Exclusionary Contracts*

Ran Jing† and Ralph A. Winter‡

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Abstract

When do participants in a market have the incentive to enter into agreements that exclude potential entrants? This paper synthesizes, extends and illustrates the theory of exclusionary contracts. In a model of incumbent contracts with downstream buyers, a "Chicago benchmark" yields no incentive for exclusionary long term contracts. Departures from the benchmark in each of three directions yield predictions of exclusion. These include the two existing theories (Aghion-Bolton 1987 and Rasmusen-Ramseyer-Wiley 1991) as well as a third, vertical theory: that a long term contract at one stage of a supply chain may extract rents at another stage. Contracts with upstream suppliers do not necessarily yield a first-mover advantage for the incumbent. We consider upstream contracts in which firms bid simultaneously for the rights to upstream inputs, with bids for exclusive rights being an available strategy, and then compete in a downstream market. With sufficient complementarity upstream and substitutability downstream, the bidding game equilibrium allocates all inputs to a single firm – excluding the other firm from the market. We examine an antitrust case that illustrates all four channels for exclusionary contract incentives.

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†University of International Business and Economics, Bejing

‡Sauder School of Business, UBC

1. Introduction

The debate over whether contracts can have anticompetitive exclusionary effects has been central to competition policy. In cases involving tying,[1] exclusive dealing,[2] and long-term contracts[3], courts have struck down contracts as anti-competitive in excluding potential suppliers. But contracts are entered into voluntarily. Why would buyers in a market have the incentive to enter contracts that are anticompetitive?

The traditional theory is that a dominant firm can *impose* exclusionary contracts to its own benefit and to the detriment of consumers. Exclusionary contracts are themselves be evidence of monopoly power over consumers signing the contracts.[4] The early Chicago school responded with a simple proposition. Contracts are voluntary, not imposed, and must maximize the combined benefits of the contracting parties. If another contract achieved higher total benefit, parties would adopt it, splitting the gains in benefits, whatever the relative bargaining power of the parties. Contractual terms, apart from price, must therefore be explained as wealth-maximizing, not as the result of relative market power or bargaining power. This insight, essentially a version of the Coase theorem (1960), is fundamental.

A second proposition, offered by some Chicago economists, would seem to follow: if a contract maximizes the combined benefits of the buyer and seller signing the contract, it must be efficient. Government intervention that limits the set of feasible contracts cannot improve welfare because a voluntary contract, chosen freely by these market participants, maximizes benefits. A contractual clause, such as a requirements or exclusivity clause, is not chosen unless it is efficient.[5]

The second Chicago proposition is wrong. As Aghion and Bolton (1987) showed, con-

[1] E.g., *Northern Pacific Railway v. United States*; and the *U.S. v. Microsoft* cases

[2] E.g., *United States v. United Shoe Machinery Corporation* (1922); *Milkovich v. Lorain Journal Co.*, 497 U.S. 1 (1990)

[3] *Canada (Director of Investigation and Research) v. Laidlaw Waste Systems Ltd. (1992), 40 C.P.R. (3d) 289 (Comp. Trib.)*; *Director of Investigation and Research v. D&B Companies of Canada Ltd., CT-1994-01 (Canada), ("Nielsen").* The latter case is analyzed in section 4 of this paper.

[4] In *Canada (Director of Investigation and Research) v. Laidlaw Waste Systems* (1992), 40 C.P.R. (3d) 289 (Comp. Trib.). ["*Laidlaw*"], the government economic expert argued that "if one contracting party is a monopolist ... it can preserve its market power by insisting that its customers (or suppliers) sign long-term contracts ..."; and "buyers gain nothing from the . . . provisions in the contract [at issue in the case]. Hence, the very fact that nearly all buyers sign such contracts is evidence that Laidlaw has and exercises market power". [Expert Report of Roger Noll, *Laidlaw*, pars. 21 and 42]

[5] Judge Robert Bork is often cited for this view. He states "The truth appears to be that there has never been a case in which exclusive dealing or requirements contracts were shown to injure competition. A seller who wants exclusivity must give the buyer something for it. If he gives a lower price, the reason must be that the seller expected the arrangement to create efficiencies that justify the lower price." (Bork (1978): 309).

tracts need not be efficient where there are externalities imposed by contractual terms on agents outside the contracts. Even a simple long term contract can be anticompetitive in acting as a barrier to entry. A "post-Chicago" literature has developed investigating the conditions under which contracts can profitably be used to exclude rivals.

This paper synthesizes and extends the theory of exclusionary contracts, then applies the theory to *Director of Investigation and Research v. D&B Companies of Canada Ltd.*, CT-1994-01 (Canada) ("*Nielsen*").[6] We use this case to illustrate the full range of incentives developed by the post-Chicago literature. *Nielsen* is remarkably rich in the set of contractual strategies adopted by the firms involved, and the case reveals a wider range of incentives for exclusionary contracts than has been developed in the literature.

We begin in the next section of the paper with a synthesis of the theory of exclusionary contracts under the traditional assumption that the incumbent has a first-mover advantage in offering contracts. Consider an incumbent in a market, purchasing an essential input from upstream input suppliers, selling to downstream buyers and facing potential entry by a number of entrants. The entrants' (common) cost of production is random, and the incumbent has the opportunity to offer a contract prior to the realization of entrants' cost. Within this framework, we set out a "Chicago benchmark" set of conditions under which no incentive for long-term exclusionary contracts exists: no market power outside the contracting pair and no fixed costs on the part of entrants. No externalities are imposed on sellers outside the contract because these sellers earn zero rents and no externalities are imposed on buyers because under constant returns to scale other buyers are not affected by a particular contract.[7] Maximum profits are extracted with an efficient long-term contract under this benchmark set of assumptions. We then introduce three minimal deviations from this benchmark that yield exclusionary contracts. The first of these is market power on the part of entrants (a single entrant). The role of a long-term contract with liquidated damages is to make the strategy of remaining in the incumbent's contract so attractive that a entrant, successfully entering the market, must offer a low price to attract the buyer (Aghion and Bolton 1987). The contract thus implements a transfer from a party outside the contract (the entrant) to one of the contracting parties (the buyer), a transfer that can be shared between the contracting parties.

The second deviation from the Chicago benchmark is to assume instead a single upstream supplier. Consider the incumbent, anticipating negotiations ex post with the input supplier

[6] Winter was an expert for the Competition Bureau in this case.

[7] This sets aside the case where buyers compete in a downstream market (Fumagalli and Motta (2006); Simpson and Wickelgren(2007)).

over the input price and searching for a strategy that would diminish the input supplier's threat point in these negotiations. The threat point for the supplier is to sell to the incumbent's rivals, the potential entrants, who would then serve the downstream buyers. Thus a profitable strategy for the incumbent is the offer of long-term contracts with downstream buyers, since these contracts make new entry less profitable, thus reducing the entrants' willingness to pay for the input. The effect of a long-term *downstream* contract is a reduction in the *upstream* input price – a transfer from the upstream supplier.

The third departure from the Chicago benchmark we consider is a fixed cost on the part of entrants. Zero profit on the part of the entrants is preserved via an assumption of contestability. In this setting, the probability of either entry or competitive discipline by the entrants depends on the number of free buyers as well as the contract itself. The incumbent signs up buyers to long-term contracts for a relatively small price by exploiting the fact that each buyer ignores the externality her acceptance decision imposes on other buyers through the reduction in the probability of entry. This idea is familiar from Aghion-Bolton (1987) and Rasmusen, Ramseyer and Wiley (1991) / Segal and Whinston (2000) (RRW-SW) but is developed here as one component of an integrated model.

Nielsen involved the Canadian market for scanner-based information including market shares, demand elasticity estimates, and sensitivity of demand to product promotions. Upstream suppliers (grocery chains) provided scanner data to Nielsen, the incumbent, which transformed the data into a usable form, combining it with software, which it then sold to downstream buyers (grocery manufacturers). In 1986, Nielsen faced the threat of entry by a second firm, Information Resources Inc. (IRI). As soon as the threat of entry by IRI was evident, Nielsen switched to long-term contracts with a critical subset of buyers. The facts of the case are consistent with both the traditional Aghion-Bolton and RRW-SW theories of the downstream contracts and, as we discuss below, the vertical theory. A second set of contracts was at issue in Nielsen: contracts with *upstream* suppliers of raw data. These contracts contained 5-year exclusivity provisions. *Nielsen* illustrates the principle that while an incumbent almost inevitably has a first-mover advantage, this is not true of upstream contracts. Nielsen and IRI negotiated for the rights to upstream inputs in a short period of time in the summer of 1986.

We develop the following model in section 3 of this paper to offer predictions on exclusionary contracts as a market outcome when the incumbent has no first-mover advantage. Two firms bid simultaneously for the rights to each of n upstream inputs. Each firm i submits a two-part bid (b_j^i, e_j^i) to each upstream supplier j. The first element is a bid for the right to the input j; the second element is a bid for the exclusive right to the input j. Then, simultaneously, each upstream firm j accepts the highest among: e_j^1, e_j^2, and $(b_j^1 + b_j^2)$. The decisions of the n input suppliers thus determine an allocation of rights $a = (a_1, \ldots a_2)$ with each $a_j = 1, 2$ or B (with $a_j = B$ representing an allocation of the jth input to both firms). Given the allocation, the two downstream firms compete in the downstream market with products whose value to buyers depends on the set of inputs incorporated in each product.

The bids by each firm for input rights reflect the profits anticipated in the downstream competition conditional upon different allocations. In the application to Nielsen, a larger set of informational inputs renders the final product more valuable to buyers; but the model applies more generally to rivalrous goods. We find that when *combined profits* are maximized by an allocation of all inputs to one firm exclusively, then this allocation also represents the only possible equilibrium to the non-cooperative bidding game. Joint profits are maximized at an exclusive allocation to one firm, under a set of two conditions: a high degree of complementarity of upstream inputs, and high inherent substitutability (conditional upon identical inputs) of the products downstream.[8] The outcome of universal, exclusionary contracts upstream in Nielsen was, we suggest, the inevitable outcome of the bidding game given upstream complementarity and downstream substitution in the market.

Finally, an application of our vertical theory of exclusionary contracts, discussed above, involves an interaction between the upstream game and the downstream game. In the upstream game, if the incumbent and the entrant are similar in their ability to earn profits as a subsequent monopolist, then most prospective rents are transferred upstream in the form of bids. The equilibrium bid in any auction under certainty is the value of the item (here, the rights) to the agent with the *second* highest value. Any strategy that the incumbent can implement to reduce the value of the rights to the entrant leads to a lower accepted bid for the rights – and therefore a reduction in the transfer of monopoly rents upstream. The adoption of long-term contracts downstream is one such strategy. Hence our vertical theory of the long-term contract with downstream buyers: by adding asymmetry to the upstream bidding game, the downstream contract implements a transfer of rents from the upstream suppliers to the contracting pair.

Section 4 of this paper applies the theories of the previous sections to *Nielsen*, then discusses the wide range of additional strategies adopted in the case.

[8] This model is in the spirit of Bernheim and Whinston (1998) (BW) with two differences. First, the downstream firms here compete over a number of inputs as opposed to competing for rights to representation in a single firm as in Bernheim and Whinston. A superb survey of the general area of market foreclosure is offered by Rey and Tirole (2007).

2. Contracting with a First-mover Advantage: Downstream

In writing contracts with buyers, an incumbent typically has a first-mover advantage in the sense that as soon a potential rival appears ready to enter the market the incumbent can be the first to offer the contracts. Production takes time, and a potential entrant can seldom write complete forward contracts for delivery of its product before the product exists. In this section, we synthesize the economic theory of exclusionary contracts with buyers under the assumption of an incumbent first-mover advantage.

Why would buyers voluntarily enter into contracts that deter entry or reduce the probability of entry? Deterring entry benefits the incumbent, but would appear to harm buyers. The right question, however, is not why buyers agree, but why the *sum* of benefits to contracting parties increases with exclusionary contracts. The answer is in the use of the contracts to extract a transfer from outside parties. We set out a "Chicago benchmark" in which no externalities are imposed on outsiders and in which a long-term contract, if it is written, must be efficient. We then delineate the incentives for exclusion through minimal departures from the benchmark model. Three departures from the benchmark correspond to the implementation of transfers from three different parties to the contracting pair. A transfer can be extracted from the entrant if the entrant has market power. A transfer can be extracted from an upstream input supplier if the supplier has market power (a vertical externality). Or transfers can be extracted from other buyers if buyer surplus is positive (a horizontal externality).

Exclusionary practices in general can lead to three types of inefficiencies: inefficiencies in the quantity sold by the protected incumbent charging high prices; inefficiencies in the loss of product variety when differentiated firms are excluded; and inefficiencies in the prevention of production by the lowest-cost producer. We restrict attention to the last of these by assuming that all buyers purchase 0 or 1 unit and share a common value v for a homogenous product. The fact that buyers must purchase from *either* the incumbent or entrant in our model means that these downstream contracts are simple long-term contracts. Exclusivity restrictions would be superfluous.

We adopt a canonical market structure (Figure 1). An incumbent firm I is supplied by upstream suppliers and sells to n downstream buyers. The incumbent firm faces potential entry by rivals, who face a random, but common, cost of production, c, with a distribution $G(\cdot)$ and density $g(\cdot)$ that is strictly positive on support $[0, \overline{c}]$ with $\overline{c} > v$. $G(c)$ is the probability that entrants would willingly supply all n buyers at a price c, and in this sense can be interpreted as the supply curve of the entrant(s). We denote the elasticity of this supply as η.

The incumbent's cost is c_I, and the upstream input cost is also known. The incumbent has the opportunity to offer buyers an ex ante (or "long-term") contract prior to the realization of the entrants' cost, c, and the entrants and incumbent compete for any "free" buyers ex post as Bertrand competitors.

The ex ante contract can be described in two ways. A contract can be denoted by a price p that the buyer pays if she does trade with the incumbent and a stipulated damage d that the buyer pays if the buyer decides ex post not to trade with the incumbent. Equivalently, the buyer pays the amount d up front and then pays an additional amount $p-d$ if she decides to buy the product. In other words, the contract can be described as a *call option* with option price d and exercise price $p-d$. We take the call option interpretation and adopt notation p_o for the option price and x for the exercise price. The entire competitive impact of an ex ante call option contract lies in whether the optimal exercise price, x^*, satisfies $x^* = c_I$ or $x^* < c_I$. If the latter holds, then for realizations $c \in (x^*, c_I)$, the entrant(s) do not produce ex post, in spite of being the lowest cost producers, since they cannot match the exercise price of the incumbent. The wrong firm produces.

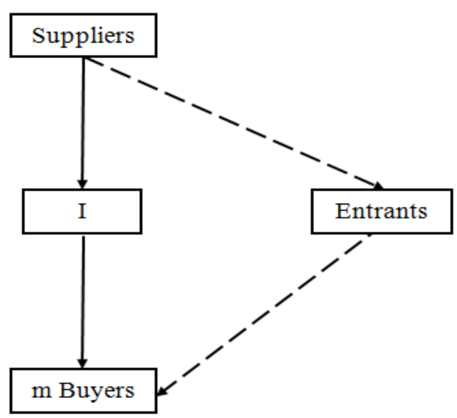

Figure 1. Exclusionary Contracts with Buyers: the Setting

Chicago Benchmark: The upstream supply and entrants are each perfectly competitive sector. Entrants share a common, random cost, c. In the ex post pricing game, the incumbent monopolist sets the price p subject to the realized competitive price available from entrants. The sum of expected benefits to the incumbent and a buyer from a contract (p_o, x) in this setting is the buyer's value minus the cost to the pair of acquiring the product, or $v - \int_0^x c dG(c) - [1 - G(x)]c_I$. Maximizing this sum yields the efficient exercise price, $x = c_I$. Because sellers outside the contract earn zero rents, and each buyer is unaffected by contracts with other buyers (there are constant returns to scale and buyers do not compete), no externalities arise.

Entrant Market Power (Aghion-Bolton): The upstream supply is perfectly competitive, but there is a single potential entrant. Without a contract, the ex post pricing game is Bertrand, with the entrant supplying at a price equal to x if $c < x$ and the incumbent supplying otherwise at a price equal to $\min(c, v)$. The contract maximizes the incumbent's profit subject to the individual rationality constraint that the buyers achieve expected utility at least as great as in the subgame without a contract. The optimal x simply maximizes the total surplus generated by the contract for the contracting parties, which is equal to v minus the expected cost of acquiring the product from either the rival or "in-house" production: $v - xG(x) - c_I[1 - G(x)]$.[9] The necessary first order condition for this maximization leads directly to the following:

$$\frac{x - c_I}{x} = -\frac{1}{\eta} \tag{2.1}$$

Equation (2.1) is simply the monopsony version of the standard Lerner equation. As Aghion-Bolton demonstrated with a functional form representation of the problem, the contracting parties act as a monopsonist in purchasing from the entrant, setting the optimal monopsony price. A monopsonist that values a product at a constant – which here is c_I, the cost of production by the incumbent that is avoided when the product is purchased from the rival – will always set a price x to satisfy (2.1). As a monopsonist, the incumbent-buyer pair sets the exercise price below its unit value. The rents that the entrant earns in low-cost states are open to extraction via the call option contract between the incumbent and each buyer: lowering x reduces the price that the entrant must charge to attract the buyer, thus implementing a transfer from the entrant to one of the contracting parties. This incentive reduces the optimal x^*, resulting in the $x^* < c_I$ inefficiency.

Upstream Market Power (the Vertical Externality Theory): Assuming competitive entrants but a single upstream supplier isolates a second theory, the vertical externality theory. We assume that the supplier produces the input at zero cost; that each unit of the downstream product requires one unit of the upstream input; and that ex post bidding for the m units of inputs takes place before production and sales to downstream buyers. (If the upstream input is non-rivalrous, such as information, then the bidding is for the *exclusive rights* to the input.)

[9] The optimal x can be characterized without reference to the individual rationality constraint. The IR constraint simply determines how the total benefits from the contract are shared.

payoffs with no long-term contract: The multiple entrants will bid $\max(0, v-c)$ for the input since owning it provides the right to be a monopolist in the downstream market with additional cost c. If $c_I < c < v$ the incumbent wins the auction, paying $(v-c)$ and produces and sells at v; if $c > v$ the incumbent wins the auction with a bid of 0. Hence the incumbent's expected profit with no long-term contract is

$$\pi_{nc} = E\left[\max(0, v - c_I - \max(0, v - c)\right] = \int_{c_I}^{v} (c - c_I)dG(c) + [1 - G(v)](v - c_I) \qquad (2.2)$$

and the buyer's expected surplus without a long-term contract is 0.

payoffs with a long-term contract: Consider first the strategy on the part of the incumbent and a buyer of entering a contract with $x > c_I$. In this case, the incumbent's maximum bid for the input ex post is $x - c_I$; the entrants' bid is $\max(0, x - c)$. The incumbent wins the bidding if $c > c_I$ and pays a bid equal to the entrant's bid. In this case the incumbent's profits earned ex post (disregarding the initial option price p_o) are $x - c_I$ minus the entrant's bid, which is

$$\begin{cases} x - c_I\,, \text{ if } c > x; \\ c - c_I, \text{ if } x > c > c_I \end{cases}$$

Since the buyer pays a price x whatever the realization of c, the total expected surplus to the incumbent and the buyer from the long-term contract when $x > c_I$ is

$$S_c = (v - x) + \int_{c_I}^{x} (c - c_I)dG(c) + [1 - G(x)](x - c_I)$$

From this, $\partial S_c / \partial x = -G(x) < 0$, showing that the strategy $x > c_I$ is dominated by $x = c_I$ and will therefore not be taken. The optimal x thus satisfies $x \leq c_I$. It then follows that the incumbent loses $(c_I - x)$ by winning the bid for the input ex post and will therefore bid 0 for the input.[10] The entrants will submit positive (and identical) bids if $x > c$. Hence the expected total surplus to the buyer and seller from a long-term contract is, for $x \leq c_I$, $S_c = (v - x) - [1 - G(x)](c_I - x)$. Optimizing S_c with respect to x yields (2.1). The buyer

[10] It must enter a bid to avoid the contingency that no bid is entered for the input; the incumbent has an obligation to fulfill the buyer's option to buy at x.

and seller again act as a monopsonist against the Marshallian supply curve of the entrants.[11]

Fixed Costs (Horizontal Buyer Externalities): This theory parallels the development of the "divide-and-conquer" argument in RRW (1991) and Segal-Whinston (2000).[12] At least two entrants each share a common fixed cost F, with $F > v$, and the common, random variable cost, c. The incumbent has an opportunity to offer a long-term contract ex ante, and ex post entrants and the incumbent make simultaneous price offers. An entrant incurs the fixed cost *after* buyers have accepted its offer. In making price offers entrants can discriminate between those who have an existing contract with the incumbent and those who do not. In the ex post pricing game, the incumbent is committed to the option price x to buyers in the long-term contract; its strategy is the offer of a price to free buyers. The pricing game has three types of outcomes depending on the realization of c: for sufficiently low c an entrant supplies all buyers at a pair of prices to contract and free buyers, (p_c, p_f) that yields zero profits; at a higher cost realization c, the incumbent supplies all buyers with its price to free buyers being limited by potential entry; and at a sufficiently high price the incumbent sets $p_f = v$.[13]

One sub-game Nash equilibrium in this game involves the incumbent offering a $(p_o, x) = (v, 0)$, with all buyers accepting, as in RRW. A single buyer has no incentive to deviate unilaterally because rejecting the contract alone would not allow any discipline by entrants on ex post pricing game and the buyer would pay $p_f = v$ as a free buyer. The incumbent extracts full profit, unaffected by the threat of entry in this equilibrium.

In this equilibrium, however, all buyers play "accept" in the acceptance subgame, earning zero surplus, whereas "reject" by all buyers is a Pareto-superior Nash equilibrium of this subgame since it allows the buyers a positive expected surplus in the (no-contract) ex post pricing game. If we restrict attention, as in Segal-Whinston, to subgame perfect Nash equilibria in which Pareto optimal Nash equilibria are selected in any subgame, then the unique equilibrium involves the offer to m^* buyers of a contract with $x^* < c_I$ and a price p_o

[11]The concept of a "supply curve" is slightly subtle here. This is a Marshallian supply curve, taking the input price fixed at 0, even though the input price will not in general be 0 in equilibrium.

[12]Aghion-Bolton (1987), section 3, developed the idea earlier but in a setting in which the incumbent could offer contracts with a price conditional upon how many buyers accept. This type of contract might be difficult to enforce.

[13]Over the range of low c where an entrant supplies at two different prices, there is a multiplicity of equilibria or "sustainable" prices. The mapping from long term contract offers and realized c to equilibrium prices is a correspondence. We adopt the following refinement on the selection of equilibrium from this equilibrium correspondence: (a) the selection is differentiable; (b) the contract option price p_o (being a sunk cost) does not affect the equilibrium over the range of c where an entrant provides; (c) the contract price $c(p_o, x; c)$ is non-decreasing in x, *ceteris paribus.*

that leaves each buyer with the same expected utility as in the no-contract subgame. This framework is the simplest departure from the benchmark to capture this incentive channel. The proof that $x^* < c_I$ under these assumptions is provided in the appendix. The results of this section are summarized in the following proposition.

Proposition 1. *Under the Chicago Benchmark, the equilibrium value of x is $x = c_I$, and the optimal contract is equivalent in terms of expected payoffs to writing no contract at all. Any equilibrium x satisfies $x < c_I$ under the sets of assumptions summarized above as: (1) entrant market power, (2) upstream market power or (3) fixed cost and contestable entrants. Under the last set of assumptions, the number of buyers offered long-term contracts, m, is less than n.*

The interpretation of a contract as an option, which is central in Aghion-Bolton as our call-option interpretation makes clear, goes back at least to Oliver Wendall Holmes (1897), who famously stated that "the duty to keep a contract at common law means a prediction that you must pay damages if you do not keep it and nothing else." This is the essence of the economic interpretation of "contract", as opposed to the interpretation by some legal centralists and philosophers that a contract entails a moral obligation not to breach.[14] To an economist, any contract is an option. The case application in section 4 of this paper draws on all three theories.

3. Simultaneous Bidding for Exclusivity: Upstream

In offering upstream contracts the incumbent may have a first-mover advantage (as it almost always does with downstream contracts). If the risk of entry is significant, an upstream firm may purchase exclusive rights to all of upstream essential inputs so as to guarantee a monopoly. The gains to trade, which are the prospective monopoly profits, are shared with the upstream firms via the purchase price of the exclusive rights.[15] In general, however, the

[14] Note that our model of the horizontal buyer externality basis for exclusionary contracts in particular respects Justice Holmes' principle that any contract is an option – the essence, as we have suggested, of the economic interpretation of "contract". This is not true of the RRW-SW model.

[15] A case which is often associated with this theory is *Alcoa* (*United States v. Aluminum Co. of America*, 44 F . Supp. 97 (S.D.N.Y. 1941). Lopatka and Godek (1992), however, suggest a different view. The theory as sketched in the text is incomplete, since a "hold-out" problem arises among upstream suppliers in that some may choose to wait to sell to a rival entrant. (An analogous hold-out problem is analyzed in section 4 of this paper.) Note that the theory has many variants. For example, if input suppliers vary in cost,

incumbent cannot be assured of first-mover advantages in setting upstream contracts. Nothing stops a new (and unanticipated) entrant from immediately engaging upstream suppliers in contractual arrangements. As we will discuss in the next section, in *Nielsen* the entrant and incumbent negotiated with upstream suppliers over a short period of time. We represent this kind of competition for upstream rights as a simultaneous auction in this section of the paper, and characterize the conditions under which the competition for upstream inputs will result in monopolization of a downstream market.

Consider two firms that are supplied by n upstream suppliers, and seller to downstream buyers. For simplicity (and to match the facts of the case studied in the next section), the n inputs supplied are, *rights* such as patent rights or the rights to the use of particular information or other property. That is, the goods are non-rivalrous.[16] Each downstream firm acquires a subset of the rights from the upstream suppliers in a bidding game described below, and the two firms then compete in the downstream market, earning profits that depend on the allocation of rights to the two firms. If the downstream output were observable, it would in general be optimal to submit contracts such as non-linear royalty contracts for the upstream inputs.[17] Competition would take the form of contract offers, as in Bernheim and Whinston (1998). We assume that outputs are not observable, so that the only feasible bids for upstream inputs are dollar amounts. Whether or not the rival has access to an input is observable, so that bids can be conditioned upon that event. The questions we ask are how the payoffs in the non-cooperative bidding game compared to the total profits that could possibly be achieved in the market; whether there is the incentive to enter into exclusive bids; and when the equilibrium in the bidding game for upstream rights will assign all rights to one firm, so that the outcome is an exclusionary *set* of contracts that ensures a monopoly for one downstream firm.

We consider the following game. First, the downstream firms $i = 1, 2$ simultaneously submit bids (b_j^i, e_j^i) to each of the n upstream suppliers; b_j^i is a bid by i for the (shared) right to j's input; e_j^i is a bid for the exclusive right. Next, each upstream supplier j accepts bid(s), choosing the maximum from $\{b_j^1 + b_j^2, e_j^1, e_j^2\}$. The result is an allocation $a \equiv \{a_1, ...a_n\}$ with

it may be optimal for an incumbent to contract with only the major, lowest-cost input suppliers. And the profitability of exclusivity in this case may derive not from the complete monopolization through erection of barriers to entry but through raising the costs of existing rivals. This theory of vertical foreclosure is a central theme of the raising-rivals'-costs literature (Krattenmaker and Salop (1986); Salop and Scheffman (1983) and (1987); Ordover, Saloner and Salop (1990)).

[16] The relaxation of this assumption is discussed at the end of this section.

[17] For example, if $n = 1$, then the single upstream input supplier by accepting the appropriate royalty contracts from downstream firms could elicit the prices downstream that maximized total industry profits.

$a_j \in \{1, 2, B\}$ where $a_j = B$ indicates that the input has been allocated to both firms. That is, each input j is allocated to $1, 2$ or both. The two downstream firms earn profits $\pi_1(a)$ and $\pi_2(a)$. These profit functions are an exogenous reduced form summary of the payoffs from downstream competition. We have in mind that the profit functions represent the payoffs from a differentiated Bertrand competition subgame, in which the value of either downstream product, 1 or 2, to buyers depends on the set of upstream inputs incorporated in the product. (In the case study following, the downstream product is an aggregation, with value added, of upstream, geographically-differentiated, raw information inputs.) $\pi_i(B, ...B) > 0$ because of, for example, *inherent* product differentiation in a Bertrand pricing game, as opposed to product differentiation induced by the assignment in a of different inputs to the two firms.[18]

Our interest in this game is in the prediction of when the equilibrium allocation of the game will assign all rights to a single downstream firm. To this end, we consider an artificial, "semi-cooperative" game in which the entire set of firms, upstream and downstream, choose an allocation subject to the constraint that given the allocation competition will take place. In this artificial game, lump sum transfers are possible so that the allocation chosen is $a^* = \arg\max_a \pi_1(a) + \pi_2(a)$. The allocation a^* maximizes industry profits subject to the constraint that given a, firms 1 and 2 compete downstream. The optimum a^* can in principle take on any one of seven configurations: all $a_i = 1$; all $a_i = 2$; all $a_i = B$; all $a_i = 1$ or 2; all $a_i = 1$ or B; all $a_i = 2$ or B; and some $a_i =$ each of $1, 2$ and B. For example, if inherent product differentiation is high enough that both firms produce in the optimum; if a subset of inputs, M, is critical to the production of either product; and if simultaneous purchase of any input outside of M would greatly reduce product differentiation (thereby making downstream price competition more intense) then a^* would allocate the inputs in M to both firms and the remaining inputs exclusively to one firm or the other. We assume that each profit function is monotonically increasing in the set of inputs allocated to the firm and decreasing in the set of inputs allocated to the rival firm.

The following proposition, proved in the appendix, connects the equilibria in the non-cooperative bidding game and the semi-cooperative game.

Proposition 2. *If* $\forall\ j \in \{1, \ldots, n\}$, $a_j^* = 1$ *or* 2, *then either* a^* *is the unique allocation implemented by the bidding game or an equilibrium does not exist.*

Corollary. *If* $a^* = (1, 1, ..., 1)$ *or* $(2, 2, ..., 2)$ *then either* a^* *is the unique allocation imple-*

[18] Inputs could in principle be cost-reducing rather than value-adding in the downstream market.

mented by the bidding game or an equilibrium does not exist.

If there were only one upstream firm, and the only kind of bids available were exclusive bids, it would be trivial to show that the allocation maximized total industry profits. Here there are many inputs, simultaneous bidding, and bids for non-exclusive and exclusive rights. In general, the equilibria in the semi-cooperative game and the bidding game do not coincide. For example, if a^* includes $a_j^* = b$, one equilibrium may involve $b_j^1 = b_j^2 = 0$ with the two firms failing to coordinate on adequate non-exclusive bids. If, however, a^* allocates each input exclusivity, the coordination problem does not arise and a^* is then the only possible equilibrium for the bidding game. The corollary, which follows directly, shows that if maximum profits are achieved by allocation of all rights to one firm exclusively, then this is the only possible outcome of the game; the other firm is excluded.

An equilibrium may not exist, however. Suppose, for example, that $n = 10$, and a^* assigns all inputs to the firm 1 which then earns monopoly profits of 100 downstream. The most that firm 1 could pay for each input on average is 10. But firm 2, a close inherent substitute, may respond by paying a total of 30 for 3 inputs: duopoly profits are less than half monopoly profits, but they may exceed 30%. In other words, 3 input suppliers may "hold out" for a higher bid from firm 2. So a^* is not an equilibrium. But then any allocation other than a^* is also not an equilibrium, since in any duopoly between close substitutes, the total monopoly profits exceed the duopoly profits; therefore 1 will out-bid 2 for any particular subset of inputs. An equilibrium does not exist in this case. On the other hand, there may be multiple equilibria. The collective profit-maximizing allocation may be B, but achieving this requires the two bidding firms to coordinate on bids b_1 and b_2; $b_1 = b_2 = 0$ for example is always an equilibrium.[19]

[19] The bidding game is a particular example of a game played through agents (GPTA), i.e. a multi-principal, multi-agent game, as analyzed in Prat and Rustichini (2003). In our model, the principals are the two firms downstream, and the agents are upstream suppliers. In a GPTA, agents take actions that affect principals' payoffs in the second stage of a game; and in the first stage principals offer simultaneously to all agents transfers as a function of the action taken subsequently by the agents. Here, an agent's action is a choice from $\{1, 2, B\}$, and we have assumed, because of antitrust law, that the transfer from firm i, conditional upon the choice of i' not equal to i, must be zero.

Prat and Rustichini provide sufficient conditions under which a pure strategy equilibrium exists in a GPTA. The key condition is a balancedness-type condition, which does not hold in our game (as is evident by the nonexistence of equilibrium for some parameters). Prat and Rustichini also provide conditions for the existence of equilibria tha maximize aggregate profit, which in our terminology means conditions under which a^* is an equilibrium. These fail in general in our game. If the bidding in our game were solely for exclusive use of inputs, then the profit-maximizing property of the equilibrium would follow directly from section 4 of Prat and Rusticini, which studies games in which agents have only 2 possible actions. But in our model, agents have a choice among 3 actions, 4 actions including the choice of not supplying rights to either firm.

Structured Model: We must address our central question – when will the equilibrium set of contracts result in exclusion of one firm from the market? – with a more structured model or example. In this structured model, we rely on the case of symmetric inputs, in assuming that $\pi_i(a)$ depends only on the *numbers* of inputs assigned to each firm. (This will be the case if the values of the two products to final buyers depend only on the numbers of inputs incorporated in each product.) Define the profit functions in this case as $\widehat{\pi}_i(n_1, n_2)$, $i = 1, 2$, where (n_1, n_2) are the numbers of inputs allocated to the two firms. Then the equilibrium $\widehat{a}$ will be $(1, ..., 1)$,i.e. will assign all inputs to firm 1, if $a^* = (1, ...1)$ and the following condition holds ("no hold out"): there is no $m < n$ such that $\widehat{\pi}_1(n, 0)/n < \widehat{\pi}_2(n - m, m)/m$. If $a^* = (1, ..., 1)$ and the no-holdout condition fails, then there is no equilibrium.

The central question is thus reduced to a necessary and sufficient set of two conditions: $a^* = (1, ...1)$ and the no-holdout condition. When will these be satisfied? To answer this question, we must get underneath the exogenous profit functions and into the conditions in the downstream market. To do this, we restrict the model still further by relying on a parameterization of the symmetric case. Consumers are uniformly distributed along a unit line segment between two downstream firms and have a common transportation cost, t. (Higher t will represent lower inherent downstream substitutability of products.) Firm's have cost zero, so once we have gross values v_1 and v_2 of consumers for the two products, it is straightforward to compute profits. The willingness of a consumer to pay for a particular downstream product, $i = 1$ or 2, depends on the number of inputs m_i embodied in good i, and is given by m_i^{θ}. The parameter θ measures the value and complementarity of the upstream inputs. Costs upstream are zero and the only costs downstream are the fixed costs of purchasing the rights to inputs.

The parameters of the model are t, θ, and n. Figure 2 below illustrates, for $n = 10$, the sets of parameters t and θ for which (1) the privately efficient allocation a^* assigns all inputs to the same firm; and (2) the parameters for which this allocation is implemented in the bidding game. When upstream complementarity is sufficiently high, the only possible values for a^* assign all rights to one firm or all rights to both firms, i.e. $a^* = (b, b, ...b)$, since the inputs must be used together. If we add the condition of sufficiently high inherent substitutability (low t), then the allocation $(b, b, ...b)$ is ruled out by the intensity of competition that would drive down profits were both firms to acquire the inputs. This leaves exclusivity as the privately efficient outcome with low t and high θ. For this exclusivity outcome to be implemented by the auction, however, the hold-out problem must be overcome. This requires even stronger upstream complementarity and/or downstream inherent

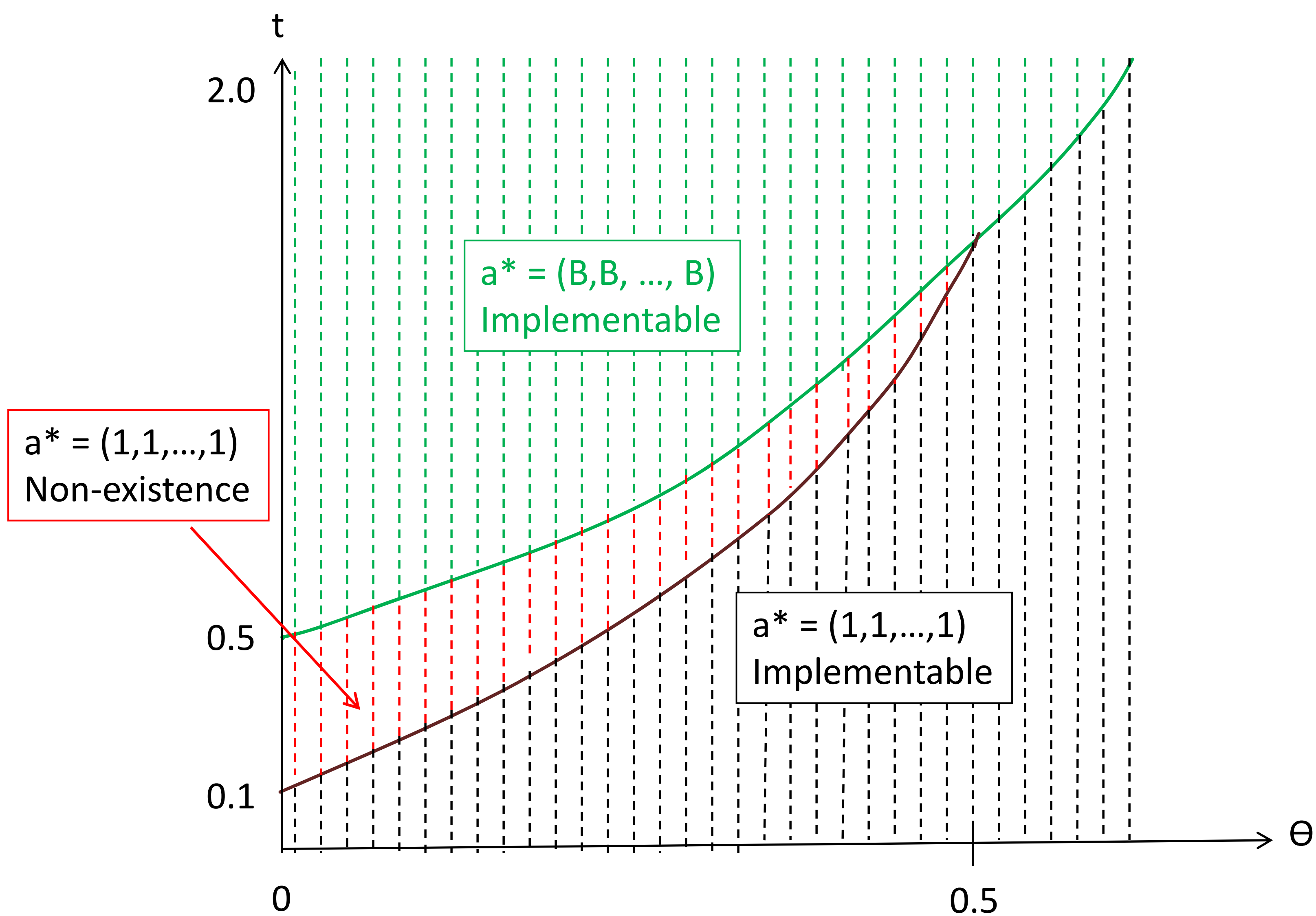

Figure 2: Parameters (ϴ,t) from structured model, for which the bidding game will implement a*

exclusivity: a* = (1,1,...,1)

non-exclusivity: a*= (B,B,...B)

substitutability because when the profitability of exclusivity at one firm is marginal, it is relatively easy for the other firm to out-bid its rival for a subset of the inputs. Its bid reflects a sharing of the prospective profits among only this subset of input providers. In short, the central prediction of the simultaneous bidding model is exclusivity, resulting from a single winner of all simultaneous bidding games, providing that three conditions hold: (1) sufficient complementarity upstream; (2) sufficient inherent substitutability downstream; and (3) informational conditions that restrict bids to dollar values rather than contracts.[20]

Interpretation in terms of Rivalrous Goods: Our structured model of bidding for upstream inputs adopts assumptions consistent with the case study in the next section of the paper, in particular the assumption that the inputs are nonrivalrous. Is the assumption of non-rivalrous goods necessary for the general, reduced-form model, which takes payoff functions $\pi_i(a), i = 1, 2$ as exogenous?[21] The model as it stands allows for the case rivalrous goods under additional assumptions. The following is an example. Assume that each input is produced a constant unit cost, and that negotiations or bidding for the contractual rights to the use of inputs is undertaken in the first period of a model. (This assumption reflects the fact that decisions on which inputs are to be used in production is often a long run decision.) Suppose, as is common in the exclusive contracts literature (e.g. RRW), that prices cannot be contracted for in the long-term contracts and that the long-term contracts are therefore naked-exclusion or "naked-rights" contracts, with the price for each input being determined in a second stage via take-it-or-leave offers by whichever firm has the rights to the input. These prices will be set, obviously, to the unit cost. The downstream firms then choose quantities simultaneously as Cournot duopolists. The profits earned in the second stage can be written as functions $\pi_i(a)$ of the allocation determined the first stage. Our model as it stands can be interpreted as including this example of rivalrous goods.[22]

[20] In the region where $a^* = (B, ..., B)$, then a^* is implemented with the bidding strategies by each firm i for each upstream input j: $[b_{ij}, e_{ij}] = [.5(1/n)\pi_1(1, 1, , , 1), (1/n)\pi_1(1, 1, , , 1)]$, and the strategy of B by each downstream firm whenever the payoff from B is the maximum. At this pair of identical strategies, neither firm has an incentive to change any of its bids unilaterally.

[21] We are grateful to a referee for posing this question.

[22] If commitment to prices and quantities is possible in long term contracts, the analysis is very different. Consider the simplest case of a single upstream supplier and two symmetric firms downstream. The input supplier can charge royalty rates to the two downstream suppliers that will elicit the monopoly price, and full monopoly profits downstream (Chen and Ross 2003). Bidding for rights would take the form of contracts and, analogous to common-agency theory, result in maximum industry profits. In contrast to our model and application, in which long term royalty contracts are not possible, this model predicts that exclusionary contracts would not be signed.

4. Application: *Nielsen*

We have outlined four channels through which an incumbent firm and its buyers, suppliers or both have the incentive to enter exclusionary contracts – that deter a rival from entering a market. In this section we illustrate the incentive with a Canadian competition policy case, *Nielsen.*[23] Nielsen, wholly owned by D&B, had a monopoly in Canada over the provision of market-tracking services for grocery store produce sales, when it was threatened in 1985 with the entry into the market by Information Resources Incorporated (IRI). IRI is a U.S. firm with which Nielsen shared the U.S. market in approximately equal market shares at the time. The products at issue in the case are a combination of software and information that allowed tracking of market shares, estimation of demand elasticities and responsiveness of demand to product promotions, and so on. The downstream buyers of these information products are mainly manufacturers of grocery products. The key inputs required are raw scanner data provided by the major grocery chains, 11 chains in Canada in 1985. Conditional upon the same raw data inputs, the Nielsen and IRI products were very similar but not identical.[24] Some important product differentiation arises, however, due to the fact that Canadian subsidiaries of U.S. firms prefer the product adopted by the U.S. parent because of complementarities in using the same software and informational products. In the upstream market, scanner data from grocery chains in the same regions were presumably functional substitutes, but evidence indicated a strong complementary in that a national data set, made up of data from all regions, was the product that Nielsen and IRI judged to be of the highest value. In short, the market was characterized by strong complementarity in *upstream* inputs and strong substitutability between the *downstream* information products. Finally, we refer to Nielsen as the incumbent because it was established in the broad market for market-tracking services, but the scanner-based information products were in development in the mid-1980's.[25]

The case involved a challenge by the Canadian competition authority, the Director of Investigation and Research (now called the Commissioner of Competition), of two sets of Nielsen contracts. With the threat of IRI's entry starting in 1985, Nielsen entered into 5 year exclusive contracts with all of the upstream grocery suppliers of scanner in 1986, contracts that contained liquidated damage clauses and prohibited the sale of scanner data to any

[23] *Canada (Director of Investigation and Research) v. The D & B Companies of Canada Ltd. (1995), 64 C.P.R. (3d) 216 (Comp.Trib.)* ("Nielsen")

[24] We label this feature as low *inherent* product differentiation in the discussion of our theoretical model.

[25] Nielsen introduced the full scanner-based information product in 1988, after the main events on which the case focussed.

other party. Nielsen had also entered into long-term (3 or more year) contracts with a set of downstream buyers (grocery product manufacturers); until then, Nielsen's downstream contracts had been evergreen contracts that were terminable on 8 month's notice (in those contracts entered as evidence).[26] The Director's challenge of both sets of contracts before the Canadian Competition Tribunal was successful. The Tribunal nullified the terms of the downstream contracts and the exclusivity restrictions in the upstream contracts.[27]

4.1. Competition for Exclusive Contracts with Upstream Suppliers

As in our model in section 4, the incumbent Nielsen did not have a first-mover advantage. In fact, as Nielsen emphasized in its evidence, the potential entrant, IRI, was the first to offer an exclusive contracts. The bidding was not literally simultaneous as in our theory, but was concentrated in a few months; our adoption of the usual assumption of simultaneous competition is a better fit than usual to the facts of the case. And consistent with the model, the principal elements in each contract were the price for upstream data and parameters of exclusivity rather than more complex royalty schemes.

The market for rights to the data inputs, in short, was one in which competition was intense – but the competition was for rights to the upstream inputs, not competition within the output market. Does this type of competition in some sense substitute for competition within the market – or provide any welfare benefits at all? Under the facts of this case, the *substitutability* or low inherent product differentiation downstream and the *complementarity* of inputs upstream, the equilibrium outcome of competition for the rights to inputs was a monopoly no matter how intense the competition, i.e. no matter how symmetric the positions of Nielsen and IRI were in their potential for exploiting the monopoly position.

The socially optimal allocation of input is clearly an allocation to both firms – especially because the input as a non-rivalrous good can be supplied to the second firm at zero cost.[28] The benefits of the non-exclusive allocation are two-fold: providing greater product variety in the market (in allowing, for example, greater matching of software between Cana-

[26] *Nielsen,* p.62.

[27] Significantly, as we shall discuss, the Tribunal did not nullify the entire upstream contracts.

[28] An element of the case that makes this conclusion *sui generis* is that the conclusion relies on the fact that the upstream data were produced at essentially zero cost as a by-product of production. In the case of patent rights, for example, the law would not properly strike down exclusivity since a contract would then merely transfer exclusive property rights granted by a patent to a downstream firm. And the collective acquisition by one firm of all patent rights would not be an example of anticompetitive patent-pooling if the upstream rights were complementary, analogous to this case. While the normative conclusions do not easily generalize, the positive analysis does.

dian subsidiaries and U.S. parents) and allowing price competition downstream instead of monopoly pricing. The model and economic principle – the conflict between privately and socially efficient contracts – generalize to the case where inherent product differentiation is strong enough that the equilibrium outcome is not a monopoly. Suppose that product differentiation is so strong that total industry profits would be maximized by the presence of both firms in the market. In general that industry profits (upstream and downstream) will be maximized by allocating some raw inputs exclusively to Nielsen and some to IRI: the difference in the allocation of inputs translates into greater differentiation and therefore less intense price competition in the output market. If the two firms were cooperatively choosing the allocation of inputs, and then competing, in general some exclusivity but not complete exclusivity may well result. Partial exclusivity can increase profits when it results in two firms competing because of the "competition-dampening effect" of exclusive dealing: increasing the sets of inputs to which firms have exclusive rights increases product differentiation in the final market, which dampens price competition, and raises equilibrium prices and profits. Firms choice of how many input suppliers to sign up exclusively would trade off the private benefits of the competition-dampening effect with the costs of reduced product value. Again, however, the social optimum involves no exclusivity because this maximizes the value of each product to any purchaser (at zero social cost) and enhances downstream price competition, bringing prices closer to marginal cost.

Competition *for* the market in the form of competition for rights to upstream data inputs, in short, does not substitute for competition *within* the market, as the Tribunal noted.[29] It does, however, yield one simple efficiency benefit. Suppose that the two firms that are bidding for exclusive rights have positive costs, rather than zero costs, with constant marginal cost. Under a mild restriction on demand, the result of the bidding game is that at least the "right" monopolist is chosen. Whichever monopolist, Nielsen or IRI, would produce the greater social surplus is the one that would win the game.[30] Two other aspects of the strategic interaction between the firms reviewed below, however, distort even this modest efficiency outcome and leave us with the Aghion-Bolton type of prediction that the higher cost (or lower surplus) firm may survive as a monopolist in this market.

The key effect of intense competition for exclusive rights, when the downstream firms

[29] *Nielsen*, p.79. See Mathewson and Winter (1987) for a model and case discussion in which the disciplining effects of competition *for* the market offset the loss of competition *within* the market in the adoption of exclusivity restrictions.

[30] A sufficient restriction on demand is that the percentage difference in demand between Nielsen's product and IRI's product be independent of price. Under this assumption, the product generating the higher profit is also the product generating the higher total surplus.

are symmetric in demand and costs and product differentiation is relatively low so that monopoly is the outcome, is a *shift in monopoly rents upstream* to the suppliers of the raw data as the price for the data is bid up to the present value of resulting monopoly profits. The scarce input was the raw data, not the ability to manage a monopoly downstream. The suppliers of raw data, the grocery store chains, were principle beneficiaries of the contract exclusivity. In light of the ultimate beneficiaries of the exclusivity contracts, it is interesting to note that the proposal to sign up retailer data suppliers exclusively was the outcome of negotiations that were initiated by the Retail Council of Canada, a trade of the (upstream) suppliers.[31]

The bidding game was not perfectly symmetric, of course. Any asymmetry in the bidding game that Nielsen was able to create – to foreshadow the implications of the downstream contracts – acted to increase Nielsen's share of the increase in aggregate industry profits attributable to exclusivity.

4.2. Nielsen's Downstream Contracts

The terms of Nielsen's contracts with selected downstream purchasers of their information products jumped from less than 1 year (evergreen contracts terminable on 8 months' notice) to 3 to 5 years as soon as IRI attempted to enter the industry. The internal documents of Nielsen read as if management had just read the Aghion-Bolton working paper. These documents indicated that the strategic purpose of the shift in contract lengths was to deter the entry of IRI by "locking up" customers in long-term contracts. The contracts contained liquidated damages payable to Nielsen if the customer terminated the contract.

The horizontal externalities theory applies here because each client would view the probability of IRI entering – an event which with positive value for the client – almost unaffected by its own decision to accept the long-term contract. A small "bribe" in terms of a lower price would be sufficient to induce the client to sign the long-term contract. The first Aghion-Bolton theory applies as well: the stipulated damage clauses was of low expected cost to the downstream customer at the time of contracting in part because even if IRI were to be successful in entering, IRI would in negotiations with the buyer effectively pay for part of the stipulated damage since this damage would reduce the joint surplus which the negotiations would allocate. By raising the stipulated damage, the incumbent and buyer in any downstream contract were implementing a transfer away from IRI, contingent on the states

[31] *Nielsen*, p.63.

of successful entry, to the pair of them.

Just as in the horizontal externalities theory, the ability of the incumbent to discriminate in long-term contract offers was an important ingredient in implementing exclusivity. Nielsen did not induce all customers to sign long-term contracts but instead targeted the Canadian subsidiaries of U.S. customers of IRI. It was the loss of these buyers to which Nielsen was most vulnerable, and the gain from signing long-term contracts with them was the highest.

Finally, a vertical externality as analyzed in section 3 of this paper applies. The fact that Nielsen as the incumbent was able to enter the *downstream* contracts described, provided it with an asymmetric advantage over IRI in the *upstream* bidding game for the exclusive rights to the data. IRI's willingness-to-pay for the upstream data was surely reduced by the disadvantage it faced in overcoming the long-term contracts downstream. The long-term contracts downstream thus imposed a negative externality, and extracted a transfer, not just from IRI but also from upstream data suppliers in allowing Nielsen to win the upstream game with lower bids.

One effect of this vertical externality is to negate even the modest efficiency property that we claimed for the upstream bidding game. It no longer follows that Nielsen would be forced out of the market in the event that it was not the "right" monopolist: the advantage transferred from the downstream contracting game to the upstream game leads to the possibility of an Aghion-Bolton type of inefficiency in allowing an inefficient incumbent to remain as a monopolist.

4.3. Renegotiation and Staggered Contracts

Let us return to the upstream contracts. After signing contracts with identical (5 year) terms with all of the data suppliers, Nielsen recognized that 5 years later (in the summer of 1991) it would potentially face the identical bidding war with IRI for the rights to the essential inputs. The prospect was again competition for the right to be the monopolist – competition that shifted rents upstream. In 1989, Nielsen renegotiated contracts with two suppliers including Safeway, the largest supplier.[32] While the effect of contract staggering was not a monopoly – this market structure was already guaranteed by exclusivity whether contracts were staggered or not – the outcome was a barrier to entry *into the position of*

[32] Nielsen was able to renegotiate the Safeway contract as a result of a merger between Safeway and Woodwards. The contract with Steinberg, a smaller supplier, was renegotiated the same year (*Nielsen*, p. 62).

being the monopolist in the market. In an internal document produced in the case, the President of Nielsen Canada stated

> "After we did our retailer deals five years ago, we recognized that we were vulnerable because virtually all of these agreements expired around the same time. We set ourselves a goal then to pursue a practice that would result in our retailer and distributor contracts expiring at different times. This would make it much more difficult for any competitor to set up a service unless he was prepared to invest in significant payments before he had a revenue stream." (*Nielsen,* p.66)

Just as with Nielsen's ability to establish downstream contracts, discussed above, this staggering of contracts negates the modest efficiency property of the upstream bidding game. The social cost of this staggered contract strategy was, at a minimum, that the most efficient monopolist would not necessarily occupy the market.[33] The profitability of the staggered contract strategy is not explained simply by its profitability to Nielsen. The two suppliers voluntarily renegotiated their contracts. It is the external effect or transfer of wealth away from the other suppliers of data to the *pair* of parties undertaking any contract renegotiation that is the key to explaining the strategy.

4.4. Most-favoured Nation Clauses

An additional issue that arose in Nielsen is that of preferred supplier contracts or most-favoured nation (MFN) clauses in the upstream contracts. These were terms whereby Nielsen would be guaranteed that its price would not be higher than a price at which the data were subsequently sold to another buyer such as IRI.[34] Two of Nielsen's contracts entered in 1994 contained MFN clauses, in addition to exclusivity clauses as Nielsen apparently recognized the risk that the latter would be struck down. In some circumstances, an MFN clause is reasonable. It ensures, for example, that the first purchaser of the input is not disadvantaged in downstream competition with a rival who is able to strike a more favorable price. (Because of the zero marginal cost of the input there is a risk that a lower price might be struck subsequently with a rival.)

[33] The strategy of staggered contracts was not in and of itself challenged by the government in the case, for an obvious reason. The prohibition of staggered contracts would be an unworkable remedy. Requiring a firm to coordinate the beginning and ending dates of its contracts with suppliers would be simply too intrusive and inefficient.

[34] The preferred-supplier contracts specified a lower price conditional upon sale of the data to a second firm, rather than a guarantee of price matching (*Nielsen*, p.62). The analysis is similar.

Suppose in this case that exclusivity were struck down in these contracts. Could the MFN clauses, if they were allowed, have the effect of exclusivity? A example shows that they could. To keep the analysis simple, imagine that there is a single upstream supplier of raw data, that the monopoly profits that could be earned with the data are 10 dollars and that the profits that could be earned by each duopolist in the market would be 3 dollars. (The monopoly profits thus exceed the sum of duopoly profits.) If the incumbent monopolist tried to bargain for a low price, say 5 dollars, for the input, then the MFN would not deter entry. The supplier of the raw data would willingly accept 3 dollars from the new entrant even with the MFN restraint leading to a reduction of 2 dollars in the incumbent's price. If the incumbent offered a price of 6.50, however, the entrant would be deterred. In short, the combination of MFN plus the offer of a *high* price deters entry. The Tribunal, convinced of this argument,[35] struck down the MFN and preferred-supplier clauses, albeit with a time-limited order. The assessment of *high* prices in combination with the MFN clauses as exclusionary contrasts with the traditional legal view of *low* prices as exclusionary, as in predatory pricing cases.

4.5. Strategy and the Timing of Contract Offers in *Nielsen*

We represented the competition between Nielsen and IRI for rights to upstream data with a model in which the two firms offered simultaneous bids for exclusive and non-exclusive rights, rather than a model with a first-mover advantage to the incumbent. At least one retailer has requested bids on both an exclusive and non-exclusive basis in this market,[36] but in representing market competition (in the standard way) as a simultaneous game, we abstracted from very interesting strategic interaction between the firms. In support of our no-incumbent-first-mover assumption, IRI was the first to offer exclusive contracts in the market and indeed signed up 10 of the 11 suppliers of retailer scanner data to exclusive contracts.[37] This fact was Nielsen's principal defense in the case:

> " Throughout the course of the proceedings counsel for Nielsen returned again and again to the origin of the present exclusive arrangements and the role of IRI to argue that, because IRI 'initiated' the practice of exclusives, Nielsen's use of

[35] "For reasons discussed ... and, in particular, Dr. Winter's model, we are of the view that the provisions in question allow Nielsen to set its payments at a level that would make entry by a rational would-be entrant unprofitable." (*Nielsen*, p.67).

[36] *Nielsen*, p.70.

[37] Expert Report of Ralph A. Winter in *Nielsen*, p. 40.

> exclusives cannot be anti-competitive. Nielsen's position was that it was forced to adopt exclusives in order to protect its legitimate business interests against the threat of being locked out of the emerging technology and to safeguard its existing tracking services." (*Nielsen*, p.68)

There is no doubt that Nielsen's decision to offer exclusive contracts in 1986 was the right business decision, notwithstanding the subsequent ruling in *Nielsen* that the contracts were illegal. Any antitrust challenge of the contracts was years away (8 years, as it turned out), the outcome of such a challenge uncertain, and the impact of a potential loss by Nielsen in the event of a challenge was simply a requirement that the contracts be abandoned.[38] Yet Nielsen's defense of exclusionary contracts as a *necessary response* on its part to the use of these contracts by IRI was properly rejected by the Tribunal. In this civil matter, the issue was whether the continued use of the contracts by any party resulted in a substantial lessening of competition in the market,[39] not whether Nielsen as a practical and historical matter needed to adopt the contracts in 1986. "In the view of the Tribunal, retaining or obtaining a dominant position in order to defend another firm potentially becoming dominant is not an acceptable business justification." (*Nielsen*, p.68). Nielsen is an unusual case in that, as the Tribunal noted, Nielsen offered no efficiency explanation for its practice beyond self interest.[40]

If IRI signed up 10 of the 11 input suppliers, how did Nielsen end up as the respondent in this case having exclusives with all 11 suppliers? The answer is in the IRI contracts. To protect against ending up with only a subset of suppliers of data, and competing against Nielsen which at least had an established demand based on a complete set of pre-scanner information on retail outlets, IRI offered contracts that were conditional upon its success in signing all suppliers. Safeway was the hold out. Nielsen was able to strike an exclusive contract with Safeway, presumably for terms generous to Safeway, and the IRI contracts unravelled. IRI's contractual strategy backfired. This is an example of the hold-out

[38] Section 79 of the Canadian Competition Act, R.S.C. 1985, c. C-34, under which Nielsen's contracts were challenged, allows the Tribunal to implement a remedy to practices that are deemed to result in a substantial lessening of competition. It did not at the time, nor does it now, provide for the possibility of penalties to be imposed by the Tribunal.

[39] The Tribunal recognized that it had no direct authority over IRI in designing its remedy:

"We do not have the authority to order IRI, which is not a party before us, to do anything. We acknowledge the undertaking given by ... IRI to the Tribunal, stating that IRI will agree not to enter into exclusive arrangements with retailers if Nielsen is prohibited from doing so... We are confident that IRI, as a reputable public company, will comply with its undertaking." *Nielsen*, p.97.

[40] "We do not accept that self-interest constitutes [a business] justification. We note that Nielsen's experts also failed to provide any efficiency rationale for the exclusives." (*Nielsen*, p.67)

problem in the acquisition of complementary inputs, parallel to the land assembly problem for an urban developer. The characterization of the optimal mechanism design in this type of situation – the mechanism that IRI should have used – is an unresolved question in economic theory.

4.6. The Impact of *Nielsen*: Exclusion via *Implicit* Contracts

Did the decision in this case transform the market for scanner-based information products from one with intense competition *for* the market to one with competition *within* the market, as in the U.S.? No. IRI competes in 8 countries around the world, but the market for scanner-based information remains a Nielsen monopoly in Canada.

The Tribunal recognized that grocery retailers might decide to continue to offer their data to only one customer even once any exclusivity inducements by Nielsen were prohibited. In fact, this is exactly what has happened. The exclusivity agreements have continued in what economists would label *implicit contracts*: each grocery supplier of raw data has apparently recognized that if it were to break the implicit agreement by selling the data to IRI as well as Nielsen, then the downstream monopoly would soon be replaced by a duopoly of close substitutes in which marginal costs were close to zero. The monopoly rents – which, as we have discussed, flowed almost entirely upstream to the grocers as suppliers of the scarce data – would disappear.

The Tribunal recognized that the likelihood of implicit contracts was increased by their decision to alter only the exclusivity clauses and not the current payments in the contracts; and the Tribunal also recognized that in the event that the implicit exclusivity contracts were not sustained, Nielsen would be left paying a higher price for the data under its (still-enforceable) contracts than IRI:

> We do recognize ... two problems that may result from striking the exclusivity clauses without touching the current payments, with the result that Nielsen may choose, or may be required by contract law, to continue to make those payments to retailers. [¶] The first problem is that while the retailers would be able to increase their revenues in the short run by selling their data to IRI while also accepting the current level of payments from Nielsen, they could choose to forgo the additional payments from IRI if they believe that dealing with IRI could reduce their earnings in the long run. The result would be at least some de facto exclusives...The second problem is that Nielsen might have to continue its current

level of payments, without receiving the benefits of exclusivity the payments were intended to secure, while its competitor makes payments at a lower level.

The Tribunal properly did not attempt to set prices in the contracts but in our view should have struck down the contracts entirely. New contracts would have been negotiated. It is of course possible that even then the de facto exclusivity may have emerged. But sustaining cooperation in dynamic games, as one equilibrium among many possible equilibria, often depends on initial conditions or focal points. The likelihood of the de factor exclusivity was increased by the Tribunal's decision because the decision left the current payments intact, as a focal point for the emergence of an implicit contract equilibrium.

5. Conclusion

This paper has synthesized the set of channels through which participants in a market have the incentive to enter into exclusionary contracts. Three of these theories operate in a market in which incumbency provides a first-mover advantage in offering contracts to buyers; the fourth yields exclusionary contracts, under some conditions, in a model in which two downstream firms bid simultaneously for the rights to upstream inputs. We examined an antitrust case that illustrated all four incentive channels as well as a set of strategic issues related to exclusionary contracts; the division of the rents from monopolization to the upstream firms and the winning monopolist; the role of downstream contracts in rendering this division of rents more favorable to the winning bidder by rendering the bidding game more asymmetric, through the vertical externality which we introduced into the theory; the role of contract renegotiation in staggering the contracts to further shift the division of rents and to create not a monopoly, but potentially a barrier to the success of the "right" monopolist; most favoured nation contracts as substitute for exclusive contracts; finally, the ultimate market success of implicit as opposed to explicit exclusionary contracts.

The Aghion-Bolton perspective on anticompetitive exclusionary contracts identifies the incentives for the contracts in terms of transfers from agents outside the contracts. The synthesis that we offer shows the power of this perspective, isolating each incentive in the simplest departure from a benchmark in which privately optimal contracts are efficient. This approach to understanding the private incentives for exclusionary contracts is valuable well beyond the static framework that we have explored in this paper.[41]

[41] Suppose, for example, that in an evolving industry the probability of discovering the next generation

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technology is higher for firms operating in current market or that there is learning-by-doing of any other form, and that the set of buyers changes to some degree over time. In this dynamic market setting, exclusionary contracts can be explained in part as implementing a transfer from future buyers to the current market participants. Exclusionary contracts are potentially of even greater cost, and the Aghion-Bolton perspective more valuable, in dynamic market settings.

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Appendix

Proposition 1. *Under the Chicago Benchmark, the equilibrium value of* x *is* $x = c_I$*, and the optimal contract is payoff equivalent to writing no contract at all. Under the sets of assumptions, (1) entrant market power, (2) upstream market power or (3) fixed cost and contestable entrants, any equilibrium* x *satisfies* $x < c_I$*. Under the last set of assumptions, the number of buyers offered long-term contracts,* m*, is less than* n*.*

The Chicago benchmark contract and the contracts for cases (1) and (2) are proved in the text. With respect to (3), we begin by characterizing the equilibrium in the pricing subgame given any history $(p_o, x, m; c)$, for some $m < n$, where m is the number of buyers accepting long-term contracts. Define

$$\begin{aligned} c_1(m,x) &\equiv \frac{m}{n}x + \frac{(n-m)}{n}c_I - \frac{F}{n} \\ c_2(m,x) &\equiv \frac{m}{n}x + \frac{(n-m)}{n}v - \frac{F}{n} \end{aligned}$$

(We suppress the arguments of these and other functions below.) Note that for $c < c_1$ and $x \leq c_I$, an entrant will supply the market with prices $p_c(p_o, x, m; c)$ and $p_f(p_o, x, m; c)$ that satisfy $mp_c + (n-m)p_f - nc - F = 0$ and $p_c \leq x$. There will in general be multiple such equilibria; we take a differentiable selection of the equilibrium correspondence mapping from $(p_o, x, m; c)$ to equilibrium sets of $p_c(p_o, x, m; c)$ and $p_f(p_o, x, m; c)$.We can express the total surplus accruing to the contractual parties as the sum of S_1, the value to the m buyers of the product minus the cost (to the contracting pairs) of obtaining the product via purchase from the entrants at $p_c(p_o, x, m; c)$ or production at cost c_I; and π_F, the profit earned from the free buyers by the incumbent. These are the two lines, respectively, of the following equation.

$$\begin{aligned} S &= mv - m\int_0^{c_1} p_c(p_o,x,m;c)dG(c) - m[1-G(c_1)]c_I \qquad (5.1) \\ &+(n-m)\int_{c_1}^{c_2} p_f(p_o,x,m;c) - c_I \, dG(c) + (n-m)[1-G(c_2)](v-c_I) \end{aligned}$$

It is straightforward to show that any $x > c_I$ is dominated by $x = c_I$, since at $x = c_I$ both components of total surplus are larger. Over the range $c \in (c_1, c_2)$, $p_f(p_o, x, m; c)$ satisfies $(n-m)p_f + mx - F - nc = 0$, i.e., $p_f = (F + nc - mx)/(n-m)$. Substituting this into (5.1), using $p_c(p_o, x, m; c_2) = x$, $p_c(p_o, x, m; c_2) = v$, the definitions of c_1 and c_2, and $\partial p_c(p_o, x, m; c)/\partial x \geq 0$ yields the following:

$$\frac{\partial S}{\partial x}_{|x=c_I} = -m\int_0^{c_1} \frac{\partial}{\partial x}p_c(p_o,x,m;c)dG(c) - m[G(c_2) - G(c_2)] < 0$$

This shows that $x^* < c_I$.

Proposition 2. *If $a^* = (1,1,...,1)$ or $(2,2,...,2)$ then either the unique equilibrium allocation in the bidding game is a^* or an equilibrium does not exist.*

Proof:

Suppose, *arguendo*, that there is an equilibrium to the simultaneous bidding game that implements an allocation $\hat{a} \neq a^*$. Then from the definition of a^*, we have

$$\pi_1(\hat{a}) + \pi_2(\hat{a}) < \pi_1(a^*) + \pi_2(a^*). \tag{5.2}$$

Let the equilibrium strategies for $i = 1, 2$ and $j = 1, ..., n$ be $(\hat{s}^1, \hat{s}^2, \hat{a})$ where $\hat{s}^i = (\hat{s}^i_1, \ldots \hat{s}^i_n)$ with $\hat{s}^i_j = \left(\hat{e}^i_j, \hat{b}^i_j\right)$ and $\hat{a} = (\hat{a}_1, ...\hat{a}_2)$ with $\hat{a}_j \in \{1, 2, B\}$ now being interpreted as the strategy of input supplier j. Given any strategies (s^1, s^2, a), denote the payment by i to j as $p^i_j(s^1, s^2, a) = e^i_j, b^i_j$ or 0 as $a_j = j, B$ or $k \neq j$ respectively, and let $P^i(s^1, s^2, a) = \sum_{j=1}^n p^i_j(s^1, s^2, a)$. For brevity, denote $\hat{P}^1 = P^1(\hat{s}^1, \hat{s}^2, \hat{a})$. Denote the equilibrium payoffs of firm i under $(\hat{s}^1, \hat{s}^2, \hat{a})$ by $H^i(\hat{s}^1, \hat{s}^2, \hat{a}) = \pi_i(\hat{a}) - \hat{P}^i \geq 0$. The following claim characterizes the relationship among $\hat{e}^1_j$, $\hat{e}^2_j$ and $\hat{b}^1_j + \hat{b}^2_j$.

Claim 1. *If $\hat{a}_j = B$, then $\hat{e}^1_j = \hat{e}^2_j = \hat{b}^1_j + \hat{b}^2_j$. If $\hat{a}_j = 1$ or 2, then $\hat{e}^1_j = \hat{e}^2_j \geq \hat{b}^1_j + \hat{b}^2_j$.*

The first part of this claim is proved in the text. To prove the second part, suppose $\hat{a}_j = 1$, the case $\hat{a}_j = 2$ being symmetric. We have $\hat{e}^1_j \geq \hat{e}^2_j$, and $\hat{e}^1_j \geq \hat{b}^1_j + \hat{b}^2_j$ from j's optimality condition. Next, $\hat{e}^1_j > \hat{e}^2_j$ is impossible, because if this strict inequality held, then firm 1 could decrease $\hat{e}^1_j$ by $\varepsilon > 0$ and $\hat{b}^1_j$ by 2ε. For ε sufficiently small, the equilibrium allocation would not be changed, but the payment P^1 would decrease (and thus $H^1(s^1, \hat{s}^2)$ increases), contradicting the hypothesis that $(\hat{s}^1, \hat{s}^2, \hat{a})$ is an equilibrium. Therefore, if $\hat{a}_j = 1$ or 2, $\hat{e}^1_j = \hat{e}^2_j$.

In the remainder of the this proof, we will show that at least one of the downstream firms has the incentive to deviate from $(\hat{s}^1, \hat{s}^2)$ to a strategy that implements a^*. Define $\hat{J}_1 = \{j : \hat{a}_j = 1\}$, and similarly define $\hat{J}_2$ and $\hat{J}_B$. We have

$$\begin{aligned}
\hat{P}^1 &= \sum\nolimits_{j\in\hat{J}_1} \hat{p}^1_j + \sum\nolimits_{j\in\hat{J}_B} \hat{p}^1_j = \sum\nolimits_{j\in\hat{J}_1} \hat{e}^1_j + \sum\nolimits_{j\in\hat{J}_B} \hat{b}^1_j, \\
\hat{P}^2 &= \sum\nolimits_{j\in\hat{J}_2} \hat{p}^2_j + \sum\nolimits_{j\in\hat{J}_B} \hat{p}^2_j = \sum\nolimits_{j\in\hat{J}_2} \hat{e}^2_j + \sum\nolimits_{j\in\hat{J}_B} \hat{b}^2_j, \text{ and} \\
\hat{P}^1 + \hat{P}^2 &= \sum\nolimits_{j\in\hat{J}_1} \hat{e}^1_j + \sum\nolimits_{j\in\hat{J}_2} \hat{e}^2_j + \sum\nolimits_{j\in\hat{J}_B} \left(\hat{b}^2_j + \hat{b}^1_j\right)
\end{aligned} \tag{5.3}$$

Further, define $J_1^* = \left\{j : a_j^* = 1\right\}$ and $J_2^* = \left\{j : a_j^* = 2\right\}$. (The analogously defined J_B^* is empty by hypothesis.) Note that at $(\hat{s}^1, \hat{s}^2, \hat{a})$, given the strategy of firm 2, for any $\varepsilon > 0$, firm 1 can change the allocation from $\hat{a}$ to a^*, by adopting a strategy $\tilde{s}^1(\varepsilon) = (\tilde{s}_1^1(\varepsilon), \ldots \tilde{s}_n^1(\varepsilon))$ with $\tilde{s}_j^1(\varepsilon) = \left(\tilde{e}_j^1, \tilde{b}_j^1\right)$ in which for $j \in \hat{J}_1 \cap J_1^*$, $\tilde{e}_j^1 = \hat{e}_j^1$; for $j \in \hat{J}_1 \cap J_2^*$, $\tilde{e}_j^1 = 0$; for $j \in \hat{J}_B \cap J_1^*$, $\tilde{e}_j^1 = \left(\hat{b}_j^1 + \hat{b}_j^2\right) + \frac{\varepsilon}{n}$;for $j \in \hat{J}_B \cap J_2^*$, $\tilde{e}_j^1 = \tilde{b}_j^1 = 0$; for $j \in \hat{J}_2 \cap J_1^*$, $\tilde{e}_j^1 = \hat{e}_j^2 + \frac{\varepsilon}{n}$; and for $j \in \hat{J}_2 \cap J_2^*$, $\tilde{e}_j^1 = 0$. (In the following, we suppress the argument of $\tilde{s}^i(\varepsilon)$.) Denoting $\tilde{p}_j^i = p_j^i(\tilde{s}^1, \hat{s}^2, a^*)$, we have

$$\begin{aligned}
P^1\left(\tilde{s}^1, \hat{s}^2, a^*\right) &= \sum\nolimits_{j \in J_1^*} \tilde{p}_j^1 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_1^*} \tilde{p}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \tilde{p}_j^1 + \sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \tilde{p}_j^1 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_1^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \left[\left(\hat{b}_j^1 + \hat{b}_j^2\right) + \frac{\varepsilon}{n}\right] + \sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \left(\hat{e}_j^2 + \frac{\varepsilon}{n}\right); \\
P^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) &= \sum\nolimits_{j \in J_2^*} \tilde{p}_j^2 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \tilde{p}_j^2 + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \tilde{p}_j^2 + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \tilde{p}_j^2 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \hat{e}_j^2 + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \hat{e}_j^2 + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \hat{e}_j^2 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \left(\hat{b}_j^1 + \hat{b}_j^2\right) + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \hat{e}_j^2,
\end{aligned}$$

the first and second terms being derived using Claim 1 above.

It then follows that

$$\begin{aligned}
& P^1\left(\tilde{s}^1, \hat{s}^2, a^*\right) + P^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) \\
= \; & \sum\nolimits_{j \in \hat{J}_1 \cap J_1^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \left[\left(\hat{b}_j^1 + \hat{b}_j^2\right) + \frac{\varepsilon}{n}\right] + \sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \left(\hat{e}_j^2 + \frac{\varepsilon}{n}\right) \\
& + \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \left(\hat{b}_j^1 + \hat{b}_j^2\right) + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \hat{e}_j^2 \\
= \; & \left(\sum\nolimits_{j \in \hat{J}_1 \cap J_1^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \hat{e}_j^1\right) + \left[\sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \left(\hat{e}_j^2 + \frac{\varepsilon}{n}\right) + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \hat{e}_j^2\right] \\
& + \left\{\sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \left[\left(\hat{b}_j^1 + \hat{b}_j^2\right) + \frac{\varepsilon}{n}\right] + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \left(\hat{b}_j^1 + \hat{b}_j^2\right)\right\}, \\
& \text{ obtained just by rearranging the terms in the first equality} \\
= \; & \sum\nolimits_{j \in \hat{J}_1} \hat{e}_j^1 + \left(\sum\nolimits_{j \in \hat{J}_2} \hat{e}_j^2 + \sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \frac{\varepsilon}{n}\right) + \left[\sum\nolimits_{j \in \hat{J}_B} \left(\hat{b}_j^2 + \hat{b}_j^1\right) + \sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \frac{\varepsilon}{n}\right], \\
& \text{using the fact that } J_1^* \cup J_2^* \text{ is equal to } \{1, \ldots, n\} \\
= \; & \sum\nolimits_{j \in \hat{J}_1} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_2} \hat{e}_j^2 + \sum\nolimits_{j \in \hat{J}_B} \left(\hat{b}_j^2 + \hat{b}_j^1\right) + \#\left(\hat{J}_2 \cap J_1^*\right)\frac{\varepsilon}{n} + \#\left(\hat{J}_B \cap J_1^*\right)\frac{\varepsilon}{n}, \\
& \text{where } \#(\cdot) \text{ stands for cardinality of the set in the bracket.} \\
= \; & \hat{P}^1 + \hat{P}^2 + \#\left(\hat{J}_2 \cap J_1^*\right)\frac{\varepsilon}{n} + \#\left(\hat{J}_B \cap J_1^*\right)\frac{\varepsilon}{n}, \text{ using the results in (5.3)} \\
\leq \; & \hat{P}^1 + \hat{P}^2 + \varepsilon, \text{ because } \#\left(\hat{J}_2 \cap J_1^*\right) + \#\left(\hat{J}_B \cap J_1^*\right) \leq n. \qquad (5.4)
\end{aligned}$$

Similarly, firm 2 can change the allocation from $\hat{a}$ to $a^*$with a strategy $\tilde{s}^2 = (\tilde{s}_1^2, \ldots \tilde{s}_n^2)$ where $\tilde{s}_j^2 = \left(\tilde{e}_j^2, \tilde{b}_j^2\right)$ is defined symmetrically to $\tilde{s}^1$. By an argument parallel to that above, we have

$$P^1\left(\hat{s}^1, \tilde{s}^2\right) + P^2\left(\hat{s}^1, \tilde{s}^2\right) \leq \hat{P}^1 + \hat{P}^2 + \varepsilon \qquad (5.5)$$

In addition, we will find useful the following precise relationships between the payments by the two firms under the two deviations (by 1 and by 2) from the supposed equilibrium

$(\hat{s}^1, \hat{s}^2, \hat{a}):$

$$\begin{aligned}
P^1\left(\hat{s}^1, \tilde{s}^2, a^*\right) &= \sum\nolimits_{j \in J_1^*} \tilde{p}_j^1 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_1^*} \tilde{p}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \tilde{p}_j^1 + \sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \tilde{p}_j^1 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_1^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \hat{e}_j^1 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_1^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_1^*} \left(\hat{b}_j^1 + \hat{b}_j^2\right) + \sum\nolimits_{j \in \hat{J}_2 \cap J_1^*} \hat{e}_j^2, \\
&\quad \text{the second and last terms being derived using the results in Claim 1.} \\
&= P^1\left(\tilde{s}^1, \hat{s}^2, a^*\right) - \left[\#\left(\hat{J}_2 \cap J_1^*\right)\frac{\varepsilon}{n} + \#\left(\hat{J}_B \cap J_1^*\right)\frac{\varepsilon}{n}\right] \\
P^2\left(\hat{s}^1, \tilde{s}^2, a^*\right) &= \sum\nolimits_{j \in J_2^*} \tilde{p}_j^2 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \tilde{p}_j^2 + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \tilde{p}_j^2 + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \tilde{p}_j^2 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \left(\hat{e}_j^1 + \frac{\varepsilon}{n}\right) + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \left[\left(\hat{b}_j^1 + \hat{b}_j^2\right) + \frac{\varepsilon}{n}\right] + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \hat{e}_j^2 \\
&= \sum\nolimits_{j \in \hat{J}_1 \cap J_2^*} \hat{e}_j^1 + \sum\nolimits_{j \in \hat{J}_B \cap J_2^*} \left(\hat{b}_j^1 + \hat{b}_j^2\right) + \sum\nolimits_{j \in \hat{J}_2 \cap J_2^*} \hat{e}_j^2 \\
&\quad + \left[\#\left(\hat{J}_1 \cap J_2^*\right)\frac{\varepsilon}{n} + \#\left(\hat{J}_B \cap J_2^*\right)\frac{\varepsilon}{n}\right] \\
&= P^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) + \left[\#\left(\hat{J}_1 \cap J_2^*\right)\frac{\varepsilon}{n} + \#\left(\hat{J}_B \cap J_2^*\right)\frac{\varepsilon}{n}\right] \qquad (5.6)
\end{aligned}$$

It follows from (5.6) that

$$P^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) \longrightarrow P^2\left(\hat{s}^1, \tilde{s}^2, a^*\right) \text{ and } P^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) \longrightarrow P^2\left(\hat{s}^1, \tilde{s}^2, a^*\right) \text{ as } \varepsilon \longrightarrow 0 \qquad (5.7)$$

If firm 1 changes its strategy from $\hat{s}^1$ to $\tilde{s}^1$, then the payoffs of the firms are

$$\begin{aligned}
H^1\left(\tilde{s}^1, \hat{s}^2, a^*\right) &= \pi_1(a^*) - P^1\left(\tilde{s}^1, \hat{s}^2, a^*\right); \\
H^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) &= \pi_2(a^*) - P^2\left(\tilde{s}^1, \hat{s}^2, a^*\right). \qquad (5.8)
\end{aligned}$$

It follows from (5.2) and (5.4) that for ε sufficiently small

$$H^1\left(\tilde{s}^1, \hat{s}^2, a^*\right) + H^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) > H^1\left(\hat{s}^1, \hat{s}^2, \hat{a}\right) + H^2\left(\hat{s}^1, \hat{s}^2, \hat{a}\right) \qquad (5.9)$$

Inequality (5.9) indicates that at least one of the differences, $[H^1(\tilde{s}^1, \hat{s}^2, a^*) - H^1(\hat{s}^1, \hat{s}^2, \hat{a})]$ and $[H^2(\tilde{s}^1, \hat{s}^2, a^*) - H^2(\hat{s}^1, \hat{s}^2, \hat{a})]$, is positive. If $[H^1(\tilde{s}^1, \hat{s}^2, a^*) - H^1(\hat{s}^1, \hat{s}^2, \hat{a})]$ is positive, then firm 1 will profit by deviating from $\hat{s}^1$ to $\tilde{s}^1$, contradicting our supposition that $(\hat{s}^1, \hat{s}^2, \hat{a})$ is an equilibrium. If $[H^2(\tilde{s}^1, \hat{s}^2, a^*) - H^2(\hat{s}^1, \hat{s}^2, \hat{a})]$ is positive, then $H^2(\tilde{s}^1, \hat{s}^2, a^*) > H^2(\hat{s}^1, \hat{s}^2, \hat{a})$ implies that

$$\pi_2(a^*) - P^2\left(\tilde{s}^1, \hat{s}^2, a^*\right) > \pi_2(\hat{a}) - P^2\left(\hat{s}^1, \hat{s}^2, a^*\right) \tag{5.10}$$

The fact that $P^2(\tilde{s}^1, \hat{s}^2, a^*) \longrightarrow P^2(\hat{s}^1, \tilde{s}^2, a^*)$ as $\varepsilon \longrightarrow 0$ (in (5.7)) implies that for ε sufficiently small, the inequality (5.10) continues to hold when $P^2(\tilde{s}^1, \hat{s}^2, a^*)$ is replaced by $P^2(\hat{s}^1, \tilde{s}^2, a^*)$ on the left-hand side. Thus $\pi_2(a^*) - P^2(\hat{s}^1, \tilde{s}^2, a^*) > \pi_2(\hat{a}) - P^2(\hat{s}^1, \hat{s}^2, a^*)$, i.e., $H^2(\hat{s}^1, \tilde{s}^2) > H^2(\hat{s}^1, \hat{s}^2)$. This also contradicts our supposition that $(\hat{s}^1, \hat{s}^2, \hat{a})$ is an equilibrium.