welfare ↑	Welfare ↓†
Substitutable Investments	Welfare ↓§	Welfare ↑¶

Table 2: Welfare effects of exclusivity with substitute goods when E is competitive

*With full internal/external complementarity.

†For $e \approx 1$, with competitive E , with either perfect investment cost complementarity or investment cost complementarity and trades independent of investments.

‡All welfare results below require full internal/external substitutability.

§For $e \approx 1$, when E is competitive and internal trade is always optimal.

¶For $e \approx 0$, or when internal trade is always optimal.