Strategic ex-ante contracts: rent extraction and opportunity costs

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This paper considers the possibility that a seller can contract with one uninformed buyer prior to an auction involving two potential buyers. The seller's optimal strategic ex-ante contract more accurately reflects joint opportunity costs of the seller and the contracted buyer, and therefore extracts more rent from the entrant. Moreover, this ex-ante contract mitigates the seller's ex-post rent-seeking vis-à-vis the contracted buyer. Accordingly, it may create more social welfare than the absence of ex-ante contracts, depending upon the contracted buyer's financial constraint and the distributions of trade surplus. Implementation of the optimal strategic ex-ante contract and policy implications are discussed.

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1. 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 right to buy Lasik if there were no competing offers, and required that any competing offers be at least 120% of ICON's strike price.[1] ICON also obtained the right of first refusal, meaning that ICON had the right to win the target by matching the terms of competing offers made by competing buyers. In return for granting ICON this privilege, Lasik received some "payments" – in the form of options to purchase certain shares of ICON's stock.[2]

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.[3] On 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 acquire additional 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 privately-informed buyers, and trade may not occur even if it could bring positive surplus.[4] These strategic ex-ante contracts appear to be anti-competitive or discriminatory -- they favor contracted buyers at the expense of subsequent competing buyers -- and they often are litigated[5] or emerge in policy debates.[6] 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.

The features of ex-ante contracts in facilitating future trade and extracting rent from entrants are not unique to pre-sales or pre-acquisition agreements, but also are observed in many long-term contracts, such as energy supply contracts, property rental contracts, executives' compensation contracts, and strategic alliance contracts. For example, energy supplies between pipeline companies and shippers face uncertainty about future trade surplus and firms may learn private information in future periods. Moreover, there often are future entrants. Long-term energy-supply contracts provide greater commitment to future trade than short-term contracts or spot markets do and, additionally, often use strategic terms such as rebates and the right of first refusal. These ex-ante contracts may include upfront transfers in cash or by other means, such as offering stocks or options and changing early periods' prices.

Formally, this paper considers a framework in which a single seller, having one indivisible asset to sell, faces two subsequent buyers. Trade always is more efficient than having no trade.[7]

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[1] The requirement for competing offers is only for Lasik's two biggest shareholders' shares.

[2] Feb. 12, 2001, CCN Disclosure

[3] In the ICON case, ICON might not have full information on its valuation of the target at the time of contracting. However, it could learn private information after contracting. During this time, third parties such as other acquirers might enter the scenario. This scenario is typical for many other contracts.

[4] Many auctions fail because sellers set high reserve prices. For example, in 2000, the Committee on Sugar Conversion and Auction held an auction with a high indicative price for the right to import sugar. However, private traders refused to submit import proposals. (July 27, 2000, Business World).

[5] Strategic contracts often are the subject of lawsuits, such as those involving remedy clauses for breaching contracts (Shavell, 1980, 1984; The Palgrave Dictionary of Economics and the Law, Stockton Press, 1998).

[6] For example, there are many policy debates on strategic energy supply contracts. The US Federal Energy Regulatory Commission (FERC) removed the term-match cap for the right of first refusal. Yet, the FERC has other regulations prohibiting certain strategic contracts (November 8, 2002, Platts Retail Energy).

[7] This assumption is made for simplicity. The results would extend to known costs at the time of contracting. If the seller has uncertain value for the asset or uncertain costs, ex-ante contracts might lead to ex-post inefficient trade with a negative surplus.

Before a second buyer enters the scenario, the seller can negotiate sale or pre-sale contracts with the first buyer, who is uninformed about his valuation for the asset and is financially constrained at the contracting stage.[8] After this, each buyer privately learns his valuation for the asset. If an ex-ante contract has been signed, the seller has to follow the contracted mechanism to sell the asset. Otherwise he can choose any mechanism with short-term monopoly power (for examples, see Myerson, 1981; Milgrom and Weber, 1982; McAfee and McMillan, 1987). This paper will examine the seller's optimal strategic ex-ante contract and, more importantly, its effects upon social welfare.

If there is no second buyer, in the absence of ex-ante contracts, the seller seeks rent from the privately informed buyer and this 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 requires 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 additional surplus.

If a second buyer does appear in the future, the seller's optimal strategic ex-ante contract still facilitates trade by mitigating his ex-post rent-seeking, vis-à-vis the first buyer. Moreover, this ex-ante contract, as opposed to the seller's optimal mechanism when there is no ex-ante contract, extracts more rent from the second buyer by creating a certain competitive advantage for the first buyer. This contract more accurately reflects joint opportunity costs[9] for the contracting parties when selling to the second buyer. Accordingly, this contract either forces the second buyer to pay more, or avoids jointly unprofitable trade with the second buyer.[10]

The seller and the first buyer could make an 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 also are restricted. The seller can implement his optimal ex-ante contract by combining some indirect contract clauses. None of the commonly used contract clauses, such as a fixed break-up fee, the non-compete clause, a stock lockup, by itself is optimal.

The seller's optimal ex-ante contract can have two effects upon social efficiency compared to the absence of ex-ante contracts. First, the contract facilitates more trade. Second, this optimal ex-ante contract affects the allocation between the two buyers, because the first buyer enjoys a competitive advantage. Both effects are enhanced when the first buyer is less financially constrained. Social policies should balance these two effects. The trade-off depends upon the first buyer's financial constraints and the distribution of trade surplus. The seller's optimal strategic ex-ante contract may increase social welfare. In particular, if all possible values of trade surplus are high enough, strategic ex-ante contracts are less efficient than the absence of ex-ante contracts. When the buyers' valuations follow a 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 low ex-ante wealth and if all possible values of trade surplus are not very high.

Policy makers or courts should consider this efficiency of ex-ante contracts in facilitating trade and, thereby, allow ex-ante contracts in certain circumstances. This paper also discusses more flexible policy choices and shows that the welfare effects of strategic ex-ante contracts are robust, when buyers have ex-post financial constraints and when the first buyer, ex-ante, learns private signals, as long as the signals are not very informative about his valuation.

This paper contributes to the literature on strategic contracts. Contracts can be used as strategic tools to deter entry or to extract rent from entrants. This proposition initially was made

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[8] If the first buyer had unlimited ex-ante wealth, the seller would simply make an ex-ante sale 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. Similar results hold with other contracting constraints.

[9] This is the first buyer's valuation in this paper.

[10] In the ICON case, the right of first refusal guaranteed that entrants' payment would be higher than the joint opportunity costs for ICON and Lasik. The option right restricts Lasik from ex-post rent-seeking.

by Aghion and Bolton (1987). Many other studies consider specific strategic clauses. Choi (2006), for example, vividly points out that the right of first refusal could be used to extract rent from entrants. Strategic contracts could mitigate hold-up problems and preserve incentives for relationship-specific investments, which may be a good justification for social efficiency of these contracts (Rogerson, 1984, 1992; Chung, 1991; Spier and Whinston, 1995; Che and Chung, 1999; Che and Hausch, 1999; Segal and Whinston, 2000; Hua, 2005; Che and Lewis, 2007). Strategic contracts also could facilitate early trade by imposing lower values on outside options (Matouschek and Ramezzana, 2007). Most of the above papers assume that the contracted buyer does not learn private information and that the seller has no ex-post commitment power.[11] In contrast, this paper considers that the contracted buyer can learn private information after contracting, and that the seller has ex-post monopoly power.[12] Furthermore, this paper analyzes strategic ex-ante contracts with a direct revelation mechanism.

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. Courty (2003) demonstrates that a monopolist would not sell both to informed and uninformed buyers. Courty and Li (2000) discuss the use of ex-ante contracts to screen buyers who have noisy information, ex-ante. These papers do not include entrants and assume that the seller can make long-term commitments. Instead, this paper considers strategic effects of ex-ante contracts against entrants. Moreover, the seller cannot make long-term commitments without ex-ante contracts.

Third, this paper discusses contracting or mechanism design when buyers have financial constraints and private valuations. Laffont and Robert (1996) derive the ex-post revenue-maximizing mechanism when different buyers have the same commonly-known budget. Malakhov and Vohra (2005) characterize a seller's revenue-maximizing mechanism when two buyers have discrete values and only one buyer is budget-constrained. Buyers also may have private information about their budgets (Che and Gale, 1996, 2000). Lewis and Sappington (2000, 2001), in principal-agent schemes, discuss contracting with agents who have private knowledge of their wealth and abilities. This paper examines the seller's optimal ex-ante contract with a direct revelation mechanism when the first buyer is financially constrained ex-ante. Moreover, the result that ex-ante contracts may increase social welfare is robust even if the buyers have ex-post financial constraints.

The next section presents the model. The third section illustrates the social welfare effects of strategic ex-ante contracts with a specific contract. The fourth section examines the seller's optimal strategic ex-ante contract, explores its effects on social efficiency, and illustrates its implementation through indirect clauses. The fifth section provides an assessment on robustness and more policy discussion. The last section offers concluding remarks. All proofs in this paper are in the appendix.

2. The model

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

[11] Choi (2006), and Che and Lewis (2007) discuss specific strategic clauses in given auctions when buyers learn private information. Other papers on strategic contracts include Noldeke and Schmidt (1995), Bulow, Huang, and Klemperer (1999), and Burch (2001).

[12] This paper is also related to collusion in auctions. Klemperer (1999) conducts surveys on the auction theory literature. The studies that have been done on collusion mostly consider collusion among bidders. In contrast, this paper addresses the optimal collusive contract between a seller and a bidder before auctions.

B1's and B2's valuations (v_1, v_2) of the asset are independently[13] drawn from distributions $F_1(v_1), F_2(v_2)$ on $[\underline{v}, \bar{v}]$, with monotone hazard rates: $H_i(v_i) = (1 - F_i(v_i))/f_i(v_i)$ 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 contracting stage. The timing is as follows:

At date 1: S and B1 have symmetric information,[14] and B1 has limited wealth, k.[15] 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.[16] The contract also includes an upfront transfer from B1 to S. If B1 accepts this 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;[17] if there is no ex-ante contract, S can choose any mechanism to sell the asset. At this time, if B1 or B2 wins the asset, he would have enough wealth to pay for it.[18] Their outside options are normalized to zero.

Without loss of generality, assume that S has all the bargaining power at the contracting stage and monopoly power at the selling stage.[19] 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 of the ex-ante contract either is impossible or too costly to maintain.[20]

This model assumes that neither S nor B1 has access to B2 at date 1. The contracting parties do not know who the entrants are. For example, in mergers and acquisitions, one buyer first identifies and approaches a target. This action itself would attract 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 future period, entrants may come from many potential buyers.[21]

Another assumption is that B1 is financially constrained at date 1. However, if he wins the asset at date 3, he will have enough wealth to pay S. This represents many scenarios. First of all, the capital market may not provide enough ex-ante financing, since the values and the control right are not realized ex-ante, while B1's budget or financing abilities may increase ex-post, especially after he controls the asset. Second, in long-term contracts such as supply contracts or

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[13] The common value of the asset is easier to be learned by all players. Therefore, the buyers' idiosyncratic values are crucial to the scenario. If the buyers' valuations are correlated and the buyers have limited liability, the intuition in this paper still holds. Further discussion will be in Section 5.

[14] When B1 has ex-ante private and noisy signals about his valuation, the results hold if his ex-ante signals are not so informative. Further discussion will be in Section 5.

[15] The model can be extended to have other contracting constraints, such as limited resale probabilities. Generally the resale probabilities are limited and the bargaining may not be efficient. Strategic ex-ante contracts still cause the trade-off of more trade and misallocation between the buyers.

[16] Direct revelation mechanisms would specify the winning probabilities and the payments of the buyers according to their reported valuations at date 3. The indirect mechanism may use contract clauses such as a breakup fee, the right of first refusal, an option, et cetera.

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

[18] However, the contract cannot force the buyers to make ex-post payments higher than their valuations.

[19] The results are not qualitatively affected so long as S has some market power ex-post.

[20] Note that B1 has private information after date 1. 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. Accordingly, the ex-ante contract could facilitate trade when ex-post renegotiation is not efficient.

[21] If S could contract with both buyers at date 1, his optimal ex-ante contract still would lead to more trade by mitigating ex-post rent-seeking.

property rental contracts, B1 may generate more ex-post wealth from transactions or operation in current periods. Third, firms often use equity or debt financing, and it takes time to finance from the capital market or banks. This is particularly true in mergers and acquisitions. A longer financing period would secure more capital, but other buyers would be more likely to enter. Therefore, many firms negotiate pre-sales or pre-acquisition contracts when they have limited capital. For example, in 2003, before its completion of $142 million financing, Enerplus Resources Fund signed a strategic pre-acquisition agreement with Ice Energy Limited.[22] In sum, there is no inconsistency between B1's ex-ante and ex-post financial constraints. Moreover, as will be discussed in Section 5, the results in this paper would not be changed qualitatively when the buyers have ex-post financial constraints.

Note that the ex-ante contract may include an upfront transfer from B1 to S. In reality, upfront payments depend more on buyers' ex-ante wealth and the bargaining power of S and B1. Upfront transfers can be in cash. For example, in 1998, Pioneer Natural Resources Company signed a pre-sales agreement with Costilla Energy, Inc., which provided Costilla with an exclusive option right to purchase certain oil and gas properties. Costilla paid Pioneer an irrevocable upfront cash payment of $41 million. In 1999, unable to raise enough financing, Costilla did not exercise the option.[23] Strategic alliance contracts also include upfront cash payments or adjustments of partners' equity stakes (for example, see Robinson and Stuart, 2007). Upfront transfers also can take other means such as stocks, options, or changing prices of current or side transactions. As in the ICON example, pre-acquisition agreements may offer sellers options, stocks or remedy protections. Long-term energy-supply or property rental contracts can require different prices for current period transactions when offering contracted buyers commitment or strategic clauses with respect to future periods.

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.[24] Moreover, this model assumes that there is no 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 facilitate trade and to extract rent from entrants.

3. Illustration--the ex-ante contract with right of first refusal and no reserve price

To illustrate the effects of strategic ex-ante contracts, this section considers one specific contract. The contract requires that B1 pays 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. Moreover, the contract specifies that S cannot set ex-post reserve prices. For simplicity, this section assumes that v_1 and v_2 are drawn independently from the uniform distribution on $[0,1]$ and that B1 has limited wealth of 5/24 at date 1. 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.

As a benchmark, if there is no ex-ante contract, S can choose any mechanism at date 3. As shown in the literature, S's optimal selling mechanisms are equivalent to the first-price or second price auction with a reserve price of 1/2 for each buyer. The expected utilities for S, B1 and B2 are (5/12, 1/12, 1/12). The social welfare, then, is 7/12. There is social loss when $v_1 < 1/2$ and $v_2 < 1/2$. But there is no misallocation loss between B1 and B2.

[22] November 17, 2003, Market News Publishing

[23] April 19, 1999, Platt's Oil gram News

[24] The fact that prices are not finalized is not unique to pre-sale agreements. In many long-term contracts, only short-period prices are specified. Re-opener clauses, for example, allow contracted parties to negotiate future-period prices.

With the ex-ante contract, B1 has the right of first refusal and S cannot impose ex-post reserve prices. Walker (1999) discusses some potential reasons for using the right of first refusal. Choi (2006) compares the right of first refusal to standard private-value auctions without reserve prices. In these standard auctions, B2 would win the asset so long as his valuation is higher than B1's valuation. However, Choi (2006) 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. As a result, there is the possibility of misallocation of the asset. The following proposition illustrates Choi's findings.

Proposition 1: Assume that 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, and the optimal upfront transfer to S is 5/24. At date 3, B2 bids $b_2 = v_2/2$. B1 would exercise the right of first refusal if and only if $v_1 \geq b_2$. If B1 does not exercise the right, B2 wins and pays b_2. The expected utilities for S, B1 and B2 are (11/24, 1/12, 1/12). There is misallocation when $v_2/2 < v_1 < v_2$.

Choi (2006)'s analysis, however, does not consider the optimal mechanism that S would choose at date 3 in the absence of an ex-ante contract. As in the benchmark case, S seeks rent vis-à-vis B1 and B2 by specifying reserve prices. In contrast, the ex-ante contract mitigates S's ex-post rent-seeking. In this illustration, S commits not to set reserve prices. Thus, there always is trade. This additional trade value dominates the misallocation loss.[25]

Corollary 1: Assume that 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 no reserve price is socially more efficient than the absence of ex-ante contracts. The social welfare is 15/24.

In sum, this ex-ante contract has two characteristics. First, it gives B1 a strategic advantage against B2. This advantage, the right of first refusal, guarantees that, if B2 wins, his payment is higher than the joint opportunity cost v_1 for S and B1. Second, this ex-ante contract mitigates S's ex-post rent-seeking. Accordingly, there are two effects on social efficiency: affecting the allocation between the buyers and facilitating more trade. However, this specific contract may not be the optimal strategic ex-ante contract for S. 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.

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 and its effects on social welfare. Then the section provides examples of how to implement S's optimal contract using indirect clauses.

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

First, note that, if there is no financial constraint for B1, S would require an appropriate upfront transfer and make B1 the residual claimant of any revenue generated at date 3. At date 3, B1 offers a monopoly price to B2 based upon his own valuation. If B2 accepts the price, then B1 receives the full payment from B2. Otherwise, B1 owns the asset. In this case, there may be misallocation due to B1's ex-post monopoly power. Moreover, trade always happens.

[25] Policy makers or courts may not be able to ban the use of reserve prices or strategic clauses, since they may not have enough information on such issues as sellers' costs. More discussion is in Section 5.

Next, when B1 faces an ex-ante financial constraint, S's optimal ex-ante contract would include two parts: (1) an upfront transfer, t_0, to be made from B1 to S at date 1; and (2) a direct revelation mechanism to be used at date 3. Each buyer, Bi, is asked to report his valuation. Given the reports (v_1, v_2), the mechanism specifies Bi's winning probability, $q_i(v_1, v_2)$, and Bi's ex-post payment to S, $t_i(v_1, v_2)$. The following notations are used: $Q_i(v_i)$ is Bi's expected winning probability, given his report v_i; $T_i(v_i)$ is Bi's expected ex-post payment to S, given his report v_i; $V_i(v_i)$ is Bi's interim expected utility; and V_0 is B1's e ex-ante expected utility if there were no ex-ante contracts. Note that $Q_i(v_i) = E_{v_j}[q_i(v_i, v_j)]$ and $V_i(v_i) = Q_i(v_i)v_i - T_i(v_i)$.

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 $(t_0^*, Q_i^*(v_i), T_i^*(v_i))$.[26]

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

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)

The first individual rationality constraint assumes that, at date 3, S cannot force each buyer to pay a transfer higher than the buyer's valuation. The incentive compatibility constraint guarantees truth telling from each buyer. Moreover, the ex-ante individual rationality constraint makes this contract accepted by B1, and the financial constraint restricts the upfront transfer.

It can be shown that the ex-ante individual rationality constraint is binding, otherwise S always could increase the upfront transfer and/or change B1's winning probability $Q_1^*(v_1)$. Let $\lambda = \lambda(k)$ be the multiplier corresponding to the ex-ante individual rationality constraint. With the standard mechanism design approach, integrating the seller's problem by parts and substituting $Q_i(v_i) = E_{v_j}[q_i(v_i, v_j)]$ in:

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

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.

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

[26] If there are solutions to the problem with interim individual rationality constraints using expected payment functions $T_i(v_i)$, then there exist $t_i(v_1, v_2)$, which solve the ex-post individual rationality constraints. .

Define $g_i(v_i;\lambda)=v_i-\lambda(1-F_i(v_i))/f_i(v_i)$ as the λ-adjusted virtual utility and $r_i^*(k)$, or $r_i^*(\lambda(k))$, as the value that satisfies $g_i\left(r_i^*(\lambda(k));\lambda(k)\right)=0$. In fact, $\lambda=\lambda(k)$ is the shadow price of B1's expected utility at date 3. Given k, B1 could make an 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 is adjusted by this shadow price. The following proposition presents S's optimal strategic ex-ante contract.

Proposition 2: S's optimal strategic 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 ex-post 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, i.e., $q_2^*(v_1,v_2)=1$; otherwise, $q_2^*(v_1,v_2)=0$.

Corollary 2: Rewrite the winning probabilities as $q_i^*(v_1,v_2;k)$ and $Q_i^*(v_i;k)$. In S's optimal ex-ante contract with a direct revelation mechanism:

(i) B1's expected winning probability $Q_1^*(v_1;k)$ is non-decreasing in k and higher than that if there were no ex-ante contracts; B2's expected winning probability $Q_2^*(v_2;k)$ is non-increasing in k and lower than that if there were no ex-ante contracts.

(ii) The probability of having trade is non-decreasing in k and higher than the probability of trade 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 mechanism as if there were no ex-ante contracts.

According to Corollary 2, if B1 has more ex-ante wealth to make a higher upfront transfer, the shadow price would be lower. Accordingly, B1's adjusted virtual utility is higher. This is significant in two ways: first, B1's adjusted virtual utility is more likely to be positive, thereby increasing the probability of trading with B1; and second, B1's adjusted virtual utility is more likely to be higher than B2's virtual utility. Note that S and B1 have a joint opportunity cost, v_1, when selling the asset to B2. If the shadow price is lower, B1's adjusted virtual utility is closer to v_1. This strategic characteristic is similar to the right of first refusal, since both mechanisms more accurately reflect the joint opportunity cost, v_1, for S and B1.

Figure 1 shows the equilibrium outcome with S's optimal strategic ex-ante contracts, when B1 faces different ex-ante financial constraints.

If k=0, effectively there is no ex-ante contract. Ex-post, S seeks rent from privately informed B1 and B2. Accordingly, there is no trade in region L+M+N. In region O+P+Q, B2 wins, and S and B1 have a joint opportunity cost equal to v_1. However, in some areas of region O+P+Q, B2

may pay less than or no larger than v_1.[27] 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 S and B1 look for their individual benefits non-cooperatively.

If $k = k_L > 0$, B1 makes an upfront transfer and S commits to mitigate his ex-post rent-seeking vis-à-vis B1. In region N, trade occurs and increases the joint surplus for S and B1. Moreover, B1 has a competitive advantage, so that the mechanism more accurately reflects the joint opportunity cost v_1. Thus, S and B1 avoid jointly unprofitable trade with B2 in region Q, that might happen when k=0, or makes B2's expected payment higher in region O+P.[28] Overall, S's optimal ex-ante contract is more profitable for the joint surplus of S and B1. As in Figure 1, both effects are enhanced when B1 has more wealth.

Social efficiency

As shown above, S' optimal strategic ex-ante contract, first of all, reduces the deadweight loss of having no trade by mitigating his ex-post rent seeking vis-à-vis B1. Second, this contract gives B1 competitive advantage and therefore may cause misallocation between B1 and B2. For example, in Figure 1, B1 wins in region Q even if his valuation is less than B2's valuation. The next proposition summarizes these social welfare effects and presents a comparative static analysis when B1's ex-ante financial constraint changes.

Proposition 3: S's optimal ex-ante contract induces a higher probability of trade than the absence of an ex-ante contract does, and may cause misallocation between the two buyers. (i) The social welfare created from the additional trade is non-decreasing in B1's ex-ante wealth, k. (ii) If B1's and B2's valuations are identically distributed, the misallocation loss is larger when B1 has more ex-ante wealth. (iii) Either of the two effects may dominate. In particular, suppose that v_1 and v_2 are drawn from a uniform distribution, then there exists a unique $\hat{k} \geq 0$, such that S's optimal ex-ante contract is more efficient than the absence of ex-ante contracts, if and only if $k \leq \hat{k}$.

As exhibited in Figure 1, the additional trade created by the contract happens in the range of smaller valuations, while misallocation may happen in the range of higher valuations. When B1's ex-ante wealth k is small, for the uniform distribution, the value created from more trade is higher than the misallocation loss, because the misallocation is less likely to happen. 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 courts may allow strategic ex-ante contracts, especially when the contracting parties are financially-constrained. They also may restrict the level of upfront transfers that are specified in contracts. One may argue that it would be more efficient not to allow strategic contracts or reserve prices. However, in practice, policy makers might not be able to do so. For example, they may not have information about the seller's costs. More discussion will be in Section 5.

The social welfare effects of S's optimal ex-ante contract also depend upon the distributions of trade surplus, as shown in the following proposition:

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[27] For example, in the first price auction, B2's payments may be less than v_1. In the second price auction, B2's payment always is equal to v_1.

[28] This comparison depends upon which specific mechanism is used in the absence of ex-ante contracts.

Proposition 4: Suppose that the distributions of the buyers' valuations shift from $[\underline{v}, \bar{v}]$ to $[\underline{v}+\Delta, \bar{v}+\Delta]$, 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 $\hat{\Delta} \geq 0$ such that S's optimal ex-ante contract is less efficient than the absence of ex-ante contracts, if $\Delta \geq \hat{\Delta}$. If v_1 and v_2 are drawn from a 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 $\Delta \geq \hat{\Delta}$.

When the trade surplus is distributed throughout ranges of higher values, S will increase the probability of trade, even when there is no ex-ante contract. Therefore, policy makers 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: if each buyer's valuation is drawn from the uniform distribution on $[0,1]$, S's optimal strategic ex-ante contract always is more efficient than the absence of ex-ante contracts; if each buyer's valuation is drawn from the uniform distribution on $[1,2]$, S's optimal strategic ex-ante contract is less efficient than the absence of ex-ante contracts.

Implementation by indirect contract clauses—the case of uniform distribution

Thus far, S's optimal ex-ante contract with a direct revelation mechanism has been examined. It also is interesting to show how to implement the optimal ex-ante contract by indirect contract clauses. It is easy to show that the right of first refusal alone does not implement S's optimal ex-ante contract. In practice, many strategic ex-ante contracts use combinations of several clauses. The following proposition shows one example of S's optimal indirect contracts.

Proposition 5: Assume that v_1 and v_2 are drawn independently from the uniform distribution on $[0,1]$. The shadow price in S's optimal ex-ante contract $\lambda = \lambda(k)$ satisfies $1/[3(1+\lambda)^2] = \min(k, 1/4) + 1/12$. The following contract with indirect clauses is 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 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 $\lambda^2/[4(1+\lambda)]$ 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 negative) $[(3-\lambda)/(1+\lambda)]b - 2(1-\lambda)/(1+\lambda)$.

In the optimal indirect contract above, if B2 does not enter, the strike price in the option serves as a reserve price for B1. Besides, this adjusted right of first refusal gives B1 a competitive advantage and, accordingly, the joint opportunity cost for S and B1 is reflected more accurately. The entry fee for B2 is selected merely to create the optimal reserve price for B2.

There are many other commonly used indirect contract clauses. When buyers learn private information ex-post, it could be shown that break-up fees, stock lockups or toeholds, and the right of first offer may not have strategic characteristics similar to S's optimal strategic ex-ante contract, while options, non-compete clauses, and the right of first refusal do.[29]

Take breakup fees as an example. Aghion and Bolton (1987) analyze the use of a break-up fee to extract rent from an entrant. In their model, B1's valuation is 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

[29] Detailed discussion of each of these clauses is available upon request.

breach the contract. However, this may not be true when the buyers learn private values ex-post. Suppose that S and B1 sign a contract specifying that. S would hold the English auction at date 3, and would pay a breakup fee, *d,* to B1 when B1 fails to obtain the asset or when S breaches the contract. Assume that B1's and B2's valuations are drawn from the uniform distribution on $[0,1]$. In the English auction, B1's and B2's optimal bidding strategies are $b_1 = v_1 - d$ and $b_2 = v_2$. The break-up fee makes B1 less aggressive in auctions. Therefore, the break-up fee itself does not have strategic characteristics similar to S's optimal ex-ante contract.

In sum, S's optimal ex-ante contract mitigates his ex-post rent-seeking vis-à-vis B1 and has strategic characteristics by more accurately reflecting their joint opportunity costs. This contract may cause misallocation between the buyers, but also can facilitate more trade. Allowing the use of strategic ex-ante contracts may be more efficient than strictly prohibiting their use. Finally, this contract could be implemented through a combination of commonly used clauses.

5. Robustness and policy discussions

Ex-ante and ex-post financial constraints

Previous sections have followed the framework in which the contracted buyer does not have ex-post, but ex-ante financial constraint. It also assumes that the financial constraint is common knowledge. As discussed in section 2, this framework represents many scenarios. Interestingly, ex-post financial constraints will not change the results qualitatively.

Laffont and Robert (1996) solve the ex-post revenue-maximizing mechanism when buyers have private valuations and the same commonly-known budget. Maskin (2000) considers ex-ante efficiency in the same framework. Malakhov and Vohra (2005) characterize the ex-post revenue-maximizing mechanism when two buyers have discrete valuations, and only one buyer is budget constrained.[30] All these mechanisms use reserve prices, though the reserve prices are lower and less effective in extracting rent from privately-informed buyers than they are in the absence of financial constraints. Moreover, these ex-post mechanisms may cause misallocation between the buyers because the seller cannot extract more than the buyer's budget and the seller may distort allocation to extract more rent from the buyer who has deeper pockets.

Intuitively, ex-ante contracts still can mitigate S's ex-post rent-seeking such as using reserve prices vis-à-vis B1. This effect facilitates more trade. In addition, these contracts may not cause too much misallocation, since financial constraints restrict ex-post rent-seeking vis-à-vis B2. The following example shows that S's optimal ex-ante contracts may be more efficient than the absence of ex-ante contracts, even when the buyers have ex-post financial constraints.

Suppose that B1's and B2's private valuations, v_1 and v_2, are drawn independently from the uniform distribution on $[0,1]$ and that both buyers have limited wealth, 1/2, both ex-ante and ex-post.[31] The timing is the same as in Section 2.

If there is no ex-ante contract, using the approach in Laffont and Robert (1996), it can be shown that the seller's optimal ex-post direct revelation mechanism is: when both buyers' reported valuations are larger than $v^* \approx 0.7747$, the asset is allocated with equal probability to the buyers; otherwise, the buyer with a higher valuation wins the asset if and only if his valuation is greater than a reserve price, $r \approx 0.4746$. Note that there may be misallocation between the two buyers when they both have high valuations. S's expected utility is $U_0 \approx 0.3710$ and B1's expected utility is $V_0 \approx 0.1131$. The social welfare is $W_0 \approx 0.5972$.

[30] Characterizing the revenue-maximizing mechanism continues to be a complex problem when budget-constrained buyers have continuous and negative virtual values, and when there are more than two buyers.
[31] The intuition in this example still holds if the buyers have different budgets.

If S and B1 sign an ex-ante contract, S's optimal contract is: ex-ante B1 pays 0.4494 to S and becomes the residual claimant; ex-post B1 can post a take-it-or-leave-it price to B2. Note that ex-post B1 cannot post the monopoly price $(1+v_1)/2$. Instead, it is optimal to set the price at B2's budget 1/2 if and only if $v_1 < 1/2$. There is no reserve price for B1, so trade always happens. And there is more misallocation loss than in the absence of ex-ante contracts. Moreover, The expected utility for S and B1 is $U + V_1 = 0.5625$, and the social welfare is $W = 0.625$, higher than in the absence of ex-ante contracts.

Another question on financial constraints is whether they are privately known by the buyers or commonly observed. In many situations, firms' financial positions and abilities to finance in the capital market are publicly disclosed or can be evaluated. For example, in mergers and acquisitions, acquirers' payment or financing abilities often are endorsed by banks or evaluated by sellers when pre-acquisition agreements are signed. However, the potential trade values for buyers are difficult for sellers to assess. For example, acquirers' private estimation of their expected market performance and organization synergies is not available to sellers.

Che and Gale (1996) compare a seller's revenue in various auctions when buyers have private information about their budgets. Che and Gale (2000) construct the ex-post revenue-maximizing mechanism when there is one single buyer with private valuation and a private budget. This mechanism may include reserve prices. Therefore, if the buyer does not know his private valuation and private budget at the ex-ante stage, ex-ante contracts still may increase social welfare. This may not be true when, ex-ante, the buyer learns his private budget.

Ex-ante noisy information

The assumption that S and B1 have symmetric information at the ex-ante stage represents many scenarios. For example, in long-term energy supply contracting, pipeline companies and shippers often do not know market situations in future periods, but they may learn private information in their current transactions. In negotiating biotech strategic alliance contracts, clients and R&D partners are uncertain about future benefits, but R&D partners may learn private information later on (for example, see Robinson and Stuart, 2007). In mergers and acquisitions, sellers and acquirers often share their data and information before entering into pre-acquisition agreements. After then, acquirers may learn private valuations by conducting independent evaluations and by seeking approval from shareholders.

In some scenarios, the buyer B1 may have private but noisy signals about his valuation ex-ante. Then, at the contracting stage, S uses ex-ante contracts to screen B1's types and extract rent from B1. Therefore, S and B1 may not reach an ex-ante contract.

However, ex-ante contracts still can mitigate S's ex-post rent-seeking vis-à-vis B1, since ex-post they have more asymmetric information. One related paper is by Courty and Li (2000). In their paper, a seller will set lower reserve prices in ex-ante contracts, when buyers' ex-ante private signals are less informative. However, in their paper, there are no entrants and the seller can make long-term commitments. In contrast, this paper considers the scenario whereby the seller cannot make such long-term commitments without ex-ante contracts, and there are entrants.

The following example shows that, as long as B1's ex-ante noisy signals are not too informative, strategic ex-ante contracts still may increase social welfare. Suppose that v_1 and v_2 follows the uniform distribution on $[0,1]$ and ex-ante B1 privately knows whether v_1 is in the low range [0, 9/10) or in the high range [9/10, 1]. The timing is the same as in Section 2. Without loss of generality, assume that B1 is not financially-constrained.

Without ex-ante contracts, S's optimal ex-post mechanism is equivalent to the second price auction with a reserve price ½. S's expected utility is 5/12. B1's expected utility is $38/675 \approx 0.0563$ if $v_1 \in [0, 9/10]$ and is $49/150 \approx 0.3267$ otherwise. The social welfare is 7/12.

If S offers a menu of ex-ante contracts and B1 always accepts one, S could have different off-equilibrium beliefs about the distribution of B1's valuation. For simplicity, suppose S believes that v_1 is uniformly distributed on [0,1] in any off-equilibrium path.[32] Consider the following offer: ex-ante, B1 purchases at a price $t_H \approx 0.4870$, and ex-post he can post a monopoly price and resell it to B2; or ex-ante B1 pays $t_L \approx 0.2362$ and the ex-post direct revelation mechanism uses this allocation rule -- B1 wins the asset when $9/10 \geq v_1 \geq 2v_2 - 1$; otherwise B2 wins. B$i$'s expected ex-post payment is $Q_i^*(v_i)v_i - \int_{\underline{v}}^{v_i} Q_i^*(x)dx$, where $Q_i^*(v_i)$ is Bi's expected winning probability.

The above contract offer maximize the joint surplus for S and B1, since there always is trade and B2 wins only if his virtual utility is greater than the joint opportunity cost, v_1, for S and B1. In equilibrium, when $v_1 \in [0, 9/10]$, B1 will pay t_L. B1's expected utility is 0.0563, the same as in the absence of ex-ante contracts. When $v_1 \in [9/10, 1]$, B1 will pay t_H and ex-post offer the price $(1+v_1)/2$ to B2. B1's expected utility is 0.4638, the same as if he deviates to choose t_L. S's expected utility is 0.4863, larger than his expected utility in the absence of ex-ante contracts. B1's expected utility is also higher than that in the absence of ex-ante contracts. Moreover, the social welfare is 5/8, larger than that observed in the absence of ex-ante contracts.

In sum, if B1's ex-ante private signal is not very informative, S and B1 can sign strategic ex-ante contracts and these contracts may increase social welfare. This may not be true if B1's ex-ante private information is too informative. In the above example, if B1 knows, ex-ante, whether his valuation is in [0, 1/2] or [1/2, 1], then S has no incentives to offer ex-ante contracts which can induce a separating equilibrium.

Correlated valuations

This paper considers buyers' independent valuations. In many scenarios, the common value of an asset is more easily learned by all players and therefore the buyers' idiosyncratic values are crucial. Some empirical research finds that, in certain auctions, an independent-private-value paradigm is a more probable scenario (for example, see Sareen, 2003). Moreover, when the buyers have correlated valuations, the strategic effects of ex-ante contracts still hold. The literature on strategic contracts has addressed specific contract clauses in models with correlated valuations (for examples, Choi, 2006; Che and Lewis, 2007).

The question is whether strategic ex-ante contracts still mitigate ex-post rent-seeking, such as reserve prices, if buyers' valuations are correlated. The literature shows that, ex-post, a seller can extract the entire surplus from buyers whose valuations are statistically correlated, and that efficient trade always happens (Cremer and Mclean, 1988; McAfee and Reny, 1992). However, these results of full surplus extraction depend upon the seller being able to impose high punishment upon the buyers. In fact, these results may not occur when buyers have limited liability or risk aversion (Robert, 1991). In many situations, as noted in this paper, buyers have financial constraints. Moreover, even ex-post they cannot be forced to pay higher than their valuations. Therefore, without ex-ante contracts, the seller has incentives to do ex-post rent-seeking by using reserve prices. Accordingly, ex-ante contracts still can facilitate more trade.

Policies on strategic ex-ante contracts

Policy debates and lawsuits on strategic contracts argue that these contracts reduce social welfare, because the strategic effects often deter competition and cause asset misallocation.

[32] The results would not be affected qualitatively as long as S believes that, in the off-equilibrium path, there is some probability for B1's valuation to be in the high range.

However, as shown in this paper, strategic ex-ante contracts may facilitate more trade and increase social welfare by mitigating ex-post rent-seeking between contracting parties. In particular, if the buyers' valuations follow the uniform distribution, S's optimal ex-ante contracts increase social welfare when the distribution of trade surplus is not in ranges of high values and/or when B1's ex-ante financial constraint is tight. Therefore, policy makers should consider such efficiency in facilitating more trade, and may support ex-ante contracts.

One natural question is why policy makers could not simply ban the use of ex-post reserve prices or other ex-post rent-seeking. First of all, if a seller can make investments to increase trade surplus, then banning reserve prices would reduce his incentives for investments. Second, policy makers or judges may not have information on the seller's costs and cannot identify different ways of ex-post rent-seeking. In this case, if only the seller and buyers observe the seller's costs, it may be efficient for policy makers to allow reserve prices. If only the seller privately observes his costs ex-post, then comparisons of ex-ante contracts, ex-post rent-seeking mechanisms, and mechanisms without reserve prices would be ambiguous. Further research should be done with such double-sided private information.

The following example shows that banning reserve prices may not be socially efficient. Suppose that the seller, S, sells an asset to one single buyer, B1.[33] B1's valuation follows the uniform distribution on [0,1], while S's cost is 0 with a probability of 1/3 and 1/2 with a probability of 2/3. Ex-post, S privately learns his cost and B1 privately learns his valuation. If there is no ex-ante contract, ex-post S specifies a mechanism of selling the asset to B1.

If no reserve prices are allowed, there would be inefficient trade when S's cost is 1/2 while B1's valuation is less than 1/2. The expected social loss is 1/12.

If there is no ex-ante contract and S can use reserve prices ex-post, according to his cost, S would offer a monopoly price at either 1/2 or 3/4. Therefore, trade may not happen and the expected social loss is 3/48, lower than 1/12.

In contrast, consider this ex-ante contract: ex-ante B1 pays 1/2; ex-post, S either delivers the asset, or refunds the upfront payment and asks for a take-it-or-leave-it price of $1-\sqrt{3}/4$. It can be shown that, in equilibrium, S would adjust the price only if his cost is ½. Compared to the absence of ex-ante contracts, this contract gives B1 the same expected utility, offers S a higher expected net utility $(1+2\sqrt{3})/24$, and reduces the social loss to $(7-4\sqrt{3})/48$.

Another question is whether policy makers could allow only ex-ante contracts without strategic or discriminative clauses. By definition, strategic or discriminatory contracts create different competitive advantages for buyers from those without these contracts. However, policy makers may lack information to identify whether contract clauses are strategic. Even if they can, it may not be efficient to suppress such contracts. For example, the literature shows that strategic contracts may protect relationship-specific investments. Besides, if there are contracting costs for S and B1, strategic contracts might increase their incentives for ex-ante contracting. Moreover, buyers may be heterogeneous with different distributions of valuations. The following example shows that non-discriminatory contracts may be less efficient than discriminatory contracts.

Assume that the buyers' valuations are not identically distributed: $F_1(v), F_2(v)$ satisfy $\lambda[1-F_1(v)]/f_1(v)=[1-F_2(v)]/f_2(v)$. When only non-discriminatory contracts are allowed, B1 would win the asset only if $v_1-[1-F_1(v_1)]/f_1(v_1)\geq v_2-[1-F_2(v_2)]/f_2(v_2)$. Clearly there may be misallocation between the buyers. Conversely, S's strategic ex-ante contract with a shadow price, λ, would not lead to misallocation, since $v_1\geq v_2$ is equivalent to $v_1-\lambda[1-F_1(v_1)]/f_1(v_1)\geq v_2-[1-F_2(v_2)]/f_2(v_2)$.

[33] The intuition can be generalized to the case with multiple buyers and entrants.

6. Conclusions

This paper has examined strategic ex-ante contracts between a seller and an ex-ante financially-constrained buyer, and their effects on social welfare. After the time of contracting, a second buyer enters and the buyers can learn private information. Compared to the absence of ex-ante contracts, the seller's optimal strategic ex-ante contract mitigates his ex-post rent seeking, vis-à-vis the contracted buyer, and facilitates more trade. Moreover, this contract extracts more rent from the entrant by more accurately reflecting the contracting parties' joint opportunity costs. This strategic effect may cause misallocation between the buyers. Both the additional trade value and the misallocation loss increase when the contracted buyer is less financially constrained.

In general, the seller's optimal strategic ex-ante contracts may increase social welfare, depending upon the distribution of trade surplus and the contracted buyer's financial constraints. Policy makers or courts should consider the efficiency of strategic ex-ante contracts in facilitating trade, and may allow ex-ante contracts in certain circumstances. These welfare effects are robust when the buyers have ex-post financial constraints and when, ex-ante, the contracted buyer learns private but not very informative signals about his valuation. The seller's optimal strategic ex-ante contract with a direct mechanism can be implemented by indirect clauses.

This paper has several empirical implications. First of all, upfront transfers in ex-ante contracts would be larger when these contracts provide more commitment to future trade and contracted buyers have more favored strategic clauses. Robinson and Stuart (2007) show that, in biotech strategic alliance contracts, 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. Secondly, the strength of commitment and strategic clauses tends to be positively related to contracted buyers' financial conditions. Finally, the use of strategic ex-ante contracts depends upon ex-post information asymmetry between contracting parties and the possibility of entry.

Several extensions would be meaningful for future research. First, strategic ex-ante contracts can protect relationship-specific investments or information acquisition efforts. Facilitating more trade, ex-ante contracts may provide more investment incentives. Secondly, if a seller has multiple units for sale, such as in the energy-supply industry, strategic ex-ante contracts also may cause quantity distortions. Thirdly, it is interesting to examine ex-ante contracts when contracted buyers have ex-ante private information about their financial constraints, and when there are other contracting constraints. Finally, it is meaningful to explore the optimal scope of commitment in ex-ante contracts when contracting parties can learn ex-post private information.[34]

Appendix

Proof of Proposition 1 and Corollary 1:

If there is no ex-ante contract, as shown in the literature, the seller's optimal ex-post mechanism is equivalent to the first price or second price auctions with a reserve price of 1/2. And it is easy to derive that the expected utilities for S, B1 and B2 are (5/12, 1/12, 1/12). The social welfare is 7/12.

If the specific ex-ante contract is offered, B1 would exercise the right of first refusal whenever his valuation is higher than B2's bid, i.e., $v_1 \geq b_2$, so that B2's winning probability is $F(b_2) = b_2$. 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 win if $v_1 \geq 1/2$ and pay the bid made by B2. He would win with a probability $2v_1$ if $v_1 < 1/2$. The players' expected utilities and the social welfare are:

[34] Hart and Moore (2004) address ex-ante contracts in which firms do not specify their actions even if these actions are verifiable. For example, professional service contracts between large institutions and small contactors often do not specify the scope of services.

$$U = \int_0^{1/2} \left\{ \int_0^{2v_1} v_1 dv_2 + \int_{2v_1}^1 (v_2/2) dv_2 \right\} dv_1 + \int_{1/2}^1 v_1 dv_1 - V_1 = 11/24$$

$$V_1 = \int_{1/2}^1 (v_1 - \int_0^1 (v_2/2) dv_2) dv_1 + \int_0^{1/2} \int_0^{2v_1} (v_1 - v_2/2) dv_2 dv_1 - 5/24 = 1/12$$

$$V_2 = \int_0^{1/2} \left\{ \int_{2v_1}^1 (v_2 - v_2/2) dv_2 \right\} dv_1 = 1/12$$

$$W = U + V_1 + V_2 = 15/24. \qquad \textit{Q.E.D.}$$

Proof of Proposition 2 and Corollary 2:

The winning conditions for the buyers in Proposition 2 follow directly from maximizing S's reduced-form problem point-wise. It remains to be verified that $Q_i^*(v_i)$ is indeed non-decreasing. 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 that 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, 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, $Q_1^*(v_1; k) < Q_1^*(v_1; k')$. However, according to the ex-ante individual rationality constraint, $0 = \{\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{v} Q_1^*(x; k) dx dF_1(v) - k - V_0\} < \{\int_{\underline{v}}^{\bar{v}} \int_{\underline{v}}^{v} Q_1^*(x; k') dx dF_1(v) - k' - V_0\} = 0$. 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 are no ex-ante contracts.

From the above analysis, $q_1^*(v_1, v_2; k)$, or $Q_1^*(v_1; k)$ correspondingly, is non-decreasing in k and $Q_1^*(v_1; k) \geq Q_1^*(v_1; k = 0)$; $q_2^*(v_1, v_2; k)$, or $Q_2^*(v_2; k)$ correspondingly, is non-increasing in k and $Q_2^*(v_2; k) \leq Q_2^*(v_2; k = 0)$. Moreover, it is easy to show that the probability of trade is non-decreasing in k. Finally, S's expected utility is non-increasing in λ or, equivalently, non-decreasing in k. *Q.E.D.*

Proof of Proposition 3:

Part (i): 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 $r_i^*(k) = r_i^*(\lambda(k))$ such that $r_i^*(\lambda(k)) f\left(r_i^*(\lambda(k))\right)/\left(1-F\left(r_i^*(\lambda(k))\right)\right) = \lambda(k)$. Thus, the optimal ex-ante contract creates trade value $\Delta W_+(k) = F_2\left(r_2^*(0)\right)\int_{r_1^*(k)}^{r_1^*(0)} v_1 dF_1(v_1)$. When differentiated with respect to k ,

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

The last inequality follows from the monotone hazard rate and $\lambda'(k) \leq 0$ by Proposition 2.

Part (ii): The optimal ex-ante contract creates 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 $\delta = \delta(v;k)$, such that $v - \delta - \lambda(1-F(v-\delta))/f(v-\delta) = v - (1-F(v))/f(v)$. Clearly, $\delta(v;k) \geq 0$. The absolute value of misallocation loss is $\Delta W_-(k) = \int_{r_2^*(0)}^{\bar{v}} \left\{\int_{v_2-\delta(v_2;k)}^{v_2} (v_2 - v_1)dF(v_1)\right\} dF(v_2)$.

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

The last inequality follows from the monotone hazard rate and the result $\lambda'(k) \leq 0$.

Part (iii): For the uniform distribution, it is sufficient to prove the case for which $\bar{v} - \underline{v} = 1$.[35] 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 $\lambda \geq \underline{v}$, $L(\lambda) = \int_{\underline{v}}^{\frac{\lambda(1+\underline{v})}{(1+\lambda)}} \left\{\int_{\underline{v}}^{v_1} v_1 dv_2 + \int_{v_1}^{\frac{1+\underline{v}}{2}} v_2 dv_2\right\} dv_1 + \int_{\frac{\lambda(1+\underline{v})}{(1+\lambda)}}^{1+\underline{v}} \left\{\int_{v_1}^{\frac{1+\lambda}{2}v_1 + \frac{(1-\lambda)(1+\underline{v})}{2}} (v_2 - v_1)dv_2\right\} dv_1$

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

Note that $\lambda \in [0,1]$. If $\lambda < \underline{v}$, then $L'(\lambda) = -(1-\lambda)/12 \leq 0$. Second, if $\lambda \geq \underline{v}$, $\frac{dL(\lambda)}{d\lambda d\lambda} = \frac{1}{12}(1+\underline{v})^3 \left\{\frac{(10-12\underline{v}/(1+\underline{v})) - 2(7-12\underline{v}/(1+\underline{v}))\lambda}{(1+\lambda)^4}\right\}$, which is positive for a smaller $\lambda \geq \underline{v}$ and becomes negative when λ is larger than a threshold. This is because $\underline{v}/(1+\underline{v}) \leq 1/2$ given $1 \geq \lambda \geq \underline{v}$. Furthermore, when $\lambda = 1$, it is easy to show that $\frac{dL(\lambda)}{d\lambda} \geq 0$.

[35] All results hold for a more general uniform distribution on $[\underline{v}, \underline{v}+a]$ ($a > 0$) with similar proof.

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

Proof of Proposition 4:

Note that $r_1^*(\lambda(k))$ 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 $\hat{\Delta} \ge 0$, such that, for $\Delta \ge \hat{\Delta}$, $(\underline{v} + \Delta) f(\underline{v} + \Delta) / (1 - F(\underline{v} + \Delta)) \ge 1$. Accordingly, when $\Delta \ge \hat{\Delta}$, 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, but may lead to misallocation between B1 and B2.

For a uniform distribution, it is sufficient to prove the case when $\bar{v} - \underline{v} = 1$. Start at $\underline{v} = 0$. Let $L(\lambda; \Delta)$ represent the expected social loss, compared to the first best outcome. Given a certain $\lambda < 1$, if $\Delta = 0$, $L(\lambda; \Delta = 0) < L(1; \Delta = 0)$. If $\Delta > \lambda$, then $L(\lambda; \Delta) = (1 - \lambda)^2 / 24$, which does not depend on Δ. Accordingly, $L(\lambda; \Delta > \lambda) > L(1; \Delta > \lambda)$. By continuity, there exists $\Delta \le \lambda$ such that $L(\lambda; \Delta) = L(1; \Delta)$. If $\Delta \le \lambda$, $L(\lambda; \Delta)$ equals:

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

Note that $\lambda / (1+\lambda) \le 1/2$. Differentiating the above $L(\lambda; \Delta)$ and substituting $L(\lambda; \Delta) = L(1; \Delta)$ in gives $\partial L(\lambda; \Delta) / \partial \Delta - \partial L(1; \Delta) / \partial \Delta = (1+\Delta)\left[1/8 - (1/2)(\lambda/(1+\lambda))^2\right] \ge 0$. Thus, for any particular $\Delta \le \lambda$ such that $L(\lambda; \Delta) = L(1; \Delta)$, $\partial L(\lambda; \Delta) / \partial \Delta \ge \partial L(1; \Delta) / \partial \Delta$. Let $\hat{\Delta} \ge 0$ be the lowest Δ such that $L(\lambda; \Delta) = L(1; \Delta)$. Then for $\Delta > \hat{\Delta}$, it must be true that $L(\lambda; \Delta) \ge L(1; \Delta)$. 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 result. Therefore, there exists a unique $\hat{\Delta} \ge 0$, such that $L(\lambda; \Delta) \le L(1; \Delta)$, if and only if $\Delta \le \hat{\Delta}$. *Q.E.D.*

Proof of Proposition 5:

From Proposition 2, in S's optimal ex-ante contract, the shadow price $\lambda = \lambda(k)$ satisfies $1/[3(1+\lambda)^2] = \min(k, 1/4) + 1/12$. If $v_1 \ge \lambda/(1+\lambda)$, B1's expected winning probability is $Q_1^*(v_1) = [(1+\lambda)/2]v_1 + (1-\lambda)/2$; otherwise, it is 0. If $v_2 \ge 1/2$, B2's winning probability is $Q_2^*(v_2) = [2/(1+\lambda)]v_2 - (1-\lambda)/(1+\lambda)$; otherwise, it is 0. Their expected ex-post payments are $T_1^*(v_1) = (1+\lambda)v_1^2/4 + (2\lambda - \lambda^2)/(4+4\lambda)$ and $T_2^*(v_2) = v_2^2/(1+\lambda) + (2\lambda - 1)/(4+4\lambda)$.

First, the indirect contract induces the same expected winning probabilities as above. Suppose that B2 enters and bids b. B1 would exercise the adjusted right of first refusal if and only if $v_1 - b - [(3-\lambda)/(1+\lambda)]b - 2(1-\lambda)/(1+\lambda) \ge 0$. Anticipating this, B2 knows that his winning probability is $4b/(1+\lambda) - 2(1-\lambda)/(1+\lambda)$. Accordingly, he chooses b to maximize

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

Next, B1's and B2's expected ex-post payments are:

$$\lambda/(2+2\lambda)+\int_{1/2}^{\frac{1+\lambda}{2}v_1+\frac{1-\lambda}{2}}(4b(v_2)/(1+\lambda)-2(1-\lambda)/(1+\lambda))dv_2=T_1^*(v_1).$$

$$\lambda^2/(4+4\lambda)+[4b(v_2)/(1+\lambda)-2(1-\lambda)/(1+\lambda))](b(v_2)==T_2^*(v_2).$$

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 $v_2\geq 1/2$. In sum, this indirect contract implements S's optimal strategic ex-ante contract. *Q.E.D.*

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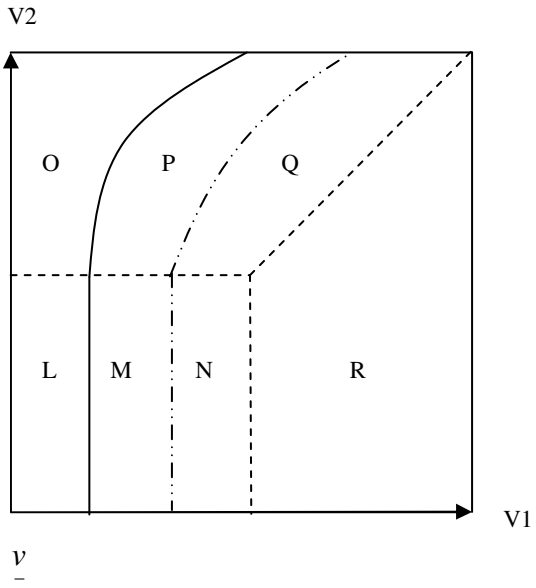
Figure 1 of 1
Equilibrium Allocation[36]



[36] If $k = 0$, there is no trade in region L+M+N; in region R, B1 wins, while in region O+P+Q, B2 wins. If $k = k_L$, there is no trade in region L+M; in region N+Q+R, B1 wins, while in region O+P, B2 wins. If $k = k_H$, there is no trade in region L; in region M+N+P+Q+R, B1 wins, while in region O, B2 wins.