Strategic Ex-ante Contracts:
Rent Extraction and Opportunity Costs[1]

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Abstract

This paper considers the possibility that a seller can contract with one uninformed buyer prior to an auction involving two potential buyers. In a more general setting than previous literature, strategic ex-ante contracts not only extract rent from entrants, but could also mitigate the seller's ex-post rent-seeking vis-à-vis the contracted buyer, thus reducing the probability of having no trade. The seller's optimal ex-ante contract has strategic characteristics similar to the right of first refusal, a commonly used clause. Moreover, this optimal ex-ante contract specifies a lower trade barrier for the contracted buyer. Accordingly, it could create more social welfare than the absence of ex-ante contracts, depending on the contracted buyer's ex-ante financial constraint and the distributions of trade surplus. This paper also shows some examples on how to implement the optimal strategic ex-ante contract by combining indirect clauses. Finally, greater flexibility in policy choice and other commonly used strategic clauses are discussed.

Key words: Strategic ex-ante contracts, auctions, commitment, entrants, ex-post rent-seeking or rent extraction, opportunity costs, the right of first refusal

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Introduction

Pre-sale and pre-acquisition agreements are widely adopted in sales and acquisitions. In 2001, Lasik Vision Corp., a leading North American provider of laser vision correction services, entered into two pre-acquisition agreements with ICON Laser Eye Centers, Inc. for the sale of all of Lasik's common stock. The agreements gave ICON an option to buy at a strike price if there were no competing offers, and required that any competing offers be at least 120% of ICON's strike price.[3] ICON also obtained the right of first refusal if subsequent offers were made by competing buyers. This meant that ICON had the right to win the target by matching the terms of competing offers. In return for granting ICON this privilege, Lasik received an option to purchase certain shares of ICON's stock.[4]

This paper considers the private incentives of sellers and buyers to write contracts at an ex-ante stage, that is, before they learn private information and before third parties enter the scenario.[5] On the one hand, ex-ante contracts may be used strategically to extract rent from third parties by affecting contracting parties' or third parties' ex-post behaviors after they learn more information. On the other hand, ex-ante contracts increase the probability of efficient trade by mitigating sellers' ex-post rent seeking vis-à-vis contracted buyers. Without ex-ante contracts, sellers have market power to seek rent from

[3] Generally, strike prices may be measured in cash or the acquirers' stock. In the ICON case, the price is measured in stock. Also, the requirement that competing offers must be at least 120% of ICON's strike price is only for Lasik's two biggest shareholders' shares.
[4] (12 Feb. 2001, CCN Disclosure) In practice, other means to make such upfront transfers in pre-acquisition agreements include cash or stock deposits and changing prices for side transactions along acquisitions. These features of giving privileges to contracted buyers and requiring upfront transfers are also observed in partnership contracts, joint-venture contracts, and energy-supply contracts. However, contracted buyers may often have limited ex-ante wealth. See the conclusion for more about those contracts.
[5] In the ICON acquisition case, ICON might not have full information on its valuation on the target at the time of contracting. But it could learn more accurate information after contracting. During this time, third parties such as other acquirers might enter the scenario. This scenario is typical for many other contracts.

privately informed buyers and trade may not occur even if it could bring positive surplus.[6] These strategic ex-ante contracts appear to be anti-competitive or discriminatory[7] -- they favor contracted buyers at the expense of subsequent competing buyers -- and they are often litigated or emerge in policy debates.[8] It will be shown that the additional value created by limiting rent-seeking vis-à-vis contracted buyers may dominate the misallocation loss. Consequently, strategic ex-ante contracts may be more efficient for society than the absence of ex-ante contracts.

Formally, this paper considers a simple framework where a single seller, having one indivisible asset to sell, faces two subsequent buyers. The same argument can be made for a single buyer facing two potential sellers. The seller has no cost for producing the asset, so trade is always more efficient than having no trade.[9] Before the second competing buyer enters the scenario, the seller could negotiate sale or pre-sale contracts with the first buyer who is uninformed about his valuation for the asset and is financially

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[6] Many auctions fail because sellers set high reserve prices for rent-seeking. For example, in 2000, the Committee on Sugar Conversion and Auction (CSCA) held an auction with a high indicative price for the right to import 100,000 MT of sugar to partly fill a third-quarter shortage. However, private traders refused to submit import proposals. (July 27, 2000, Business World).

[7] Anti-competitive or discriminatory clauses are often identified as those contract clauses that create different competitive advantages for buyers.

[8] The arguments against these contracts are that they cause misallocation or discourage other bidders. Those supporting these contracts argue that they protect relationship-specific investments and encourage contracted bidders to acquire information. For example, in 1998, an Ontario court dismissed CanWest Co.'s application for an order to scrap a strategic pre-acquisition agreement between Vancouver-based WIC Co. and Calgary-based Shaw Co. (May 12, 1998, the Toronto Star and Dow Jones Online News). As another example, the US Federal Energy Regulatory Commission (FERC) created different policies as to long-term strategic contracts. The FERC removed the restriction on using rebates in long-term contracts. It also removed the term-match cap that limited the length of a contract term an existing firm shipper was required to offer when exercising the right of first refusal. (November 8, 2002, Platts Retail Energy). Such deregulations gave strategic long-term contracts an advantage. Yet, the FERC nevertheless has other regulations prohibiting certain long-term contracts.

[9] This assumption is made for simplicity. The results would easily extend to known costs at the time of contracting. If the seller has uncertain value for the asset or uncertain costs of production, the ex-ante contracts might lead to ex-post inefficient trade with negative surplus. This paper focuses on the trade-offs between facilitating trade with positive surplus and rent extraction from entrants.

constrained at the contracting stage.[10] After this, each buyer privately learns his valuation for the asset. If an ex-ante contract was signed, the seller would have to follow the contracted mechanism to sell the asset. If no ex-ante contracts are employed, he could choose any mechanism with short-term monopoly power. Several questions are raised here. First, what is the optimal strategic ex-ante contract with a direct mechanism for the seller? Second, what are the social welfare effects of the optimal ex-ante contract? Finally, how can the optimal ex-ante contract be implemented indirectly by commonly used contract clauses?

If there is no second buyer, the seller and the first buyer do not need strategic contracts to extract rent. But ex-ante contracts can facilitate more efficient trade by committing to a selling mechanism before the first buyer learns any private information. In the absence of ex-ante contracts, the seller seeks rent from the privately informed buyer. In this case, the seller's monopoly power creates a deadweight loss since efficient trade might not occur. In contrast, the seller's optimal ex-ante contract could avoid this by committing to a higher probability of ex-post trade. It works as a two-part tariff: the seller commits to a lower varied payment ex-post, so that the buyer is willing to buy ex-post; and the seller requires a fixed upfront transfer from the buyer, who is uninformed ex-ante, to extract the entire additional surplus.

If a second buyer will appear in the future, an ex-ante contract still facilitates trade by mitigating the seller's ex-post rent-seeking vis-à-vis the first buyer. Moreover, a second reason for using an ex-ante contract is that the seller and the first buyer can

[10] If the first buyer had unlimited ex-ante wealth, the seller would simply make an ex-ante selling to the first buyer and the buyer can resell the asset to the second buyer ex-post. However, in reality many contracting parties are ex-ante financially constrained. Alternatively, there are many other ex-ante contracting constraints such as limited resale probabilities, which would generate effects similar to the financial constraint does. The model can be easily extended to have other contracting constraints.

collude to extract rent from the second buyer. To achieve this objective, the seller's optimal ex-ante contract with a direct revelation mechanism, as opposed to the optimal selling mechanism when there is no ex-ante contract, should create a certain competitive advantage for the first buyer by giving him a higher winning probability. Effectively, the mechanism in the optimal ex-ante contract more accurately reflects joint opportunity costs[11] for the contracting parties when selling to the second buyer. Accordingly, they either force the second buyer pay more, or avoid jointly unprofitable trade with the second buyer.[12]

Besides, the seller and the first buyer could adjust the upfront transfer to achieve different splits of their joint surplus. Since the upfront transfer is limited by the first buyer's ex-ante wealth, the rent extracted and trade facilitated are also restricted.

The seller's optimal ex-ante contract can have two effects on social efficiency. First, the contract facilitates more trade by mitigating the seller's ex-post rent-seeking vis-à-vis the first buyer. This effect is measured by the difference between the loss from having no trade if the optimal ex-ante contract is employed and the loss from having no trade if there is no ex-ante contract. Second, this optimal ex-ante contract affects the allocation between the two buyers, because the first buyer enjoys a competitive advantage with a higher winning probability than he would if there were no ex-ante contracts. This allocation effect is measured by the difference between the social loss from a misallocation between the two buyers if the optimal ex-ante contract is employed

[11] This is the first buyer's valuation.

[12] In the ICON case, the pre-acquisition agreement satisfies the above two characteristics. First, the right of first refusal gave ICON a higher winning probability, since the company had the second-mover advantage to learn entrants' information. Thus, ICON had a competitive advantage. Second, the option and the 20% adjustment created reserve prices for ICON and any entrant. Lasik could not impose higher reserve prices ex-post, so ex-post rent-seeking was avoided.

and the loss from a misallocation if there is no ex-ante contract. Social policies should balance these two strategic ex-ante contract effects on social welfare.[13] The trade-offs depend on the distributions of trade surplus and the first buyer's ex-ante financial constraint.

To implement his optimal ex-ante contract with a direct revelation mechanism, the seller could use a combination of commonly used contract clauses. In particular, if the buyers' valuations independently follow the uniform distribution, one optimal indirect contract could be offering the first buyer an option to purchase at a specific price, and the right of first refusal with adjustments by a premium or a rebate. The optimal indirect contract should also specify an entry fee for the entrant. None of the commonly used contract clauses such as a fixed break-up fee, an option, the right of first offer, the non-compete clause, a stock lockup or toehold, is by itself optimal. Moreover, some of these clauses do not have the strategic characteristics similar to the seller's optimal contract.

This paper contributes to the literature on strategic contracts. Contracts could be used as strategic tools to deter entry or to extract rent from entrants. This proposition was first made by Aghion and Bolton (1987). However, they only examine the uncertainty of an entrant's valuation and show that strategic contracts are inefficient.[14] Many other studies consider specific strategic clauses. Choi (2003), for example, vividly discusses a very interesting contract with the right of first refusal. He points out that the right of first refusal could be used to extract rent from entrants by giving contracted buyers an

[13] Previous policy debates over energy-supply contracts have primarily focused on competitiveness, rather than on facilitating trade. With respect to managerial contracts, most papers have focused on the flexibility and commitment in the labor market, rather than the strategic consideration to extract rent (see, e.g., Pindyck 1988; Kandel and Pearson, 1998).

[14] Strategic contracts are often the subject of law suits, such as those involving remedy clauses for breaching contracts. For a survey on such remedies, see Shavell (1980, 1984) or The Palgrave Dictionary of Economics and the Law, page 174 (Stockton Press, 1998).

informational advantage or a second-mover advantage. Strategic contracts could mitigate hold-up problems and preserve incentives for relationship-specific investments or information-acquisition effort, which may be a good justification for social efficiency (Rogerson, 1984, 1992; Chung, 1991; Spier and Whinston, 1995; Segal and Whinston, 2000; Che and Lewis, 2002; Hua, 2002). Strategic contracts could also facilitate an early trade by imposing lower values of outside options (Matouschek and Ramezzana, 2003). Most of the above papers, however, assume that the contracted buyer does not need to learn more information and the seller has no ex-post commitment power. In contrast, this paper considers that the contracted buyer can learn more accurate information on its valuation after the time of contracting and the seller does have some ex-post commitment power. In this case, ex-ante contracts have social values, because they facilitate trade by mitigating the seller's ex-post rent-seeking vis-à-vis the contracted buyer. Accordingly, this paper examines the seller's optimal strategic ex-ante contract and its effect on facilitating trade.

Second, this paper adds a new twist to the literature regarding a monopolist's ex-ante contracting with uninformed buyers versus ex-post selling to privately informed buyers. If trade surplus is not always positive and there is a large ex-post heterogeneity, either ex-ante or ex-post regimes might be better for the monopolist. Ex-ante contracts allow sellers to extract more information rent, while ex-post selling may give sellers time to infer more information. For example, Courty (2003) considers a learning process with respect to information and shows that a monopolist would not sell to both informed and uninformed buyers. Courty and Li (2000) discuss the use of ex-ante contracts to screen buyers when buyers have noisy information ex-ante. But all existing papers on this topic do not consider the probability of having limited capacity and competition among buyers. This paper assumes that the monopolist has only one unit and that another buyer enters ex-post. Presently, the monopolist has a strategic incentive for ex-ante contracting.

Finally, this paper is related to the theories on collusion and mechanism design, especially the limited, but growing, literature on collusion in auctions. Klemperer (1999, 2001) conducts surveys on collusion and predation in auction markets. The studies that have been done (e.g., Robinson, 1985; Hendricks and Porter, 1989; McAfee and McMillan, 1992; Baldwin et al, 1997) mostly consider collusion among bidders. In contrast, this paper addresses the optimal collusive contract between a seller and a bidder before auctions.[15] Moreover, this paper is related to the literature on mechanism design with budget-constrained buyers. [16] Che and Gale (2000) and Bockem and Schiller (2001), for example, analyze the optimal selling mechanism when there is only one buyer who is financially constrained. Lewis and Sappington (2000, 2001) also address this.

The next section presents the general framework. The third section illustrates the effects of strategic ex-ante contracts in extracting rent from entrants and in facilitating trade by a specific contract with the right of first refusal, which may be more efficient than the absence of ex-ante contracts. The fourth section examines the seller's optimal strategic ex-ante contract with a direct revelation mechanism, and explores its effects on social efficiency. Its implementation through indirect clauses is also analyzed with some examples. The fifth section discusses some commonly used strategic clauses and some extensions. The last section offers the concluding remarks.

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[15] A few other papers (Che and Lewis 2002, Choi 2003) consider collusions between a seller and one bidder using particular contract clauses.

[16] Most papers assume that each buyer is privately informed about both his valuation and financial constraint. It remains to be a problem to derive the seller's optimal mechanism when many buyers' different ex-post budget constraints are common knowledge. See Malakhov and Vohra (2004).

Section 2: The Model

There are three players: the seller (S), the first buyer (B1), and the subsequent buyer (B2). All players are risk-neutral. S has one indivisible asset to sell. S's outside value for the asset and his costs of production are normalized to be zero. This would not affect the main results, as long as the outside value and the costs are commonly known ex-ante. Thus, trade always brings positive surplus.

S can sign an ex-ante sale or pre-sale contract with B1 before B1 learns his valuation of the asset and before B2 enters the scenario. B1's and B2's valuations (v_1, v_2) of the asset are independently[17] drawn from distributions $F_1(v_1), F_2(v_2)$ on $\left[\underline{v}, \bar{v}\right]$. Assume that the hazard rate is monotone: $H_i(v_i) = (1 - F_i(v_i))/f_i(v_i)$ is decreasing in v_i. Although these distributions are commonly known to all three players, the realization, v_i, is privately observed by B$_i$ after the initial contracting stage.

The timing is as follows:

At date 1: S and B1 have symmetric information, and B1 has limited wealth k.[18] S and B1 know that B2 will enter at date 2, but neither has access to B2 at this contracting stage. S offers a sale or pre-sale contract with a direct or indirect selling mechanism to B1.[19] It also includes an upfront transfer from B1 to S. If B1 accepts this

[17] The common value of the asset is easier to be learned by all players. Therefore, the buyers' idiosyncratic values are crucial to the scenario. A more general distribution $F(v_1, v_2)$ could be considered such that B1's and B2's valuations are affiliated. The main ideas still hold true.
[18] The model can be extended to have other ex-ante contracting constraints such as limited resale probabilities, which would not affect the main results qualitatively.
[19] The direct revelation mechanism would specify the winning probabilities and payments from each buyer to the seller at date 3. The indirect revelation mechanism may use contract clauses such as a break-up fee, the right of first refusal, an option, etc.

contract, he pays the specified upfront transfer. However, if B1 refuses, no ex-ante contract is signed.

At date 2: B1 privately learns his valuation, v_1, for the asset; B2 enters and privately learns his valuation v_2. Both valuations are non-verifiable.

At date 3: if there is an ex-ante contract between S and B1, S has to follow the specified mechanism to sell the asset;[20] if there is no ex-ante contract, S can choose any mechanism to sell the asset. At this time, B1 and B2 would have enough wealth to pay for the good.[21] Their outside options are normalized to be zero.

For simplicity, assume that S has all the bargaining power at the contracting stage and the monopoly power at the selling stage.[22] Yet, in the long run he cannot commit to a selling mechanism if there is no ex-ante contract. This paper further assumes that ex-post renegotiation on the ex-ante contract is either impossible or too costly to maintain.[23] Other important features of the model are as follows.

First, it is important to note that neither S nor B1 has access to B2 at date 1. If either S or B1 knew the identity of B2, then they could negotiate an ex-ante contract with B2. In reality, the contracting parties may only know about the possibility of having future entrants, but do not know who the potential entrants are. For example, in take-over or acquisitions, one buyer first identifies an interesting target and approaches it. This

[20] For example, courts would either enforce the contract or impose high remedies for breaching the contract.

[21] However, the ex-ante contract cannot force B1 to make an ex-post payment not conditional on whether B1 wins the asset. Also, the contract cannot force the buyers to make ex-post payments higher than their expected valuations. For example, B1 has enough wealth to make a payment less than his valuation only if he wins the asset.

[22] Even if both S and B1 have partial bargaining power, the results are not qualitatively affected so long as S has some market power ex-post.

[23]Note that B1 has asymmetric information at date 2 and 3. Thus, the renegotiation would be costly and hard to carry on. A discussion on renegotiation in section 5 shows that this assumption is not crucial to the results.

action itself would signal other potential buyers, who might not show any interest in the target unless some buyer approaches it first. For another example, in long-term contracts such as energy-supply contracts, the seller needs only one buyer for each period. For any given period, entrants may come from a large pool of potential buyers.

Second, B1 is financially constrained at date 1. However, if he takes the possession of the asset at date 3, he will have enough wealth to pay S.[24] For example, the asset is a productive machine. B1 could use it to produce goods and generate revenue v_1. Yet the capital market would not provide enough ex-ante financing since the values and the control right are not realized ex-ante. Alternatively, it could take time to finance from the capital market. If entry may happen any time during the financing period, a longer period of time would bring more capital to B1, but B2 would be more likely to enter. Therefore, B1 may want to contract with S early when he has only financed limited capital.[25] Accordingly, there is no inconsistency between B1's ex-ante and ex-post financial constraints. The ex-ante financial constraint restricts the upfront transfer that could be made from B1 to S, which in turn affects the contract's effects on rent extraction and the probability of trade.

Third, the ex-ante contract may include an upfront transfer from B1 to S. As in the ICON case, pre-acquisition agreements may give sellers options to purchase buyers' stock. Many other contracts also include upfront transfers through various means. For example, partnership or strategic alliance contracts often include upfront cash payments

[24] The main intuition in this paper would still hold with ex-post financial constraints. It remains a problem to derive S's optimal mechanism when many buyers' ex-post budget constraints are common knowledge.

[25] Many firms use stock or debt financing for acquisitions because they have a limited cash balance. Martin (1996) studies cash or stock financing in acquisitions. He shows that acquirers with higher cash balances tend to prefer cash-financed acquisitions. Therefore, many acquirers tend to sign pre-acquisition agreements with targets before finishing the stock or debt financing. For example, Calvalley Petroleum, Inc. signed pre-acquisition agreements with Probe Exploration, Inc. before the completion of C$45-million equity financing (February 15, 2000, Reuters News).

or adjustments of partners' equity stakes. Energy-supply or property rental contracts could impose different prices for current periods. Price adjustments in side transactions are also used to create upfront transfers for those main sale contracts. All these work as upfront transfers in strategic ex-ante contracts.

Finally, the ex-ante contract can be either a sale contract including a specified price, or simply a pre-sale agreement without a specified price.[26] Moreover, this model assumes that there is neither effort nor investment. There is ample research on the use of strategic contracts to protect investments. The objective here, however, is to analyze the use of contracts to extract rent from entrants and to facilitate trade.

Section 3: Illustration--the Right of First Refusal

To illustrate the effects of strategic ex-ante contracts, this section compares the case of one specific contract including the right of first refusal and no reserve price to the case in which no ex-ante contract is signed. The contract requires that B1 pay an upfront transfer to hold the right of first refusal, which says that the seller must reveal B2's bid to B1, and B1 has the right to purchase the asset by matching B2's bid.

For simplicity, this section assumes that B1's and B2's private valuations, v_1 and v_2, are independently drawn from the uniform distribution on $[0,1]$ and that B1 has limited wealth of 5/24 at date 1. Note that this section does not look for S's optimal strategic ex-ante contract. It attempts to show the effects of strategic ex-ante contracts on social efficiency.

[26] The fact that prices are not specified is not unique to pre-sale agreements. In many long-term contracts, such as energy-supply contracts, only short-period prices are specified. Also, re-opener clauses are sometimes used to allow future price renegotiation while keeping all other terms of the initial contract.

Denote the expected utilities of S, B1, B2 and social welfare as U, V_1, V_2, and W when S and B1 agree on an ex-ante contract; or U_0, V_{10}, V_{20} and W_0 when there is no ex-ante contract. Clearly, $W = U + V_1 + V_2$. Additionally, denote the absolute value of the social loss, compared to the first best outcome, as L when a strategic ex-ante contract is involved, or L_0 when there is no ex-ante contract.

3.1 Equilibrium in the absence of ex-ante contracts

If there is no ex-ante contract, S can choose any mechanism to sell the asset at date 3. In this case, S will hold a standard auction with a fixed reserve price.

Proposition 1: Assume that B1's and B2's valuations, v_1 and v_2, are independently drawn from the uniform distribution on $[0,1]$. If there is no ex-ante contract, S's optimal selling mechanisms are equivalent to the first-price auction with a reserve price 1/2 for each buyer (and equivalent to the second-price auction with a reserve price of 1/2 for each buyer). Consequently, each buyer bids $b_i = v_i/2 + 1/(8v_i)$ in the first-price auction (and bids $b_i = v_i$ in the second-price auction) so long as $v_i \geq 1/2$. The expected utilities for S, B1 and B2 are (U_0, V_{10}, V_{20}) = (5/12, 1/12, 1/12). The social welfare, then, is 7/12.

In all the above selling mechanisms, there would be no trade when $v_1 < 1/2$ and $v_2 < 1/2$. Accordingly, there is a loss of social welfare. The expected loss is L_0=1/12. Note that there is no misallocation loss between B1 and B2.

3.2 Equilibrium with the right of first refusal

In this case, S can offer a contract to B1 at date 1, which includes an upfront transfer from B1 to S, and gives B1 the right of first refusal. Note that S cannot impose ex-post reserve prices now. Walker (1999) discusses some potential reasons for using the right of first refusal, and Choi (2003) analyzes using the right of first refusal to extract rent from entrants. The following proposition summarizes Choi's findings.[27]

Proposition 2: Assume that B1's and B2's valuations, v_1 and v_2, are independently drawn from the uniform distribution on $[0,1]$. B1 is offered the right of first refusal in the ex-ante contract at date 1, and the optimal upfront transfer to S is 5/24. At date 3, B2 bids $b_2 = v_2/2$. B1 would then exercise the right of first refusal if and only if $v_1 \geq b_2 = v_2/2$. If B1 does not exercise the right, B2 wins and pays $b_2 = v_2/2$. The expected utilities for S, B1 and B2 are (U, V_1, V_2) = (11/24, 1/12, 1/12). The social welfare, then, is 15/24.

Proof: see the appendix.

Choi (2003) compares the right of first refusal to standard private-value auctions, such as first-price, second-price, or English auctions. In these standard auctions, B2 would win the asset so long as his valuation is higher than B1's valuation and the joint surplus of S and B1 always equals the expectation of B1's valuation, v_1. However, Choi (2003) points out that when B1 has the right of first refusal, B2 would win the asset only when B1's valuation is less than B2's bid. Accordingly, the joint surplus of S and B1 is

[27] Choi (2003) gives the result for general distributions. This paper only illustrates the result by using the uniform distribution.

higher than the expectation of B1's valuation, v_1. Compared to standard auctions, the right of first refusal creates discrimination between B1's and B2's winning probabilities. As a result, there is the possibility of a misallocation of the asset. Thus, the strategic ex-ante contract with the right of first refusal may be less efficient than standard auctions.

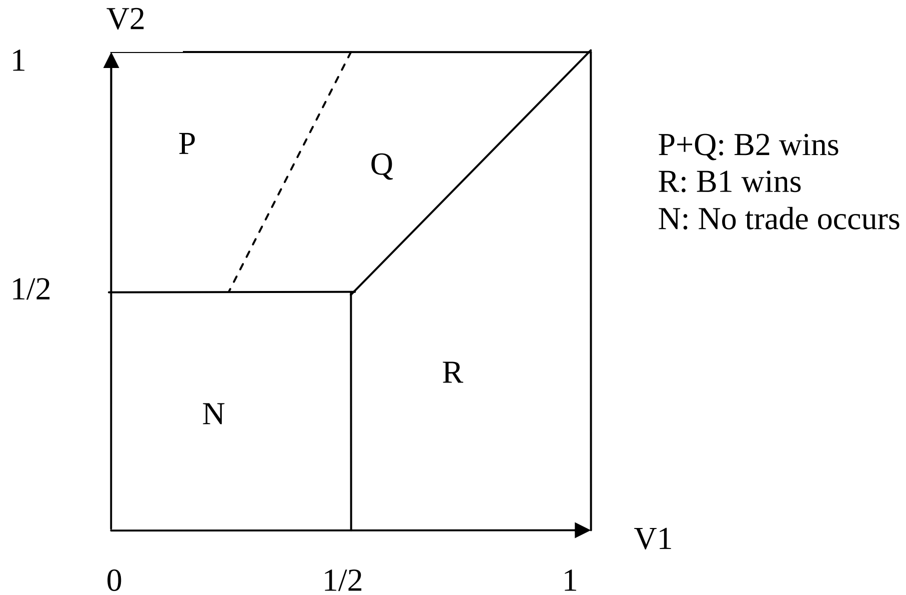
For the uniform distribution, the right of first refusal causes a misallocation between the buyers whenever $v_2 / 2 < v_1 < v_2$. This would generate an expected social loss L =1/24. Note that there is no reserve price in the contract.[28] Thus, there is always trade.

This analysis, though, only compares a strategic ex-ante contract including the right of first refusal to standard auctions. It does not consider the optimal selling mechanism that the seller, with the ex-post commitment power, would choose at date 3 in the absence of ex-ante contracts. The next section shows that the overall effects of the ex-ante contract including the right of first refusal comparing to the absence of ex-ante contracts.

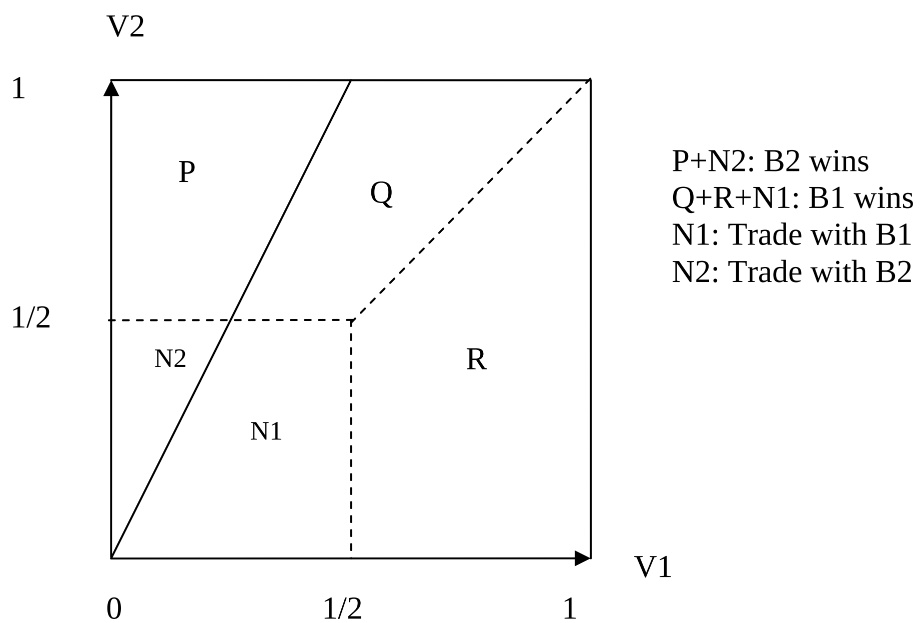
3.3 Revenues and social efficiencies comparisons

Graph 3.1 on the following page shows the equilibrium outcome in the first price auction or the second-price auction with a reserve price 1/2, while Graph 3.2 shows the equilibrium outcome with the right of first refusal, where the joint surplus of S and B1 is higher.

[28] Sometimes the right of first refusal is only applied to those entrants' bids that are acceptable to S. So in practice, S could still hold a reserve price for B2. However, anticipating this, in ex-ante contracts S and B1 could instead agree on no reserve price. Further, one may argue that it may be difficult to specify the reserve price ex-ante, such as when S's cost is uncertain. Then the optimal contracts would also be different, but the commitment effect still exists. So the key thing is to illustrate the efficiency of strategic contracts, but not just to discuss one particular form of contracts.



3.1: The First-Price or Second-Price Auction with a Reserve Price 1/2



3.2: The Right of First Refusal without Reserve Prices

In the first price auction, S seeks rent vis-à-vis both B1 and B2 by specifying ex-post reserve prices. Accordingly, in region N, there is no trade and the joint profit for S and B1 is zero. In region P+Q, B2 wins and pays $b_2 = v_2/2 + 1/(8v_2)$, which is the joint revenue for S and B1. But S and B1 have a joint opportunity cost equal to v_1 when selling the asset to B2. In most areas of region Q, the joint revenue is lower than the joint cost for S and B1. This is because B1 privately knows the joint opportunity cost, while S and B1 look for their individual benefits non-cooperatively.

With the ex-ante contract specifying an upfront transfer, S commits not to set reserve prices. Accordingly, in region N1+N2, trade occurs and the joint profit for S and B1 is positive. This provides the first means to increase the expected joint surplus of S and B1. Moreover, with the right of first refusal, B1 has a competitive advantage and B2 bids less aggressively, $b_2 = v_2/2$. In region P, B2 wins and the joint revenue for S and B1 is lower. However, in region P, the joint revenue $v_2/2$ for S and B1 is always higher than their joint opportunity cost v_1. B1 also wins in region Q. Thus, S and B1, jointly, avoid unprofitable trade with B2 that would happen under the first price auction. Therefore, although B2 bids less aggressively and pays less in region P, the right of first refusal reflects the joint opportunity cost more accurately and effectively. Accordingly, B2's information rent is reduced.[29]

[29] Alternatively, compare the equilibrium outcome in the second price auction with a reserve price 1/2 (Graph 3.1) to the equilibrium outcome with the right of first refusal (Graph 3.2). In the second price auction, B2 pays v_1 when he wins in region P+Q. This joint revenue equals to the joint cost for S and B1. However, when B1 has the right of first refusal, in region P, B2 wins by paying more than v_1, otherwise B1 should have exercised the right of first refusal. Therefore, the joint surplus of S and B1 is higher with the right of first refusal. This is because B1 has information advantage and commits to be more aggressive. This makes B2 pay more and avoids jointly unprofitable trade with B2 in the second price auction. Again, the right of first refusal creates higher expected surplus for S and B1 by facilitating trade in region N.

According to the above analysis, the contract with the right of first refusal is a strategic tool which gives B1 a competitive advantage ex-post. This more accurately reflects S and B1's joint opportunity cost.[30] Then, S and B1 could avoid jointly unprofitable trade with B2. Moreover, the ex-ante contract mitigates S's ex-post rent-seeking and creates additional surplus for S and B1.

For social welfare, the absence of ex-ante contracts brings inefficiency from having no trade when the buyers' valuations are lower than the reserve price. The strategic ex-ante contract creates additional social welfare by facilitating trade in region N1+N2, but leads to a misallocation between B1 and B2 in region Q. In this example, the additional value is higher than the misallocation loss.

Proposition 3: Assume that B1's and B2's valuations, v_1 and v_2, are independently drawn from the uniform distribution on $[0,1]$. The ex-ante contract with the right of first refusal and with no reserve price is more efficient than the absence of ex-ante contracts. It also generates more joint surplus for S and B1. Moreover, this ex-ante contract has two characteristics. First, it gives B1 a competitive advantage against B2. B1 has a higher winning probability than he would have if there were no ex-ante contracts, and B2 has a lower winning probability than he would have if there were no ex-ante contracts. Second, it reduces the probability of having no trade.[31]

[30] Note than B1 is the player who knows the private information of the joint opportunity cost for S and B1 when selling the asset to B2. Therefore, he should have more advantage in the ex-post mechanism.

[31] In this example, B2 has the same expected utility regardless of whether the ex-ante contract is employed. This seems to go against the purpose of strategic contracts, which seek to extract rent from B2. This is because the contract imposes no reserve price for B2. Therefore, B2 attains additional utility from having trade in region N. This compensates his information rent loss. As will be shown in section 4, in S's optimal strategic contract, B2's expected utility is always lower than his utility if there were no ex-ante contracts.

This illustration demonstrates the two effects of strategic ex-ante contracts on social efficiency: affecting the allocation among buyers and facilitating trade. According to Proposition 3, the ex-ante contract with the right of first refusal should be allowed by policy makers.[32] However, this contract may not be the optimal strategic ex-ante contract for S at date 1. If B1 has unlimited ex-ante wealth, S could generate more revenue by requiring an upfront transfer of 1/2 and making B1 the residual clamant. Even if B1 has limited ex-ante wealth, S can design contracts to be more profitable than the right of first refusal.[33]

For B1's different ex-ante wealth levels, what are the optimal ex-ante contracts for S? Are these optimal contracts always more efficient than the absence of ex-ante contracts? These questions will be answered in the next section.

Section 4: S's Optimal Ex-ante Contract, Social Efficiency, and Implementation

The revelation principle applies to this model. This section first examines S's optimal ex-ante contract with a direct revelation mechanism, which has characteristics similar to the right of first refusal and mitigates S's ex-post rent-seeking vis-à-vis B1. Next, it will analyze the social welfare effects of this optimal ex-ante contract. This contract may cause more misallocation between the buyers, but may also facilitate more trade. Allowing the use of strategic ex-ante contracts may be more efficient than strictly

[32] One may argue that courts could only support those ex-ante contracts that specify standard auctions or other efficient mechanisms, but not other contracts. However, it may be technically difficult or costly for courts to monitor and verify various forms of contracts. For example, consider the case with observable but costly-verifiable cost for the seller. Furthermore, S and B1 may not have enough incentive to sign a contract with an efficient mechanism.

[33] Suppose that B1 has an ex-ante wealth of 5/24. S offers B1 a contract which requires the same upfront transfer of 5/24, gives B1 an option to purchase at a price of 0.065 if B2 does not enter, and offers B1 the right to learn about B2's bid and win the asset by paying $3.74b-1.74$ if B2 enters. There would be a required entry fee of 0.0045 for B2. With this contract, B1's expected utility is 1/12. Accordingly, he would accept the contract. This contract is optimal for S, as shown in section 4.3.

prohibiting their use. Finally, S's optimal ex-ante contract could be indirectly implemented through a combination of some commonly used clauses.

4.1 S's optimal ex-ante contract with a direct revelation mechanism

First, note that S has all the bargaining power at the contracting stage. If there is no financial constraint for B1, S would offer B1 a contract, which would require an appropriate upfront transfer and make B1 the residual claimant of any revenue generated at date 3. At date 3, B1 has the right to offer a monopoly price to B2 based on his own valuation.[34] If B2 accepts the price, then B1 receives the full payment from B2. If B2 does not accept, B1 will own the asset. In this case, there may be a misallocation due to B1's ex-post monopoly power. Also there is more trade than in the absence of ex-ante contracts, because either B1 or B2 owns the asset in the end.

Next, when B1 faces an ex-ante financial constraint at date 1, S's optimal ex-ante contract would include two parts: (1) an upfront transfer to be made from B1 to S at date 1; (2) and a direct revelation mechanism to be used for selling the asset at date 3. Specifically, each buyer Bi is asked to make a report v_i on his own valuation. The following notations are used:

t_0: the upfront transfer from B1 to S at date 1;

$q_i(v_1, v_2)$: Bi's winning probability given the buyers' reports (v_1, v_2);

$t_i(v_1, v_2)$: Bi's payment to S given the buyers' reports (v_1, v_2) on valuations;

$Q_i(v_i)$: Bi's expected winning probability given his report v_i on the valuation;

$T_i(v_i)$: Bi's expected payment to S at date 3 given his report v_i on the valuation;

[34] This is the joint opportunity cost for S and B1 when selling to B2.

$V_i(v_i)$: Bi's interim expected utility given his valuation v_i at date 2;

U : S's ex-ante expected utility including the upfront transfer;

V_i: Bi's e ex-ante expected utility including the upfront transfer;

V_0: B1's e ex-ante expected utility if there were no ex-ante contracts;

$Q_{i0}(v_i)$: Bi's expected winning probability if there were no ex-ante contracts.

Note that $Q_i(v_i) = E_{v_j}[q_i(v_i, v_j)]$ and $V_i(v_i) = Q_i(v)v - T_i(v)$.

S would choose a contract $(t_0^*, q_i^*(v_1, v_2), t_i^*(v_1, v_2))$ to maximize his expected revenue. The problem could be written as follows using $(t_0^*, Q_i^*(v_i), T_i^*(v_i))$.[35]

$$Max_{\{t_0, Q_i, T_i\}}\; t_0 + \int_{\underline{v}}^{\bar{v}} T_1(v)dF_1(v) + \int_{\underline{v}}^{\bar{v}} T_2(v)dF_2(v)$$

Subject to: $Q_i(v)v - T_i(v) \geq Q_i(\tilde{v})v - T_i(\tilde{v})$ for all $i, v, \tilde{v}$ (IC)

$Q_i(v)v - T_i(v) \geq 0$ for all i, v (IR)

$\int_{\underline{v}}^{\bar{v}} [Q_1(v)v - T_1(v)]dF_1(v) - t_0 \geq V_0$ (Ex-ante IR for B1)

$t_0 \leq k$ (Ex-ante financial constraint for B1)

As in the standard mechanism design problem, the first individual rationality constraint assumes that, at date 3, S cannot force each buyer to pay an expected transfer higher than the buyer's expected valuation. This makes each buyer voluntarily participate. The incentive compatibility constraint guarantees truth telling from each

[35] Since the buyers valuations are independent, if there are solutions to the problem with the interim individual rationality constraints using expected payment functions $T_i(v_i)$, there exist payment functions, which solve the problem with the ex-post individual rationality constraints $q_i(v_1, v_2)v_i - t_i(v_1, v_2) \geq 0$. For example, let the payment function for Bi be $t_i^*(v_i, v_j) = T_i^*(v_i)q_i^*(v_i, v_j)/Q_i^*(v_i)$. Therefore, even if B1 can only make an ex-post payment less than his valuation, the above analysis guarantees that there exist solutions. For discussions on interim and ex-post incentive compatibility constraints, see Segal (2003).

buyer. Moreover, the different constraints include an ex-ante individual rationality constraint for B1, which makes the ex-ante contract accepted by B1, and an ex-ante financial constraint for B1, which restricts the upfront transfer from B1 to S. The optimal selling mechanism has the following common characteristics.

Lemma 1: The direct revelation mechanism in S's optimal ex-ante contract satisfies the following conditions:

(1) $Q_i^*(v_i)$ is non-decreasing in v_i;

(2) $V_i(v_i) = V_i(\underline{v}) + \int_{\underline{v}}^{v_i} Q_i^*(x)dx$;

(3) $T_i^*(v_i) = Q_i^*(v_i)v_i - V_i(\underline{v}) - \int_{\underline{v}}^{v_i} Q_i^*(x)dx$;

(4) $V_i(\underline{v})$=0.

Given Lemma 1, B1's expected utility at date 1, if he accepts the contract, is $V_1 = \int_{\underline{v}}^{\bar{v}}\int_{\underline{v}}^{v} Q_1^*(x)dxdF_1(v) - t_0$, which should equal V_0 -- B1's expected utility when there were no ex-ante contracts. If V_1 is greater than V_0, S could always increase the upfront transfer and/or changing B1's winning probability $Q_1^*(v_1)$.[36] Combining this with B1's ex-ante financial constraint, S's reduced-form problem is:

[36] If the ex-ante individual rationality constraint were not binding, then the seller's problem would be the same as the mechanism design problem without ex-ante contracts. Thus, B1 would have the same expected utility as in the absence of ex-ante contracts. Accordingly, B1 would not accept such a contract requiring a positive upfront transfer. Therefore, the ex-ante individual rationality constraint must be binding.

$$Max_{\{t_0,Q_i\}} \int_{\underline{v}}^{\bar{v}} vQ_1(v)dF_1(v) + \int_{\underline{v}}^{\bar{v}} \{vQ_2(v) - \int_{\underline{v}}^{v} Q_2(x)dx\} dF_2(v) - V_0$$

Subject to: $\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{v} Q_1(x)dxdF_1(v) = t_0 + V_0 \leq k + V_0$

$Q_i(v_i)$ is non-decreasing in v_i

Let $\lambda = \lambda(k)$ be the multiplier corresponding to the above ex-ante financial constraint.

Definition 1: $\lambda = \lambda(k)$ is the shadow price of B1's expected utility at date 3.[37] It satisfies $\lambda\{\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{v} Q_1^*(x)dxdF_1(v) - k - V_{1N}\} = 0$.

Integrating the reduced-form problem by parts and substituting $Q_i(v_i) = E_{v_j}[q_i(v_i, v_j)]$ in:

$$Max_{\{q_i,\lambda\}}$$

$$\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{\bar{v}} \left\{ \left[v_1 - \lambda \frac{1 - F_1(v_1)}{f_1(v_1)} \right] q_1(v_1, v_2) + \left[v_2 - \frac{1 - F_2(v_2)}{f_2(v_2)} \right] q_2(v_1, v_2) \right\} dF_1(v_1) dF_2(v_2) - V_0$$

Subject to: $\lambda\{\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{v} Q_1(x)dxdF_1(v) - k - V_0\} = 0$

$Q_i(v_i)$ is non-decreasing.

$0 \leq q_1(v_1, v_2) + q_2(v_1, v_2) \leq 1$

[37] Since the upfront transfer is restricted by B1's ex-ante wealth level k, the shadow price λ is a function of k.

According to the monotone hazard rates, the point-wise solutions to the above problem are:

(1)If $v_1 - \lambda(1-F_1(v_1))/f_1(v_1) \geq v_2 - (1-F_2(v_2))/f_2(v_2)$ and $v_1 f_1(v_1)/(1-F_1(v_1)) \geq \lambda$, then $q_1^*(v_1, v_2) = 1$; otherwise, $q_1^*(v_1, v_2) = 0$.

(2)If $v_2 - (1-F_2(v_2))/f_2(v_2) > v_1 - \lambda(1-F_1(v_1))/f_1(v_1)$ and $v_2 f_2(v_2)/(1-F_2(v_2)) \geq 1$, then $q_2^*(v_1, v_2) = 1$; otherwise, $q_2^*(v_1, v_2) = 0$.

(3) $\lambda = \lambda(k)$ satisfies $\lambda\{\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{v} Q_1^*(x) dx dF_1(v) - k - V_{1N}\} = 0$.

The following definitions are also useful:

Definition 2: $g_i(v_i;\lambda) = v_i - \lambda(1-F_i(v_i))/f_i(v_i)$ is the λ-adjusted virtual utility.

Definition 3: $r_i^*(k)$, or $r_i^*(\lambda(k))$, is the value that satisfies $g_i(r_i^*(\lambda(k));\lambda(k))$=0.

Note that $\lambda = \lambda(k)$ is the shadow price of B1's expected utility at date 3. Given k, B1 could make a certain upfront transfer. In exchange, he should share more ex-post surplus than he would if there were no ex-ante contracts. Accordingly, his virtual utility should be adjusted by the shadow price. In other words, the shadow price links B1's upfront payment to his ex-post utility. The following proposition presents S's optimal ex-ante contract.

Proposition 4: S's optimal ex-ante contract specifies an upfront transfer t_0^* and a direct revelation mechanism { $q_i^*(v_1, v_2)$, $t_i^*(v_1, v_2)$ }, such that the expected payment from Bi is $T_i^*(v_i) = Q_i^*(v_i)v_i - \int_{\underline{v}}^{v_i} Q_i^*(x)dx$. The shadow price $\lambda = \lambda(k) \in [0,1]$. Also

(i) There exists one unique k^* such that $\lambda(k)$=0 if $k \geq k^*$, and $\lambda(k)$>0 if $k < k^*$. $\lambda(0)$=1. $\lambda(k)$ is non-increasing in k. The upfront transfer is $t_0^* = \min(k, k^*)$.

(ii) If B1's adjusted virtual utility is positive and greater than B2's virtual utility, i.e., $g_1(v_1;\lambda) \geq \max(0, g_2(v_2;1))$, B1 wins the asset, i.e., $q_1^*(v_1, v_2) = 1$; otherwise, $q_1^*(v_1, v_2) = 0$.

(iii) If B2's virtual utility is positive and greater than B1's adjusted virtual utility, i.e., $g_2(v_2;1) \geq \max(0, g_1(v_1;\lambda))$, B2 wins the asset, i.e., $q_2^*(v_1, v_2) = 1$; otherwise, $q_2^*(v_1, v_2) = 0$.

Proof: see the appendix.

Note that, in the above optimal contract, the buyers' winning probabilities depend on the shadow price, which is determined by B1's ex-ante wealth. Accordingly, the winning probabilities could be rewritten as $q_i^*(v_1, v_2; k)$ and $Q_i^*(v_i; k)$.

When B1 has no ex-ante wealth, the shadow price is $\lambda = \lambda(0) = 1$ and the optimal ex-ante contract specifies the optimal mechanism that S would choose if there were no ex-ante contracts. When B1 has positive ex-ante wealth, the direct revelation mechanism in the optimal ex-ante contract is different. The key difference here is that B1's virtual utility is adjusted by the shadow price.

Corollary 1: In S's optimal ex-ante contract with a direct revelation mechanism,

(i) B1 has a competitive advantage: there is discrimination between B1's and B2's winning probabilities. $q_1^*(v_1, v_2; k)$, or $Q_1^*(v_1; k)$ correspondingly, is non-decreasing in k and B1 has higher expected winning probabilities than he would have if there were no ex-ante contracts, i.e., $Q_1^*(v_1; k) \geq Q_{10}^*(v_1)$. $q_2^*(v_1, v_2; k)$, or $Q_2^*(v_2; k)$ correspondingly, is non-increasing in k and B2 has lower expected winning probabilities than he would have if there were no ex-ante contracts, i.e., $Q_2^*(v_2; k) \leq Q_{20}^*(v_2)$.

(ii)There is more trade: the probability of having no trade, $F(r_1^*(k))F(r_2^*(0))$, is non-increasing in k and lower than the probability of having no trade, $F(r_1^*(0))F(r_2^*(0))$, if there were no ex-ante contracts.

(iii) S's expected utility is non-decreasing in k. If B1 has no ex-ante wealth, the optimal ex-ante contract specifies the same direct revelation mechanism as the optimal mechanism if there were no ex-ante contracts, i.e., $Q_i^*(v_i; k = 0) = Q_{i0}^*(v_i)$.

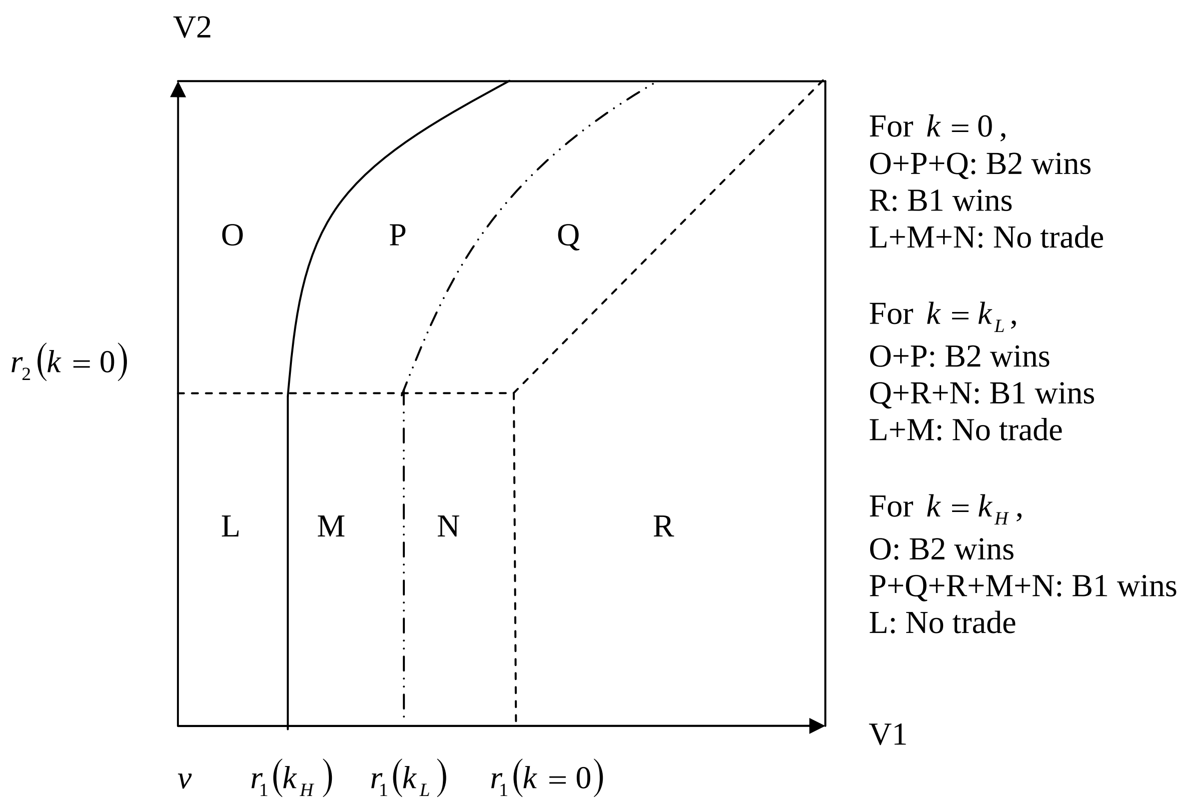
Proof: see the appendix.

According to Corollary 1, S's optimal ex-ante contract has the strategic characteristics similar to a contract with the right of first refusal. In other words, they both offer a competitive advantage to B1. This is not so when there is no ex-ante contract. Moreover, they both lower the trade barrier vis-à-vis B1.

Furthermore, if B1 has more ex-ante wealth to pay for a higher upfront transfer, then the shadow price for B1's expected utility at date 3 should be lower. Accordingly, B1's adjusted virtual utility is also lower. This lower adjusted virtual utility is significant in two ways: first, the adjusted virtual utility is more likely to be positive, thereby increasing the probability of trading with B1; and second, the adjusted virtual utility is more likely to be higher than B2's virtual utility, thereby raising B1's winning probabilities and lowering B2's winning probabilities.

Note than S and B1 have a joint opportunity cost, v_1, when selling to B2. If the shadow price is lower, B1's adjusted virtual utility is closer to v_1. This means that the joint opportunity cost for S and B1 is more accurately reflected in the optimal mechanism.

The following graph 4 shows how S generates more revenue from two means by adopting the ex-ante contract. Note that, ex-ante, S cares about the joint surplus of S and B1.



4: The Equilibria under S's Optimal Strategic Contracts Given Different k

If k =0, effectively, there is no ex-ante contract. Ex-post, S has the monopoly power for rent-seeking vis-à-vis privately informed B1 and B2. Accordingly, there is no trade in region L+M+N, where B1 and B2 have low valuations. However, the joint surplus for S and B1 would be positive in these regions if there were trade. In region O+P+Q, B2 wins and gains information rent; and S and B1 have a joint opportunity cost equal to v_1 when selling the asset to B2. However, in some areas of region O+P+Q, B2 may pay less than v_1.[38] Therefore, in those areas, the joint revenue is lower than the joint opportunity cost for S and B1. This is because B1 privately knows the joint opportunity cost, while ex-post S and B1 look for their individual benefits non-cooperatively.

If $k = k_L > 0$, B1 could make an upfront transfer and obtain a competitive advantage with a higher winning probability. Given the upfront transfer, S could commit to more trade by mitigating his ex-post rent-seeking vis-à-vis B1. In region N, trade occurs and the joint profit for S and B1 is v_1. This provides the first means to increase the expected joint surplus of S and B1. Moreover, B1 has a competitive advantage, so that the mechanism more accurately reflects the joint opportunity cost v_1. Note that B2 only wins in region O+P and B1 also wins in region Q. Thus, S and B1 avoid some jointly unprofitable trade with B2 in region Q that might happen when k =0, or makes B2's

[38] These areas depend on B2's payment functions in the optimal mechanism for S without ex-ante contracts. There are multiple payment schedules to achieve the optimal mechanism. Without ex-ante contracts and with the same distribution for v_1 and v_2, in region O+P+R, B2's ex-ante expected payment equal to the expectation of v_1. Therefore, there must be some areas where trade with B2 is jointly unprofitable for S and B1. There still exist areas with unprofitable trade with B2 even if v_1 and v_2 follow different non-degenerated distributions.

expected payment higher in region O+P.[39] This reduces B2's information rent and increases the expected joint surplus for S and B1.

If $k = k_H > 0$, B1 has a larger competitive advantage with an even higher winning probability. Given a higher upfront transfer, S commits to even less ex-post rent-seeking vis-à-vis B1. In region M, trade also occurs and the joint profit for S and B1 is v_1. Now, B1 has a larger competitive advantage and the mechanism reflects the joint opportunity even more accurately. S and B1, jointly, avoid more unprofitable trade with B2 in region P that might happen when k were lower, or makes B2's expected payment higher in region O.

According to the above analysis, first, by requiring a higher upfront transfer from ex-ante uninformed B1, S could commit to even less ex-post rent-seeking vis-à-vis B1. This increases the probability of trade and avoids some deadweight loss for S and B1. Second, the optimal ex-ante contract, strategically, gives B1 ex-post competitive advantage with a higher winning probability and thus more accurately reflects S and B1's joint opportunity cost.[40] Accordingly, S and B1 could avoid jointly unprofitable trade with B2. This increases the expected rent extracted from B2.

In sum, the optimal ex-ante contract is more profitable for the joint surplus of S and B1, both by mitigating S's ex-post rent-seeking vis-à-vis B1 and by strategically extracting more positive rent from B2. All these depend on B1's ex-ante wealth to pay upfront transfers. Robinson and Stuart (2002) study the contracts between clients and R&D partners in biotech strategic alliances. They find that upfront transfers are widely

[39] B2 may pay more or less in this region, depending on which specific mechanism is used without ex-ante contracts. It is possible that B2 pays less in region O+P, but this joint loss for S and B1 is dominated by the joint gain in region Q. See section 3 for examples of the first price auction and the second price auction.
[40] Note than B1 is the player who knows the private information of the joint opportunity cost for S and B1 when selling the asset to B2. Therefore, he should have more advantage in the ex-post mechanism.

used in those contracts. The study also shows that upfront transfers from clients tend to be larger and sizes of clients' equity stakes are less when clients are protected by more severe ex-post contingent clauses.

4.2 Social efficiency and optimal policies

Suppose that S chooses his optimal ex-ante contract. What are its effects on social efficiency? And what is the socially optimal policy over strategic ex-ante contracts?[41] Contrary to the implications of previous literature, which has focused on the misallocation caused by strategic contracts, the optimal policy must balance the effect to reduce the deadweight loss from having no trade with the possible misallocation among buyers. The analysis starts with defining these two effects of S's optimal ex-ante contract on social welfare.

First, if there is no ex-ante contract, trade occurs when B1's or B2's virtual utility is positive, i.e., $g_1(v_1;1) \geq 0$ and/or $g_2(v_2;1) \geq 0$. As shown in Graph 4, there is a deadweight loss for having no trade in region L+M+N. If B1's ex-ante wealth is $k = k_L > 0$ and S's optimal ex-ante contract is employed, additional trade occurs in region N. Similarly, if B1 has more wealth $k = k_H > k_L$, the ex-ante contract creates additional trade in region M+N. Clearly, given B1's ex-ante wealth k, mitigating S's ex-post rent-seeking vis-à-vis B1 increases social welfare by $F_2\left(r_2^*(0)\right)\int_{r_1^*(k)}^{r_1^*(0)} v_1 dF_1(v_1)$, denoted by $\Delta W_+(k)$.

[41] Suppose that policy makers or enforcers only choose between supporting and banning all ex-ante contracts. For example, it may be costly for courts to monitor and verify various forms of contracts.

Second, suppose that B1's and B2's valuations are identically distributed. If there is no ex-ante contract, B1 wins the asset when his virtual utility is positive and greater than B2's virtual utility, i.e., $g_1(v_1;1) \geq \max(0, g_2(v_2;1))$. As exhibited in Graph 4, there is no misallocation between the two buyers. However, if S's optimal ex-ante contract is employed and B1 has more ex-ante wealth, the allocation curve between B1 and B2 shifts more in favor of B1. B1 wins the asset additionally in region Q when he has a lower level of wealth k_L, and additionally in region P+Q when he has a higher wealth k_H. Therefore, extracting more positive rent from B2 causes a misallocation in more regions. $\Delta W_{-}(k)$ is defined as the difference between the misallocation loss if S's optimal ex-ante contract is employed and the misallocation loss if there is no ex-ante contract.

The next proposition summarizes the above social welfare effects and presents a comparative static analysis when B1's ex-ante financial constraint changes. For certain levels of the ex-ante wealth k, S's optimal ex-ante contract may be more efficient than the absence of ex-ante contracts.

Proposition 5: S's optimal strategic ex-ante contract affects the allocation between the two buyers and facilitates trade.

(i). S's optimal ex-ante contract leads to a higher probability of trade than the absence of ex-ante contracts does. The social welfare created from the additional probability of trade, i.e., $\Delta W_{+}(k)$, is positive and non-decreasing in B1's ex-ante wealth k.

(ii). If B1's and B2's valuations are i.i.d., S's optimal ex-ante contract leads to a misallocation between the buyers, while there would be no misallocation between the buyers if there were no ex-ante contracts. There is more social loss from this misallocation when B1 has more ex-ante wealth. That is, $\Delta W_{-}(k)$, is non-increasing in k.

(iii). It is possible for either of the above two effects to dominate. For the uniform distribution, in particular, there exists a unique wealth level $\hat{k} \geq 0$ such that S's optimal ex-ante contract is more efficient than the absence of ex-ante contracts if and only if $k \leq \hat{k}$.

Proof: see the appendix.

As exhibited in Graph 4, the additional trade created by the contract happens in the range of smaller valuations, while the misallocation may happen in the range of higher valuations. When B1's ex-ante wealth k is small enough, for the uniform distribution, the value created from more trade is higher than the misallocation loss, because they work for close ranges of valuations and the misallocation is less likely to happen. Accordingly, S's optimal ex-ante contract is more efficient than the absence of ex-ante contracts. When B1's ex-ante wealth k is great enough, the marginal value created from more trade is very small. But there is a higher probability of misallocation since B1 has a larger competitive advantage. Accordingly, the misallocation loss dominates the additional trade value created.

According to the above result, policy makers or enforcers might be willing to allow strategic ex-ante contracts when the additional trade value by mitigating sellers' ex-post rent-seeking is higher than the misallocation loss. Of course, this policy requires that policy makers or enforcers have enough information on the matter. In practice, they might not have the full picture. Nevertheless, they could still infer what the expected trade value and the misallocation loss are. Policy makers could also restrict the level of upfront transfers that are specified in contracts.

The social welfare effects of S's optimal ex-ante contract depend not only on B1's financial constraint, but also on the distributions of trade surplus. This paper has normalized the seller's cost to be zero. Therefore, if the distributions of the buyers' valuations are in a range of higher values, there is more trade surplus that could be realized. Consequently, even if there were no ex-ante contracts, the seller would facilitate more trade for rent-seeking. The following proposition analyzes the social welfare effect of S's optimal ex-ante contract when there is greater trade surplus.

Proposition 6: Suppose B1's and B2's valuations are i.i.d., i.e., $F_1(v) = F_2(v)$. Also suppose that the distributions shift from $\left[\underline{v}, \bar{v}\right]$ to $\left[\underline{v}+\Delta, \bar{v}+\Delta\right]$, and that B1's ex-ante wealth k is increased such that S's optimal ex-ante contract keeps the same shadow price λ. There exists a $\hat{\Delta} \geq 0$ such that S's optimal ex-ante contract is less efficient than the absence of ex-ante contracts if $\Delta \geq \hat{\Delta}$. For the uniform distribution, in particular, there exists a unique $\hat{\Delta} \geq 0$ such that S's optimal ex-ante contract is less efficient than the absence of ex-ante contracts if and only if $\Delta \geq \hat{\Delta}$.[42]

Proof: see the appendix.

[42] Similarly, suppose S faces a fixed cost c. Change B1's ex-ante wealth such that S's optimal ex-ante contract keeps the same shadow price. Thus, there exists a unique $c*$ such that S's optimal ex-ante contract is less efficient than the absence of an ex-ante contract if $c \leq c*$.

When the trade surplus is distributed throughout ranges of higher values, the probability of having no trade is lower even when there is no ex-ante contract. Therefore, policy makers or enforcers should not allow strategic ex-ante contracts in such cases. They might be willing to allow strategic ex-ante contracts when the trade surplus is distributed throughout ranges of lower values. This is illustrated by the following two examples.

Example 4.1: Each buyer's valuation is drawn from the uniform distribution on $[0,1]$.

For any B1's wealth level, S's optimal strategic ex-ante contract is more efficient than the absence of ex-ante contracts, because the value created from more trade always dominates the misallocation loss.

Example 4.2: Each buyer's valuation is drawn from the uniform distribution on $[1,2]$.

For any B1's wealth level, even without ex-ante contracts, trade always occurs, because it is always true that $v - \frac{1-F(v)}{f(v)} \geq 0$. Accordingly, S's optimal strategic ex-ante contract is less efficient than the absence of ex-ante contracts.

4.3 Implementation by indirect contract clauses—the uniform distribution

Thus far, S's optimal ex-ante contract with a direct revelation mechanism has been examined. It is also interesting how to implement the optimal ex-ante contract by indirect contract clauses. As an illustration, assume that v_1 and v_2 are independently drawn from the uniform distribution on $[0,1]$. Thus, according to Proposition 4, S's optimal ex-ante contract with a direct revelation mechanism is as follows.

The shadow price $\lambda = \lambda(k)$ satisfies $1/[3(1+\lambda)^2]$ = $\min(k,1/4)+1/12$. If $v_1 \geq \lambda/(1+\lambda)$, B1's expected winning probability is $Q_1^*(v_1) = [(1+\lambda)/2]v_1 + (1-\lambda)/2$; otherwise, it is 0. If $v_2 \geq 1/2$, B2's winning probability is $Q_2^*(v_2) = [2/(1+\lambda)]v_2 - (1-\lambda)/(1+\lambda)$; otherwise, it is 0. The expected payment from Bi is $T_i^*(v_i) = Q_i^*(v_i)v_i - \int_{\underline{v}}^{v_i} Q_i^*(x)dx$.

As analyzed in section 3, the right of first refusal provides that B1 has the right to win the asset if he matches B2's bid. If B1 has the right of first refusal, B1's and B2's expected winning probabilities are $Q_1^{RFR}(v) = \min(2v,1)$ and $Q_2^{RFR}(v) = v/2$. Therefore, the right of first refusal alone does not implement the above optimal contract.

In practice, many strategic ex-ante contracts use combinations of several clauses. For example, the pre-acquisition agreements in the ICON case include both a right of first refusal and an option. These contracts may also incorporate other terms such as a rebate, premium payment or breakup fee. The following proposition presents one indirect contract to implement S's optimal ex-ante contract.

Proposition 7: Assume that v_1 and v_2 are independently drawn from the uniform distribution on $[0,1]$. Note that the shadow price in S's optimal ex-ante contract is $\lambda = \lambda(k)$. The following contract with indirect clauses between S and B1 is equivalent to the optimal ex-ante contract with a direct revelation mechanism: (i) B1 pays an upfront transfer of $\min(k,1/4)$ to S at date 1; (ii) B1 has an option to purchase the asset at the strike price $\lambda/(1+\lambda)$ if B2 does not enter; and (iii) if B2 enters, B2 pays an entry fee

$\frac{\lambda^2}{4(1+\lambda)}$ to S, and B1 has the adjusted right of first refusal to match B2's bid b and to pay a premium (or rebate if it is negative) $\frac{3-\lambda}{1+\lambda}b - \frac{2(1-\lambda)}{1+\lambda}$.

Proof: see the appendix.

In the optimal indirect contract above, if B2 does not enter, B1 would exercise the option if and only if his valuation is lower than the strike price. Therefore, the strike price in the option serves as a reserve price for B1. Besides, this adjusted right of first refusal is a strategic clause, which gives B1 a competitive advantage. Accordingly, the joint opportunity cost for S and B1 is reflected more accurately. This avoids jointly unprofitable trade with B2 and extracts rent from B2. The entry fee for B2 is selected merely to create the optimal reserve price for B2.[43] This optimal indirect contract is similar to the pre-acquisition agreements in the ICON case. It could not only extract rent from entrants, but could also facilitate trade.

Of course, there may be other types of indirect contracts that would be optimal. For example, suppose that B1 has enough wealth after learning his valuation, but cannot be forced to make an unconditional payment to S at date 2 or date 3. Then the following contract with indirect clauses is also equivalent to S's optimal ex-ante contract with a direct revelation mechanism: (i) B1 pays an upfront transfer of $\min(k, 1/4)$ to S at date 1; (ii) B1 has an option to buy the asset at the price $\lambda/(1+\lambda)$ if B2 does not enter; and (iii)

[43]Entry fees or rebates are used by many contracts. Energy-supply contracts often include rebates for current contracted buyers, see also footnote 8. And many real auctions specify entry fees for outside bidders.

if B2 enters, S holds an auction, where B2 pays an entry fee $\frac{\lambda^2}{4(1+\lambda)}$ and B1 pays an entry fee $\frac{11\lambda+3}{8(1+\lambda)}$. In the auction, B1 has the right of first refusal and would get a breakup fee $\frac{3-\lambda}{1+\lambda}b+\frac{4\lambda-3}{2(1+\lambda)}\geq 0$ if he loses in the auction.[44] Moreover, different indirect contracts may require different upfront transfers, even if they implement the same optimal ex-ante contract with a direct mechanism.[45]

Even when the buyers' valuations follow some other distributions, the optimal indirect contract could also specify an option for B1 to purchase the asset if B2 does not enter, and give B1 the right of first refusal with adjustments by a rebate or a premium if B2 enters. However, this is just an illustration of how the indirect strategic ex-ante contracts could be designed. In practice, it may be hard to design the optimal contract.

This section has examined S's optimal ex-ante contract with a direct revelation mechanism, which not only extracts rent from the entrant, but also facilitates more trade. Thus, this optimal ex-ante contract might be more efficient than the absence of ex-ante contracts, depending on B1's ex-ante wealth and the distributions of trade surplus. Also, it could be implemented by contracts with indirect clauses. One such contract combines an option, an entry fee and an adjusted right of first refusal.

[44] The proof is similar to that for Proposition 7.

[45] Here is a numerical example. Assume that B1's and B2's valuations are drawn from the uniform distribution. And suppose the shadow price λ is 0 in the optimal ex-ante contract with a direct revelation mechanism. There are several indirect contracts that could implement it. The contract making B1 requires an upfront transfer 1/2. Thus, this indirect contract could not be adopted if B1 has an ex-ante wealth less than 1/2. However, the indirect contract exhibited in proposition 7 only requires an upfront transfer 1/4. Thus, this indirect contract could be employed as long as B1's ex-ante wealth is greater than 1/4.

Section 5: Discussion

5.1 Some commonly used contract clauses

Some indirect contract clauses are commonly used. It is important to see whether they have any strategic characteristics similar to S's optimal ex-ante contract. The primary characteristic is to give B1 a competitive advantage and to create discrimination in the winning probabilities for B1 and B2, i.e., $Q_1(v) \geq Q_0(v) \geq Q_2(v)$. In this section, assume that B1's and B2's valuations are drawn form the uniform distribution on $[0,1]$. In addition, each clause could be used together with an entry fee or a minimum bid requirement.

Clause 1: Fixed break-up fees

A break-up fee is widely used in strategic ex-ante contracts. Suppose that S and B1 sign a contract with a break-up fee d. S (or sometime B2) would make a payment d to B1 when B1 fails to obtain the asset or when S breaches the contract. Aghion and Bolton (1987) analyze the use of a break-up fee to deter entry or to extract rent from an entrant. In Aghion and Bolton's model, B1's valuation is fixed and commonly known. Therefore, B2 must make a higher bid than he would if there were no break-up fee, in order to induce S to breach the contract.

This paper considers the situation when B1's valuation is also uncertain and he could learn more information after entering into a contract. Suppose that the ex-ante contract specifies a break-up fee and S would hold the standard English auction at date 3. Here, unlike in Aghion and Bolton (1987), the contract with a price and a break-up fee is not the optimal strategic ex-ante contract, because the breakup fee does not reflect the contracting parties' joint opportunity costs for selling to entrants.

If the break-up fee is paid from S to B1, B1's and B2's optimal bidding strategies are $b_1 = v_1 - d$ and $b_2 = v_2$.[46] Therefore, their expected winning probabilities are $Q_1(v) = v - d$ and $Q_2(v) = v + d$. Or, if B2 pays the break-up fee to B1, the optimal bidding strategies are $b_1 = v_1 - d$ and $b_2 = v_2 - d$. Therefore $Q_1(v) = Q_2(v) = v$. In either case, the break-up fee does not have strategic characteristics similar to S's optimal ex-ante contract. This is not surprising because the break-up fee makes B1 less aggressive in auctions.

There are other considerations for specifying a break-up fee. One effect is to induce buyers to participate in auctions if it is costly for them to bid, as analyzed by Che and Lewis (2002). Break-up fees could also preserve incentives for relationship-specific investments, as addressed by several papers (Rogerson, 1984, 1992; Spier and Whinston, 1995; Che and Hausch, 1999).

Clause 2: Stock lock-ups

A stock lock-up is sometimes used as a general term for many types of clauses. One such typical clause would offer B1 a share $s \in [0,1]$ of S's ownership if and only if B1 loses in the auction. Che and Lewis (2002) show that stock lockups make buyers bid less aggressively and inducing buyers to participate in auctions. Burch (2001) supports these effects with an empirical study of the use of lockup contracts in corporate mergers. Clearly, if there is no need to induce participation, such stock lockups reduce sellers' revenue.

[46] In contrast to Aghion and Bolton (1987), B1 here could change his price ex-post. In Aghion and Bolton's paper, B1's valuation is fixed. Thus, the ex-ante contract would specify a price and a break-up fee for B1. There is no need to change B1's price ex-post, unless the parties renegotiate the contract. In this paper, though, B1's valuation is uncertain at the contracting stage. Thus, the contract that allows B1 to change the price ex-post is valuable.

Suppose that a modified stock lockup clause would offer B1 a share $s \in [0,1]$ of S's ownership if B1 wins. Also suppose that S holds the English auction at date 3. If B1 wins, he only pays $1-s$ share of the price at which B2 exits. Accordingly, B1's and B2's optimal bidding strategies are $b_1 = v_1/(1-s)$ and $b_2 = v_2$. Therefore, their expected winning probabilities are $Q_1(v) = v/(1-s) \geq v$ and $Q_2(v) = (1-s)v \leq v$. Thus, such modified stock lock-ups have strategic characteristics similar to S's optimal ex-ante contract, though they may not be equivalent.

Clause 3: Toeholds

A toehold clause is similar to a stock lock-up, except that B1 gets a share $s \in [0,1]$ of S's ownership no matter whether he wins the asset or not. Again, suppose that S holds the English auction. If B1 wins, he pays only $1-s$ share of the price at which B2 exits. If B1 loses, he gets s share of the price at which B2 wins. Accordingly, their optimal bidding strategies are: $b_1 = v_1$ and $b_2 = v_2$. Therefore, toehold clauses do not have strategic characteristics similar to S's optimal ex-ante contract. Nevertheless, they could still be used to induce participation in auctions or to protect investments.

Clause 4: Options

An option clause provides that the contracted buyer B1 has the option to purchase the asset at a strike price *p* under certain conditions.

First suppose that B1 could decide whether to exercise the option before the English auction. B1 has to compare his utility $v_1 - p$ from exercising the option to his expected utility $r_2(v_1 - r_1) + \max(0, \int_{r_2}^{v_1}(v_1 - v_2)dv_2)$ in the auction, where r_1, r_2 are the possible reserve prices for B1 and B2. It is easy to examine that there exists one $\hat{v}(p)$

such that B1 would exercise the option only if $p \le v_1 \le \hat{v}(p)$. Therefore, B1's expected winning probability is $Q_1(v) = 1$ for $p \le v \le \hat{v}(p)$ or $Q_1(v) = v$ for $v \ge \max(\hat{v}(p), r_1)$. Thus, option clauses may have strategic characteristics similar to S's optimal ex-ante contract. Noldeke and Schmidt (1995) also consider using an option clause to mitigate hold-up problems and protect investments.

Second, option clauses often have exercising conditions. For example, in the optimal indirect contract exhibited in Proposition 7, B1 could exercise the option only if there is no entrant. In such cases, strike prices in options serve as reserve prices.

Clause 5: Non-compete clauses

A non-compete clause provides that if S wants to sell the asset, he could not sell it to any buyers other than B1. Therefore, B2 never has a chance to win if there is no renegotiation, that is, $Q_2(v)$=0. Thus, non-compete clauses have strategic characteristics similar to S's optimal ex-ante contract. However, some competition from the entrant may be better for the seller, as well as for social efficiency. Therefore, non-compete clauses are not equivalent to S's optimal strategic ex-ante contract.

Non-compete clauses could have other effects. The first is to protect investments (Segal and Whinston, 2001). Second, Matouschek and Ramezzana (2003) show that non-compete clauses also facilitate ex-ante trade. This is so because such clauses reduce the expected values of contracting parties' outside options. This point is different from the argument in this paper that ex-ante contracts mitigate sellers' ex-post rent-seeking.

Clause 6: The right of first offer

The right of first offer is the reverse of the right of first refusal. It gives the contracted buyer B1 the right to make an offer p to S such that S could not sell the asset to B2 at a price lower than p. Similar to the analysis of the right of first refusal, B1's expected winning probability is less than B2's expected winning probability, i.e., $Q_1(v) \leq Q_2(v)$. Thus, the right of first offer does not have strategic characteristics similar to S's optimal ex-ante contract. In fact, the right of first offer would be in favor of B2, in this paper' setting. Thus, there should be other effects for using the right of first offer. One possible effect is to reveal valuable information in a common-value situation. Another effect is to make a preemptive bid if it is costly for entrants to bid.

5.2 Policies on discriminatory and non-discriminatory contracts

Suppose that policy makers have greater flexibility with strategic ex-ante contracts. They could distinguish between discriminatory and non-discriminatory contracts with minimal cost. By definition, discriminatory contracts are identified as those contracts that create different competitive advantages for buyers from those without ex-ante contracts. Accordingly, three simple policies are possible:[47] (1) no ex-ante contracts are allowed; (2) any types of ex-ante contract are allowed; and (3) only non-discriminatory contracts are allowed. In some circles, people consider the last policy to be the most efficient because it does not impede competition. In this paper, the suggestion is true if the buyers' valuations are i.i.d., but not for general cases.

First, assume that the buyers' valuations are i.i.d. and there is no other cost. In this case, allowing only a non-discriminatory contract is the most efficient policy of the three. Under this policy, the seller's reduced-form problem in choosing the optimal contract must be rewritten with one additional constraint, $Q_1(v) = Q_2(v) = Q(v)$:

[47] Assume that it is costly for policy makers or enforcers to monitor different types of contracts in details.

$$Max_{\{Q_i\}} \int_{\underline{v}}^{\bar{v}} vQ(v)dF(v) + \int_{\underline{v}}^{\bar{v}} \{vQ(v) - \int_{\underline{v}}^{v} Q(x)dF(x)\}dF(v) - V_0$$

Subject to: $\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{v} Q(x)dF(x)dF(v) \leq k + V_0$

$Q(v)$ is non-decreasing in v

Since the buyers' valuations are i.i.d., the optimal non-discriminatory winning probability must be $Q^{ND}(v) = F(v)$ if $v \geq r^{ND}$, where r^{ND} is the effective reserve price for both buyers. Specifically, given B1's ex-ante wealth k, $r^{ND}(k) \leq r_1^*(\lambda(k))$. Clearly, the optimal non-discriminatory contract leads to a higher probability of trade. It does not, however, lead to a misallocation between B1 and B2. Thus, it is more efficient than S's optimal strategic ex-ante contract and than the absence of ex-ante contracts.

Second, assume that the buyers' valuations are not identically distributed. In this case, the optimal strategic ex-ante contract might indeed be more efficient than the optimal non-discriminatory contract. For example, suppose $F_1(v), F_2(v)$ satisfy $\lambda \frac{1-F_1(v)}{f_1(v)} = \frac{1-F_2(v)}{f_2(v)}$ for all possible valuations. If only non-discriminatory contracts were allowed, then B1 would win the asset only if $v_1 - \frac{1-F_1(v_1)}{f_1(v_1)} \geq v_2 - \frac{1-F_2(v_2)}{f_2(v_2)}$. There is a misallocation, since $v_1 \geq v_2$ is equivalent to $v_1 - \lambda \frac{1-F_1(v_1)}{f_1(v_1)} \geq v_2 - \frac{1-F_2(v_2)}{f_2(v_2)}$. If discriminatory contracts were allowed, then S's optimal strategic ex-ante contract with a shadow price λ would not lead to a misallocation and might be more efficient than non-discriminatory contracts.

Finally, if there is any contracting cost between S and B1, allowing only non-discriminatory contracts might impede ex-ante contracts. Note that the joint expected surplus of S and B1 under non-discriminatory contracts is lower than the joint surplus under S's optimal strategic ex-ante contract. In such cases, allowing ex-ante contracts may be more efficient than engaging in a selective policy.

5.3 Renegotiation and resale

Previous sections have not considered renegotiation or resale possibilities. This section discusses whether renegotiation or resale would affect the effects of strategic ex-ante contracts to extract rent and facilitate trade.

First, if S and B1 had symmetric information in the beginning of the selling stage, they could presumably renegotiate their ex-ante contract. Therefore, the strategic ex-ante contract need not provide commitment to more trade. However, in this paper, B1 has private information at the selling stage. Thus, renegotiation might not maximize the joint surplus of S and B1. Instead, in the renegotiation, S would seek rent from the privately informed B1. Thus, trade still might not occur. Accordingly, the ex-ante contract could facilitate trade when ex-post renegotiation is not efficient.

Second, suppose that after the selling stage, B1 and B2 observe each other's valuations and the winner could resell the asset to the loser. Assume that the bargaining process is efficient and each buyer has positive bargaining power. Now the strategic ex-ante contract still facilitates more trade by mitigating S's rent-seeking at the selling stage.

Moreover, the contract should give B1 a competitive advantage with a higher winning probability at the selling stage. Thus, his outside option value in the resale bargaining with B2 is more likely to be higher. Therefore, the strategic ex-ante contract could extract rent from B2, but would not lead to a misallocation as long as the resale bargaining is efficient. In sum, the strategic ex-ante contract increases social welfare.

5.4 The seller's optimal ex-ante contract with both buyers

Suppose that both B1 and B2 are accessible and have limited wealth k_1 and k_2 at date 1. This section briefly discusses several contracting scenarios. Further research on these scenarios, though, should be made.

In the first scenario, S could only offer a contract to B1 and B2 jointly. Each buyer individually decides whether to accept or refuse it. If one refuses, there is no ex-ante contract and S will choose the optimal selling mechanism at date 3. Similar to the previous analysis regarding the seller's strategic ex-ante contracts, here the optimal contract may create a competitive advantage for one buyer, depending on the buyers' ex-ante wealth levels. However, the optimal contract also commits to a higher probability of trade. Therefore, the optimal contract may be more efficient than the absence of ex-ante contracts.

In the second scenario, S could offer either a single contract to both buyers jointly, or a contract to only one buyer, but not separate contracts to the buyers. Also, S could not offer a new contract if the initial contract was refused. Here, the key decision for S is to choose between contracting with both buyers and contracting with one buyer. Clearly, it is optimal for S to offer a contract to both buyers to mitigate ex-post rent-seeking and to facilitate more trade.

In the final scenario, S could even offer separate contracts to the buyers. Here it is difficult to examine the optimal contract with a direct revelation mechanism. It depends on one buyer's beliefs about the other buyer's decision whether to accept or refuse the contract.

Conclusion:

This paper has examined strategic ex-ante contracts and their effects in facilitating trade and extracting rent from entrants. Contrary to previous literature, it considers the environment in which the contracted buyer can learn more information after the time of contracting. Without ex-ante contracts, the seller's rent-seeking mechanism may lead to no trade even if trade would create a surplus. With an ex-ante contract, the seller mitigates his ex-post rent seeking vis-à-vis the contracted buyer and facilitates trade. Moreover, compared to the absence of ex-ante contracts, the seller's optimal strategic ex-ante contract is designed to extract more positive rent from entrants. This is achieved by giving a competitive advantage to the contracted buyer. Thus, the contracting parties' joint opportunity cost when selling to the entrant is more accurately reflected. The contracted buyer may pay an upfront transfer to obtain a competitive advantage. Moreover, the optimal strategic ex-ante contract with a direct mechanism could be implemented by indirect clauses, such as a combination of an option, the adjusted right of first refusal and an entry fee for the case of the uniform distribution.

In general, strategic ex-ante contracts may increase social welfare by facilitating more trade. If all possible values of trade surplus are high enough, strategic ex-ante contracts are less efficient than the absence of ex-ante contracts. For the uniform distribution, the seller's optimal strategic ex-ante contract is more efficient than the absence of ex-ante contracts if the contracted buyer has very limited ex-ante wealth and if all possible values of trade surplus are low. These have implications for policy makers who may decide to allow ex-ante contracts even if they contain strategic clauses.[48]

The role of ex-ante contracts in facilitating trade and extracting rent from third parties is not unique to pre-acquisition agreements. Partnership contracts, such as strategic alliance contracts or joint-venture contracts, also contain strategic clauses and clauses of re-allocating ownership. Re-allocating ownership is a kind of ex-post trade among partners. And strategic clauses extract rents from entrants when some partners want to exit the partnerships and sell their ownership shares to outside investors. These contracts often include upfront transfers either in cash or by changing partners' shares of equity.[49] Long-term contracts, such as energy-supply contracts between pipeline companies and shippers, also provide greater commitment to facilitate future trade than short-term contracts or spot markets do. Additionally, long-term contracts with strategic terms serve as mechanisms to extract rent from subsequent suppliers.[50] Upfront transfers could be made by changing early periods' prices paid to current suppliers.

[48] This paper restricts the policy arrangement to whether ex-ante contracts should be allowed. Some other policy considerations, such as a court-imposed right of first refusal and restrictions on the effective periods of strategic clauses might be available.

[49] For example, Robinson and Stuart (2002) study the contracting between clients and R&D partners in biotech strategic alliances, in which upfront transfers are widely used.

[50] Energy supply contracts often include strategic terms such as the right of first refusal, rebates, etc. See also footnote 8.

One empirical implication from this paper is that upfront transfers should be larger when contracted buyers are protected by more favored strategic clauses. For example, Robinson and Stuart (2002) show that, in biotech strategic alliances, upfront transfers from clients tend to be larger and sizes of clients' equity stake are less when they are protected by more severe ex-post contingent clauses.

Several extensions would be meaningful for future research. First, using strategic ex-ante contracts to protect investments is not considered in this paper. There are two types of investments: (1) relationship-specific investments affecting trade surplus; and (2) efforts to acquire more accurate information on trade surplus. With the effect of facilitating more trade, ex-ante contracts may provide more incentive for those investments. Second, more auction or contracting problems could be addressed when there are possible collusions between sellers and some buyers. For example, if a seller has multiple units for sale, such as in the energy-supply industry, strategic ex-ante contracts may also cause quantity distortions. Or, if buyers' financing in the capital market takes a long time, decisions on the contracting time could be made endogenously. Also it remains to be interesting to explore ex-ante contracts when there are other contracting constraints or renegotiation. Finally, this paper has a general implication for the boundary of firms and for the principle-agent problem. It could be used for further research on the choice between producing within firms and outsourcing, and on firms' horizontal organizations. Contracted buyers could be viewed as agents or divisions within firms, while entrants represent parties outside firms.

Appendix

In the following proofs, the function $L(\ )$ represents the absolute value of the expected social loss, compared to the first best outcome.

Proof of Proposition 1:

If there is no ex-ante contract, the optimal mechanism follows from the literature on mechanism design. And the players' expected utilities and the social welfare are as follows:

$$U_0 = 2*(1/2)*(1/2)*(1/2) + \int_{1/2}^{1}\left\{\int_{v_1}^{1} v_1 dv_2 + \int_{1/2}^{v_1} v_2 dv_2\right\}dv_1 = 5/12$$

$$V_{10} = V_{20} = \int_{1/2}^{1}\left\{1/2*(v_1 - 1/2) + \int_{1/2}^{v_1}(v_1 - v_2)dv_2\right\}dv_1 = 1/12$$

$$W_0 = U_0 + V_{10} + V_{20} = 7/12$$

$$L_0 = \int_{0}^{1/2}\left\{\int_{0}^{v_1} v_1 dv_2 + \int_{v_1}^{1/2} v_2 dv_2\right\}dv_1 = 1/12$$ Q.E.D.

Proof of Proposition 2:

If the contract offers the right of first refusal, B1 would exercise the right whenever his valuation is higher than B2's bid, i.e., $v_1 \geq b_2$, so that B2's winning probability is $F(b_2) = b_2$. In anticipation of this scenario, B2 would choose b_2 to maximize his expected utility, $(v_2 - b_2)b_2$. The optimal bid is $b_2 = v_2/2$. Thus, B1 would definitely win if $v_1 \geq 1/2$ and pay the bid made by B2. He would win with a probability $2v_1$ if $v_1 < 1/2$. Therefore, the players' expected utilities and the social welfare are as follows:

$$U = \int_{0}^{1}\left\{\int_{0}^{2v_1} v_1 dv_2 + \int_{2v_1}^{1}(v_2/2)dv_2\right\}dv_1 - V_1 = 11/24$$

$$V_1 = \int_{1/2}^{1}(v_1 - \int_{0}^{1}(v_2/2)dv_2)dv_1 + \int_{0}^{1/2}\int_{0}^{2v_1}(v_1 - v_2/2)dv_2 dv_1 - 5/24 = 1/12$$

$$V_2 = \int_{0}^{1/2}\left\{\int_{2v_1}^{1}(v_2 - v_2/2)dv_2\right\}dv_1 = 1/12$$

$$W = U + V_1 + V_2 = 15/24$$

$$L = \int_{0}^{1}\left\{\int_{v_2/2}^{v_2}(v_2 - v_1)dv_1\right\}dv_2 = 1/24$$ Q.E.D.

Proof of Proposition 4 and Corollary 1:

The winning conditions for the buyers in Proposition 4 follow directly from maximizing S's reduced-form problem point-wise. It remains to verify that $Q_i^*(v_i)$ is indeed non-decreasing. Note that $Q_i^*(v_i) = E_{v_j}[q_i(v_i, v_j)] = \int q_i^*(v_i, v_j)dF_j(v_j)$. Also, the hazard rate is monotone such that $H_i(v_i) = (1 - F_i(v_i))/f_i(v_i)$ is decreasing in v_i, so the λ-adjusted virtual utility $g_i(v_i;\lambda) = v_i - \lambda(1 - F_i(v_i))/f_i(v_i)$ is non-decreasing in v_i. Therefore, given a particular v_j, if $v_i > v_i'$, then $q_i^*(v_i, v_j) \geq q_i^*(v_i', v_j)$. Accordingly, $Q_i^*(v_i) \geq Q_i^*(v_i')$.

Note that $q_1^*(v_1, v_2)$ is non-increasing in λ, and $q_2^*(v_1, v_2)$ is non-decreasing in λ. Take any two feasible shadow prices where $\lambda < \lambda'$. Accordingly, $g_1(v_1;\lambda) \geq g_1(v_1;\lambda')$. Given a particular v_2, if $g_1(v_1;\lambda) \geq \max(0, g_2(v_2;1))$, $q_1^*(v_1, v_2)$=1. Therefore, if $g_1(v_1;\lambda') \geq \max(0, g_2(v_2;1))$, then $g_1(v_1;\lambda) \geq \max(0, g_2(v_2;1))$, so that $q_1^*(v_1, v_2)$=1. The reverse might not be true, though. The same holds for $q_2^*(v_1, v_2)$.

Furthermore, the shadow price $\lambda = \lambda(k)$ is non-increasing in k. Suppose that there were $k > k'$, such that $\lambda(k) > \lambda(k')$>0. Then $q_1^*(v_1, v_2; k) \leq q_1^*(v_1, v_2; k')$ (the sign may be strictly less for some valuations). Thus, $Q_1^*(v_1; k) < Q_1^*(v_1; k')$. Therefore, according to the ex-ante individual rationality constraint, it is true that $0 = \{\int_{\underline{v}}^{\bar{v}}\int_{\underline{v}}^{v} Q_1^*(x;k)dxdF_1(v) - k - V_{1N}\} < \{\int_{\underline{v}}^{\bar{v}}\int_{\underline{v}}^{v} Q_1^*(x;k')dxdF_1(v) - k' - V_{1N}\} = 0$.

As a result of this contradiction, $\lambda = \lambda(k)$ is non-increasing in k and it is easy to show that there exists a unique k^*, such that $\lambda(k \geq k^*)$=0. Therefore, $t_0^* = \min(k, k^*)$

Also, the shadow price must be between 0 and 1, i.e., $\lambda = \lambda(k) \in [0,1]$, otherwise B1's expected utility would be lower than his expected utility if there were no ex-ante contracts. When k =0, $\lambda(0) = 1$, clearly the mechanism is the same as when there were no ex-ante contracts.

From the above analysis, accordingly, $q_1^*(v_1, v_2; k)$, or $Q_1^*(v_1; k)$ correspondingly, is non-decreasing in k and $Q_1^*(v_1; k) \geq Q_{10}^*(v_1)$; $q_2^*(v_1, v_2; k)$, or $Q_2^*(v_2; k)$ correspondingly, is non-increasing in k and $Q_2^*(v_2; k) \leq Q_{20}^*(v_2)$. Moreover, it is easy to show that the probability of having no trade, $F(r_1^*(k))F(r_2^*(0))$, is non-increasing in k: $r_1^*(\lambda(k))$ is non-decreasing in λ because $g_i(v_i; \lambda)$ is non-increasing in λ.

Finally, in the reduced-form problem, S's expected utility is non-increasing in λ. Since $\lambda = \lambda(k)$ is non-increasing in k, S's expected utility is non-decreasing in k.

Q.E.D.

Proof of Proposition 5:

Part 1: Under S's optimal ex-ante contract, there is trade, as opposed to when there is no ex-ante contract, if $1 > v_1 f_1(v_1)/(1 - F_1(v_1)) \geq \lambda$. Define $r_1^*(k) = r_1^*(\lambda(k))$ such that $r_1^*(\lambda(k)) f(r_1^*(\lambda(k)))/(1 - F(r_1^*(\lambda(k)))) = \lambda(k)$. Thus, the optimal ex-ante contract creates additional trade value $\Delta W_+(k) = F_2(r_2^*(0)) \int_{r_1^*(k)}^{r_1^*(0)} v_1 dF_1(v_1)$. When differentiated with respect to the wealth level,

$$\frac{d\Delta W_+(k)}{dk} = -F_2(r_2(0)) r_1'(k) r_1(k) f(r_1(k)) = -\lambda'(k) F_2(r_2(0)) \frac{[1 - F(r_1(k))] r_1(k)}{1 - \lambda(k) H'(r_1(k))} \geq 0$$

The last inequality follows from the fact that $H_1'(\ ) \leq 0$ by assuming a monotone hazard rate and $\lambda'(k) \leq 0$ by Corollary 1. In other words, the additional trade value created by the optimal ex-ante contract is non-increasing in λ, or non-decreasing in k.

Part 2: Compared to the absence of ex-ante contracts, the optimal ex-ante contract creates inefficiency through a misallocation when

$$v_1 - \lambda(1 - F(v_1))/f(v_1) > v_2 - (1 - F(v_2))/f(v_2) > v_1 - (1 - F(v_1))/f(v_1).$$

Define $\delta(v; k)$, such that $v - \delta - \lambda(1 - F(v - \delta))/f(v - \delta) = v - (1 - F(v))/f(v)$. Clearly, $\delta(v; k) \geq 0$. Thus the expected loss from the misallocation is:

$$\Delta W_-(k) = -\int_{r_2^*(0)}^{\bar{v}} \left\{ \int_{v_2 - \delta(v_2; k)}^{v_2} (v_2 - v_1) dF(v_1) \right\} dF(v_2).$$

When differentiated,

$$\frac{d\Delta W_{-}(k)}{dk} = \lambda'(k)\int_{r_2^*(0)}^{\bar{v}} \left\{ \frac{[1-F(v_2-\delta(v_2;k))](\delta(v_2;k))}{1-\lambda(k)H'(v_2-\delta(v_2;k))} \right\} dF(v_2) \le 0.$$

The last inequality follows from the monotone hazard rate and the earlier result $\lambda'(k) \le 0$. In other words, the social loss from the misallocation between B1 and B2 is non-decreasing in λ, or non-increasing in k. Also, when there were no ex-ante contract, or λ =1 equivalently, there would be no misallocation between the two buyers.

Part 3: For the uniform distribution, it is sufficient to prove the case when $\bar{v} - \underline{v} = 1$.[51]

Under the optimal ex-ante contract, the absolute value of the total social loss from having no trade and the misallocation between B1 and B2 is:

If $\lambda \ge \underline{v}$, $L(\lambda) = \int_{\underline{v}}^{\frac{\lambda(1+\underline{v})}{(1+\lambda)}} \left\{ \int_{\underline{v}}^{v_1} v_1 dv_2 + \int_{v_1}^{\frac{1+\underline{v}}{2}} v_2 dv_2 \right\} dv_1 + \int_{\frac{\lambda(1+\underline{v})}{(1+\lambda)}}^{1+\underline{v}} \left\{ \int_{v_1}^{\frac{1+\lambda}{2}v_1 + \frac{(1-\lambda)(1+\underline{v})}{2}} (v_2 - v_1) dv_2 \right\} dv_1$

If $\lambda < \underline{v}$, $L(\lambda) = \int_{\underline{v}}^{1+\underline{v}} \left\{ \int_{v_1}^{\frac{1+\lambda}{2}v_1 + \frac{(1-\lambda)(1+\underline{v})}{2}} (v_2 - v_1) dv_2 \right\} dv_1 = (1-\lambda)^2/24$

It has been shown that $\lambda = \lambda(k)$ is non-increasing. Accordingly, λ could be used as the independent variable. When $L(\lambda)$ is differentiated,

If $\lambda \ge \underline{v}$, $\frac{dL(\lambda)}{d\lambda} = \frac{dL}{d\lambda} = (1+\underline{v})^3 \left\{ \frac{7\lambda - 1}{12(1+\lambda)^3} - \frac{\lambda \underline{v}}{(1+\lambda)^3(1+\underline{v})} \right\}$

If $\lambda < \underline{v}$, $\frac{dL(\lambda)}{d\lambda} = -(1-\lambda)/12$

First, note that $\lambda \in [0,1]$. If $\lambda < \underline{v}$, then $L'(\lambda) = -(1-\lambda)/12 \le 0$. In other words, the absolute value of the social loss is non-increasing in λ if $\lambda < \underline{v}$, or non-decreasing in k if $k > k^{-1}(\lambda = \underline{v})$.

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[51]All results hold for a more general uniform distribution on $[\underline{v}, \underline{v}+a]$ ($a \ge 0$). The proof is very similar to the above. In this case, there are different loss functions for $\lambda < \underline{v}/a$ and $\lambda \ge \underline{v}/a$.

Second, if $\lambda \geq \underline{v}$, $\frac{dL(\lambda)}{d\lambda d\lambda} = \frac{1}{12}(1+\underline{v})^3 \left\{ \frac{(10 - 12\underline{v}/(1+\underline{v})) - 2(7 - 12\underline{v}/(1+\underline{v}))\lambda}{(1+\lambda)^4} \right\}$. It is positive for a smaller $\lambda \geq \underline{v}$, and may be negative for a larger $\lambda \geq \underline{v}$. This is because $\underline{v}/(1+\underline{v}) \leq 1/2$ gives $1 \geq \lambda \geq \underline{v}$.[52] In other words, the social loss is first convex and then concave in λ if $\lambda \geq \underline{v}$. Furthermore, when $\lambda = 1$, it is easy to show that $\frac{dL(\lambda)}{d\lambda} \geq 0$.

In sum, the absolute value of the social loss first decreases, then is convex, and finally increases and is concave in λ within the relevant range. Also, note that the absolute value of the social loss, if there is no ex-ante contract, is $L(\lambda = 1)$. Therefore, there exists a unique $\hat{\lambda}$ such that $L(\lambda) \leq L(1)$ if and only if $\lambda \geq \hat{\lambda}$.

Let $\hat{k}$ satisfy $\lambda(\hat{k}) = \hat{\lambda}$. Since $\lambda = \lambda(k)$ is non-increasing, S's optimal contract is more efficient than the absence of ex-ante contracts if and only if $k \leq \hat{k}$. Q.E.D.

Proof of Proposition 6:

Part 1: Note that, given $\lambda(k) = \lambda$, $r_1^*(\lambda(k))$ satisfies $r_1^*(\lambda(k)) f(r_1^*(\lambda(k))) / (1 - F(r_1^*(\lambda(k)))) = \lambda(k)$. The left hand side is increasing in $r_1^*(\lambda(k))$ given the distribution function. Now the distribution is shifted from $[\underline{v}, \bar{v}]$ to $[\underline{v} + \Delta, \bar{v} + \Delta]$. There must be some $\hat{\Delta} \geq 0$, such that, for $\Delta \geq \hat{\Delta}$, $(\underline{v} + \Delta) f(\underline{v} + \Delta) \Big/ \left(1 - F(\underline{v} + \Delta)\right) \geq 1$. Accordingly, when $\Delta \geq \hat{\Delta}$, even if there is no ex-ante contract, $r_1^*(\lambda(k) = \lambda)$ equals the lower bound of the distribution. Thus, the ex-ante contract creates no additional trade and may lead to a misallocation between B1 and B2.

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52 The proof is very similar for a more general uniform distribution on $[\underline{v}, \underline{v} + a]$ ($a \geq 0$). In this case, there are different loss functions for $\lambda < \underline{v}/a$ and $\lambda \geq \underline{v}/a$. Note that, if $1 \geq \lambda \geq \underline{v}/a$ (that is, $\underline{v} \leq a$), $\underline{v}/(a + \underline{v}) \leq 1/2$.

Therefore, the absence of ex-ante contracts is more efficient than S's optimal ex-ante contract.

Part 2: For the uniform distribution, it is sufficient to prove the case when $\bar{v} - \underline{v} = 1$.[53] Start at $\underline{v} = 0$. Given λ <1, the absolute value of the expected social loss satisfies $L(\lambda; \Delta = 0) < L(1; \Delta = 0)$. If $\lambda < \Delta$, then $L(\lambda; \Delta) = (1-\lambda)^2 / 24$, which does not depend on Δ. Accordingly, $L(\lambda; \Delta) > L(1; \Delta)$. Therefore, there may exist a Δ such that $L(\lambda; \Delta) = L(1; \Delta)$.

Next claim that for $\Delta < \lambda$, if there is some particular Δ such that $L(\lambda; \Delta) = L(1; \Delta)$, then $\partial L(\lambda; \Delta)/\partial \Delta \geq \partial L(1; \Delta)/\partial \Delta$ for this Δ. It could be calculated that

$$L(\lambda; \Delta) =$$

$$(1+\Delta)^3 \{(1-\lambda\}^2 /[24(1+\lambda)^3] + \lambda^3 /[6(1+\lambda)^3] + \lambda /[8(1+\lambda)] - \Delta\lambda^2 /[2(1+\Delta)(1+\lambda)^2]\}$$
$$- (1+\Delta)^2 \Delta / 8 + \Delta^3 / 3$$

$$\partial L(\lambda; \Delta)/\partial \Delta =$$

$$3(1+\Delta)^2 \{(1-\lambda\}^2 /[24(1+\lambda)^3] + \lambda^3 /[6(1+\lambda)^3] + \lambda /[8(1+\lambda)] - \Delta\lambda^2 /[2(1+\Delta)(1+\lambda)^2]\}$$
$$- (1+\Delta)\lambda^2 /[2(1+\lambda)^2] + 5\Delta^2 / 8 - \Delta / 2 - 1/8$$

Substituting $L(\lambda; \Delta) = L(1; \Delta)$ in, we have

$\partial L(\lambda; \Delta)/\partial \Delta - \partial L(1; \Delta)/\partial \Delta = (1+\Delta)\left[1/8 - (1/2) * (\lambda/(1+\lambda))^2\right] \geq 0$ because $\lambda/(1+\lambda) \leq 1/2$, coming from $\Delta < \lambda \leq 1$.[54] Thus, the above claim is true.

Given λ <1, starting at $\Delta = 0$, $L(\lambda; \Delta = 0) < L(1; \Delta = 0)$. Let $\hat{\Delta} \geq 0$ be the lowest Δ such that $L(\lambda; \Delta) = L(1; \Delta)$, then for $\Delta > \hat{\Delta}$, it must be true that $L(\lambda; \Delta) \geq L(1; \Delta)$. Otherwise, by continuity, there exists a Δ satisfying $L(\lambda; \Delta) = L(1; \Delta)$ and $\partial L(\lambda; \Delta)/\partial \Delta < \partial L(1; \Delta)/\partial \Delta$. This contradicts the above claim.

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[53] The proof is very similar for a more general uniform distribution on $[\underline{v}, \underline{v} + a]$ ($a \geq 0$). In that case, there are different loss functions for $\lambda < \underline{v}/a$ and $\lambda \geq \underline{v}/a$.

[54] The proof is very similar for a more general uniform distribution on $[\underline{v}, \underline{v} + a]$ ($a \geq 0$).

Therefore, there exists a unique $\hat{\Delta} \geq 0$, such that $L(\lambda;\Delta) \leq L(1;\Delta)$ if and only if $\Delta \leq \hat{\Delta}$. Q.E.D.

Proof of Proposition 7:

The indirect contract induces the same expected winning probabilities and expected ex-post payments as S's optimal contract with a direct revelation mechanism. Given B1's ex-ante wealth, the shadow price $\lambda = \lambda(k)$ satisfies

$$1/\left[3(1+\lambda)^2\right] = \min(k, 1/4) + 1/12.$$

Now examine B1's and B2's winning probabilities. Suppose B2 enters and bids b. B1 would exercise the adjusted right of first refusal if and only if $v_1 - b - (\frac{3-\lambda}{1+\lambda}b - \frac{2(1-\lambda)}{1+\lambda}) \geq 0$. This is equivalent to $v_1 \geq \frac{4}{1+\lambda}b - \frac{2(1-\lambda)}{1+\lambda}$. Anticipating this, B2 knows that his winning probability is $\frac{4}{1+\lambda}b - \frac{2(1-\lambda)}{1+\lambda}$. Accordingly, he chooses the bid b, which satisfies:

$$Max_b \; (\frac{4}{1+\lambda}b - \frac{2(1-\lambda)}{1+\lambda})(v_2 - b)$$

The optimal bid is $b(v_2) = \frac{v_2}{2} + \frac{1-\lambda}{4}$. Therefore, B2's expected winning probability is $\frac{4}{1+\lambda}b(v_2) - \frac{2(1-\lambda)}{1+\lambda} = \frac{2}{1+\lambda}v_2 - \frac{(1-\lambda)}{1+\lambda} = Q_2^*(v_2)$; B1's expected winning probability is $\frac{1+\lambda}{2}v_1 + \frac{(1-\lambda)}{2} = Q_1^*(v_1)$.

Next, examine the expected ex-post payments from B1 and B2. B1 could purchase the asset at a price $\lambda/(1+\lambda)$ if B2 does not enter. Then, given $v_1 \geq \lambda/(1+\lambda)$, B1's expected payment is:

$$\frac{1}{2}\frac{\lambda}{1+\lambda} + \int_{1/2}^{\frac{1+\lambda}{2}v_1 + \frac{1-\lambda}{2}} \left(\frac{4}{1+\lambda}b(v_2) - \frac{2(1-\lambda)}{1+\lambda}\right)dv_2 = \frac{1+\lambda}{4}v_1^2 + \frac{2\lambda - \lambda^2}{4(1+\lambda)},$$

This equals to $T_1^*(v_1) = Q_1^*(v_1)v_1 - \int_0^{v_1} Q_1^*(x)dF(x)$. Similarly, B2's expected payment including the entry fee is

$$\frac{\lambda^2}{4(1+\lambda)} + (\frac{4}{1+\lambda} b(v_2) - \frac{2(1-\lambda)}{1+\lambda})(b(v_2)) = \frac{1}{1+\lambda} v_2^2 + \frac{2\lambda - 1}{4(1+\lambda)} = T_2^*(v_2).$$

Finally, it is easy to determine that B1's expected utility is positive if and only if $v_1 \geq \lambda/(1+\lambda)$; B2's expected utility is positive if and only if $v_2 \geq 1/2$. Therefore, this indirect contract implements S's optimal ex-ante contract with a direct revelation mechanism. At the same time, it satisfies B1's financial constraint. Q.E.D.

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