

# **Market Competition, Institutions, and Contracting Outcomes: Preliminary Model and Experimental Results**

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## **Market Competition, Institutions, and Contracting Outcomes: Preliminary Experimental Results**

This paper presents a preliminary model and experimental results concerning how institutions and market power may affect contracting outcomes. Some policy makers and farm advocates have expressed concern that increasing consolidation of large agribusinesses has eroded the bargaining power and profitability of many farmers that are under contract with processors. Among the issues that have received attention include alleged opportunistic behavior by processors and the difficulty of verifying whether the obligations of contracting parties have been met. In this paper, we examine the potential impact of market concentration and contracting institutions on the nature of contracting. We first develop a microeconomic model of contracting under two enforcement environments and then vary the degree of market concentration to determine how efficiency and the distribution of surplus is impacted. We then test our predictions using experimental economics.

We develop a preliminary theoretical model under the assumption that people have the option of engaging in one-shot contracting or forming relational agreements through repeat trading. We believe these assumptions are consistent with the contracting environment in agriculture. We assume people structure contracts to enforce promises made by all contracting parties. These obligations can be either third-party enforceable or can be self-enforcing via a relational contract based on a reputation based, perfect Bayesian Nash equilibrium that imposes sequential rationality on the parties. Assuming that the parties are sufficiently patient and are reasonably optimistic about the existence of “cooperative” types in the population that will honor contracts even in the last period

of a finitely repeated game, even purely self-interested parties will honor the contract on the equilibrium path, and the parties revert to the no trade outcome and receive their reservation payoffs if they fail to honor their obligations.

We derive the optimal contracts under two enforcement environments. We show that when contract enforcement is perfect, then the optimal contract that maximizes joint surplus is a complete contract that enforces all relevant obligations. However, when enforcement is imperfect, incomplete contracts are unavoidable. Nonetheless, we find that there is an optimal degree of incompleteness that leaves only enough gaps in the contract to balance discretionary flexibility across parties. However, the principal always prefers a contract that provides her with maximum discretionary flexibility. In other words, she prefers a contract that is more incomplete (in a direction that is favorable to the principal) than what is socially optimal. Intuitively, she can use her flexibility to either to reward or punish the agent, or more negatively, to extract rents from the agent. When concentration in favor of the principal is added, the principal has more leverage to implement contracts that exceed the optimal degree of incompleteness. Our model may explain why many agricultural contracts are silent on important obligations, such as when technological upgrades are to be made or when pay rates can be adjusted, leaving these obligations largely to the discretion of the processor.

We test our predictions using experimental economics. The experimental design involves trading between subjects that are randomly assigned to be buyers (processors) and sellers (growers) of an abstract good. Buyers and sellers trade across many identical trading periods where in each trading period, buyers can endogenously offer a range of

possible contracts in order to trade a unit of good that varies in quality. A typical contract includes obligations such as payment terms, which includes a fixed price  $P$  and possibly incentive bonuses or deducts to be made by a buyer, and quality,  $Q$ , to be produced by the seller. Thus, a contract is a price-bonus/deduct-quality triplicate,  $(P, B/D, Q)$  of mutual obligations which a seller can accept or reject. We allow buyers to endogenously choose whether to include some or all of the obligations in a contract and to determine whether obligations are “binding”. A binding obligation (enforced by the computer) is analogous to a legally enforceable obligation, which means the party responsible for the obligation has no latitude to deviate from the obligation ex post. If an obligation is included but not binding, then there is latitude to deviate.

We include four treatments. In treatment RS1,  $Q$  can be made binding and there is a balanced number of buyers and sellers. This mimics an environment where contracts can be perfectly enforced and there is no concentration. Treatment RS1B is the same as RS1 except there are fewer buyers and sellers so that there is concentration in favor of buyers. Buyers have more bargaining power as some sellers will be unemployed. Next, treatment RS2 is the same as RS1 except  $Q$  can no longer be made binding. That is,  $Q$  cannot be enforced by a third-party so contract enforcement is imperfect. Finally, treatment RS2B is the same as RS2 except buyers have more bargaining power.

Our preliminary experimental results suggest that sellers are more reluctant to accept highly discretionary contracts that are stacked in favor of buyers. However, adding market power increases sellers’ willingness to accept all classes of contracts and therefore allows buyers to implement unbalanced contracts. These contracts increase

buyers' profits while decreasing sellers's profits. They also increase the incidence of rent seeking where buyers use their discretion to extract profits from sellers. Indeed, our experimental results show that a significant fraction of sellers earned profits that fell below reservation levels under highly discretionary contracts. Efficiency-wise, when contracts are not third-party enforceable so that buyers always have discretion, then contracts that provide buyers with partial discretion are more efficient than contracts that provide buyers with either too little or too much discretion.

### **A Simple Model of Contracting**

This section develops a simple, two period contracting model between a contractor (buyer/processor) and contractee (seller/supplier) in order to generate some testable hypotheses. While the model may appear simple, its insights can be easily generalized to  $T$  periods. A more general model is presented in a more complete companion paper by MacDonald and Wu (2009).

Suppose that a buyer and seller can potentially trade one unit of a good with a quality index  $q \in [\underline{q}, \bar{q}]$ , where  $q$  is observable but may or may not be third-party enforceable. When a contracting institution exists to verify and enforce  $q$ , then complete contracting is possible. However, if the contracting institution is imperfect or missing, then neither  $q$  nor payments that are contingent on  $q$  can be made legally binding in a contract. The lack of third-party enforceability is a realistic assumption in agricultural contracting as growers often complain about the lack of third-party verification of performance outcomes.

If trade occurs at some price,  $p$ , along with a bonus,  $b$ , then the payoffs to the buyer and seller are  $\pi = R(q) - p - b$  and  $U = p + b - c(q)$ . The revenue function,  $R(q)$ , obeys  $R(\underline{q}) = 0$ ,  $R'(q) > 0$  and  $R''(q) \leq 0$ . The cost of producing a good of quality  $q$  is  $c(q)$ , where  $c(\underline{q}) = 0$ ,  $c'(q) > 0$  and  $c''(q) \geq 0$ . Hence, the buyer and seller's profits from exchange are functions of  $q$ . If no trade occurs, then the buyer earns  $\tilde{\pi}$  and the seller earns a reservation payoff of  $\tilde{u}$ . Think of these payoffs as expected profits from finding a different trading partner. Social surplus is then given by  $S = R(q) - c(q) - \tilde{u} - \tilde{\pi}$ . Assume  $S(\bar{q}) > 0 = S(\underline{q})$  and  $R'(q) \geq c'(q), \forall q \in [\underline{q}, \bar{q}]$ , so that trade at  $q = \bar{q}$  is socially efficient.

The timing of a one-shot trading (stage) game is as follows. At time 0, the buyer can make a take-it-or-leave-it offer to the seller. The contract may specify a base price,  $P$ , a bonus  $B$ , and/or quality,  $Q$ . At time 1, the seller decides whether to accept or reject the contract. If the contract is rejected, the parties find other trading partners and earn expected payoffs  $\tilde{\pi}$  and  $\tilde{u}$ . If it is accepted, the parties move to time 2 where the seller chooses actual quality  $q$ , which may not equal  $Q$ , since quality is third-party enforceable (i.e. binding). At time 3, after  $q$  is observed, the buyer chooses actual price,  $p$  which may differ from  $P$  if price is not third-party enforceable. If a bonus  $B$  was specified, then it is paid if  $q \geq Q$  when  $B$  is binding. Otherwise, the buyer may choose to withhold a bonus or choose some  $b \neq B$ . For simplicity and to economize on notation, we will just assume that a seller honors the contract by delivering  $q = Q$  as opposed to  $q \geq Q$ .

*Q Third-Party Enforceable*

When contracting institutions exist to monitor  $Q$  and make it public information so that it can be enforced by a third-party, then the optimal contract can be derived from the following problem:

$$(1) \quad \max_{Q,P,B} (R(Q) - P - B) \quad \text{s.t. } P + B - c(Q) \geq \tilde{u}$$

This problem states that the principal chooses contract terms  $Q$ ,  $P$ , and  $B$ , in order to maximize profits subject to the constraint that the agent is willing to accept the contract.

To solve the problem, note that a profit maximizing principal would never leave the agent with rents so that one can assume that the participation constraint is binding and substitute it into the principal's objective function to get:

$$(2) \quad \max_Q (R(Q) - \bar{u} - c(Q))$$

which gives the first-order condition:

$$(3) \quad R'(Q) - c'(Q) = 0.$$

By assumption,  $R'(Q) \geq c'(Q) \quad \forall Q \in [q, \bar{q}]$  so the buyer's requested  $Q = q = \bar{q}$ . With  $Q$  in hand, it is easy to recover  $P = p = c(\bar{q}) + \bar{u}$  to induce the seller's participation. Note that  $B=0$  as its inclusion would be redundant since it would play no incentive role. This is because  $Q$  can be directly specified into a contract and enforced by a third-party such as a court. Assume that any deviation from  $Q$  by a buyer would trigger a court mandated punishment that is sufficiently severe to deter shirking. Note that since this contract induces acceptance (participation satisfied) and  $Q = q = \bar{q}$ , it is fully efficient. No other contract would yield higher surplus. One can of course, construct an equally efficient complete contract by not specifying  $Q$  directly, but including a bonus that satisfied the

agent's incentive compatibility constraint; that is,  $B \geq c(\bar{q}) - c(\underline{q})$ . In this case, the court would enforce  $B$  rather than  $Q$  but either contract leads to the same result. Finally, the role of repetition from the repeated game matters little with perfect enforcement as repeat trading is not necessary to provide self-enforcement of obligations.

**Proposition 1:** *When  $q$  can be perfectly and costlessly enforced by a third-party, then the contract that directly specifies  $Q = q = \bar{q}$  and  $P = p = c(\bar{q}) + \bar{u}$  is optimal.*

Proposition 1 predicts that with perfect contracting institutions, we should observe the efficient outcome and the agent should earn no rents.

#### *Q not Third-Party Enforceable*

When  $Q$  is not third-party enforceable, then a full reputation perfect Bayesian equilibrium can be used to provide self-enforcement of either  $Q$ , or  $B$  (the bonus is contingent on quality). The reputation equilibrium assumes that there are two types of players: (1) those that are cooperative and therefore honor their contract agreements, and (2) strictly self-interested players who will shirk on the bonus and price unless it is in their self-interest not to do so. Assume that the strategy space of the cooperative type is restricted so that they either honor their obligations when the other party has not shirked, and shirk if the other party has shirked. Using the logic of Kreps, et. al. (1982) and Healy (2007), a repeated game can provide incentives to selfish buyers to make their payments in all but the final period of a finitely repeated game. In essence, selfish buyers “mimic” cooperative buyers to preserve their reputation. To keep things simple, we restrict the analysis to a two period repeated game, though results generalize easily to the T period



case. Moreover, it is assumed that the buyer can endogenously choose the contract to incorporate greater or lesser degrees of discretion by choosing to either make  $P$  “binding” by making it legally enforceable, or by relying on an informal handshake agreement about  $P$ . Under a handshake agreement, the buyer has the discretion of “going back on his word” and deviate on promised payments. Note that even if contracting institutions such as efficient and unbiased courts do not exist, one can easily mimic perfect enforcement of  $P$  through an upfront payment of  $P$ . Note that it is not possible to make the terms  $Q$  and  $B$  binding given the unenforceability of  $Q$ . There are three possible contracts with varying degrees of discretion (1) a repeat purchase mechanism (RPM) which guarantees a price  $P$  across all contingencies and specifies no bonus; (2) a discretionary bonus contract which guarantees a base price of  $P$ ; and (3) an “illusory promise” or a handshake agreement which only informally promises a payment in exchange for a quality level  $Q$ .

We will now analyze a discretionary bonus contract and then discuss how results are affected under the other two contracts. The two-period repeated game is analyzed by backward induction. Starting in the second and final period, note that the stage-game of this repeated game is a sequential move game with the buyer being the last mover. Backward inducting within the stage game, note that a selfish buyer will renege on any promised bonus,  $B$ , even if the seller delivers  $q_2 = Q_2$ , where all subscripts denote the period. Backward inducting to the seller’s move, assume that the seller’s belief that a buyer is of a cooperative type is  $h \in (0,1)$ . The seller will honor the contract by

delivering  $q_2 = Q_2$  only if her expected payoff from doing so exceeds her payoff from breaching the contract,

$$(4) \quad h[P_2 + B_2 - c(Q_2)] + (1-h)[P_2 - c(Q_2)] \geq P_2 - c(\underline{q})$$

where the subscript refers to the second period. Letting the inequality bind and solving for  $h$  yields,

$$(5) \quad h_b = \frac{c(Q_2) - c(\underline{q})}{B_2}$$

which implies that the seller will meet contractual obligations if beliefs are sufficiently optimistic such that  $h \geq h_b$ . Backward inducting further to the buyer's contract offer stage, note that for a given belief,  $h$ , which is assumed to be common knowledge, the buyer's optimal bonus offer just satisfies the incentive compatibility condition,

$$(6) \quad B_2 = \frac{c(Q) - c(\underline{q})}{h}$$

to induce the seller to choose high quality. In order to induce the seller to accept the contract, the buyer's choice of  $P$  must satisfy the seller's participation constraint,

$$(7) \quad h[P_2 + B_2 - c(Q)] + (1-h)[P_2 - c(Q)] \geq \tilde{u}$$

which, combined with (6), yields,

$$(8) \quad P_2 = \tilde{u} + c(\underline{q})$$

where equality is assumed because the buyer would not pay more than necessary to induce participation.

Returning to the repeated game, backward inducting to period 1, note that a buyer's contract design problem is,

$$(9) \quad \max_{Q_1, P_1, B_1} (R(Q) - P_1 - B_1) \quad \text{s.t.}$$

$$(i) \quad P_1 + B_1 - c(Q_1) \geq \tilde{u}$$

$$(ii) \quad P_1 + B_1 - c(Q_1) + h[P_2 + B_2 - c(Q_2)] + (1-h)[P_2 - c(Q_2)] \geq P_1 - c(\underline{q}) + \tilde{u}$$

$$(iii) \quad R(Q_1) - P_1 - B_1 + \delta[R(Q_2) - P_2] \geq R(Q_1) - P_1 + \delta\tilde{\pi}$$

where  $\delta$  the buyer's discount factor and  $\delta < 1$ . If the buyer does not discount the future, it is straightforward to show that he will always shirk on the bonus. For simplicity, assume that the seller does not discount. Constraint (9i) is a participation constraint and constraints (9ii & 9iii) are dynamic incentive constraints or self-enforcement constraints. If these constraints are satisfied, then it would be sequentially rational for both buyer and seller to honor their contractual obligations. In particular, even selfish buyers will mimic cooperative buyers in the first period to preserve their reputation. If a selfish buyer shirks on the bonus, then the seller would update her belief in period 2 and know with certainty that the buyer is selfish and would not deliver quality in the second period.

The solution for (9) can be obtained by first substitution second period optimal price and bonus (6) and (8) into constraints (9i) and (9ii). Then assuming both constraints bind with equality, one can obtain the solutions,

$$(10) \quad B_1 = c(Q) - c(\underline{q})$$

$$(11) \quad P_1 = \tilde{u} + c(\underline{q})$$

These can be substituted into constraint (9iii) and then solving for  $\delta$  yields (assume constraint binds),

$$(12) \quad \delta_b = \frac{c(Q) - c(\underline{q})}{R(Q) - c(\underline{q}) - \tilde{u} - \tilde{\pi}}$$

Expression (12) gives us the lower bound on the discount factor for which a selfish buyer will honor its bonus in the first period (i.e. mimic cooperative types). That is, selfish buyers mimic if  $\delta \geq \delta_b$ . Finally, substituting the optimal values for  $P_1$  and  $B_1$  into the objective function gives us the problem,

$$(13) \quad \max_Q (R(Q) - \tilde{u} - c(Q))$$

Which yields the first order Kuhn-Tucker condition  $R'(Q) - c'(Q) \geq 0$ . By assumption,  $R'(q) \geq c'(q), \forall q \in [\underline{q}, \bar{q}]$ . Hence, the optimal solution is a corner solution at  $Q = \bar{q}$ .

This discretionary bonus contract is ex post efficient as the buyer requests the highest level of quality and uses the incentive compatible self-enforcing bonus (6) to induce the seller to comply.

It is straightforward to show that, under reasonable conditions, buyers have incentives to design and offer a contract that is less ex ante efficient than the one just presented. Suppose that the buyer offers an illusory promise which includes no enforceable terms. The primary difference between the illusory promise and the discretionary bonus presented above is that the fixed price  $P$  is also made discretionary so that the buyer can renege (refuse to pay). If a purely self-interested buyer reneges, assume that he makes the most profitable deviation, which is  $p_2 = 0$ . Real world examples of such contracts include cases where payment takes place after a job is

complete or after delivery. This exposes the seller to significant counter-party risk as it provides the buyer with an option to rent-seek.

One can proceed with the analysis of illusory promises using the same steps as before. Starting with the last mover in the last period, note that a selfish buyer will renege on both the bonus and  $P_2$ . Backward inducting to the seller's move, we can modify (4) to determine whether the seller will deliver the promised quality. Inequality (4) is modified to,

$$(4^*) \quad h[P_2 + B_2 - c(Q_2)] + (1-h)[-c(Q_2)] \geq h[P_2 - c(\underline{q})] + (1-h)[-c(\underline{q})]$$

This inequality can be used to solve for the incentive compatible bonus, which turns out to be identical to (6). The seller will accept the contract if,

$$(7^*) \quad h[P_2 + B_2 - c(Q)] + (1-h)[-c(Q)] \geq \tilde{u}$$

which, combined with (6), yields,

$$(8^*) \quad P_2 = \frac{\tilde{u} + c(\underline{q})}{h}$$

Comparing (8\*) to (8), it is clear that the promised price must be raised to compensate for counter-party risk. Moving back to period 1, the contract design problem analogous to (9) is,

$$(9^*) \quad \max_{Q_1, P_1, B_1} (R(Q_1) - P_1 - B_1) \quad \text{s.t.}$$

$$(i) \quad P_1 + B_1 - c(Q_1) \geq \tilde{u}$$

(ii)

$$P_1 + B_1 - c(Q_1) + h[P_2 + B_2 - c(Q_1)] + (1-h)[-c(Q_1)] \geq h[P_1 - c(\underline{q})] + (1-h)[-c(\underline{q})] + \tilde{u}$$

$$(iii) R(Q_1) - P_1 - B_1 + \delta[R(Q_1)] \geq R(Q_1) + \delta\tilde{\pi}$$

The solutions to (9\*) are,

$$(10^*) \quad B_1 = c(Q_1) - c(\underline{q}) - \frac{[c(\underline{q}) + \tilde{u}]}{h}$$

$$(11^*) \quad P_1 = \frac{\tilde{u} + c(\underline{q})}{h}$$

$$(12^*) \quad \delta_1 = \frac{c(Q_1) + \tilde{u}}{R(Q_1) - \tilde{\pi}}$$

It is also straightforward to show that, like the discretionary bonus contract, the buyer will request the highest level of quality,  $Q = \bar{q}$ . Thus, the illusory promise is ex post efficient although it will be shown that is not as ex ante efficient as the discretionary bonus contract.

Finally, the RPM optimal solution can be derived by backward induction. Note that under the RPM, the buyer is committing to pay a fixed price  $P$  under all contingencies so that the buyer has no ex post discretion. However, since  $Q$  is not enforceable, the seller has the discretion to choose  $q < Q$ . Thus, after the contract is signed, the seller is the last mover. Assume that selfish sellers will choose  $q = \underline{q}$  regardless of the level of  $P$  and  $Q$  specified in the contract whereas cooperative sellers will always honor the contract after accepting the contract. Assume that the buyer's beliefs about the proportional of cooperative sellers is also  $h$ . Then in the second period, the buyer solves the following contract design problem:

$$(14) \quad \max_{Q_2, P_2} h(R(Q_2) - P_2) + (1-h)(R(\underline{q}) - P_2) \quad P_2 - c(Q_2) \geq \tilde{u}$$

That is, the buyer maximizes her expected profits subject to cooperative sellers accepting the contract. Selfish sellers' participation constraints will not bind since they will earn positive rents for any  $P_2 > \tilde{P} = \tilde{u} + c(\underline{q})$  which is necessarily the case if the buyer wants to induce cooperative sellers to choose  $q_2 = Q_2 > \underline{q}$ . Letting the participation constraint bind, and substituting into the objective function yields,

$$(15) \quad \max_{Q_2} h(R(Q_2) - \tilde{u} - c(Q_2)) + (1-h)(R(\underline{q}) - \tilde{u} - c(Q_2))$$

which yields the first order condition,

$$(16) \quad R'(Q_2) - c'(Q_2) - \frac{(1-h)}{h} c'(Q_2) = 0$$

Hence, if  $\frac{(1-h)}{h} c'(Q_2)$  is sufficiently large, which is the case if  $h$  is small (buyer pessimistic), then  $Q_2 < \bar{q}$ . Given a  $Q_2$  that satisfies (16), the optimal price is,

$$(17) \quad P_2 = \tilde{u} + c(Q_2)$$

Note that the selfish type will always earn rents under this contract since the selfish seller will only deliver  $\underline{q}$ . This inefficiency causes the buyer to hedge her risk of encountering selfish sellers by reducing the level of quality requested to below  $\bar{q}$ .

Moving back to period 1, the contract design problem is,

$$(18) \quad \max_{Q_1, P_1} h(R(Q_1) - P_1) + (1-h)(R(Q_1) - P_1) \quad \text{s.t.}$$

$$P_1 - c(Q_1) \geq \tilde{u}$$

$$P_1 - c(Q_1) + P_2 - c(\underline{q}) \geq P_1 - c(\underline{q}) + \tilde{u}$$

where the second constraint is the selfish seller's dynamic incentive constraint. When this constraint is satisfied, then the selfish seller will mimic the cooperative seller in the first period and honor the contract. Note that (17) can be substituted into the constraint and after canceling and rearranging terms, the constraint reduces to  $c(Q_2) \geq c(Q_1)$ , which implies,

$$(19) \quad Q_2 \geq Q_1$$

That is, the expected second period output (and hence  $P_2$ ) must be sufficiently high to induce the selfish seller to delay her shirking decision until the second period. If she shirks in the first period, then the buyer will know with certainty that she is a selfish type and would not offer her  $P_2$  in the second period. Consequently, for a sufficiently high  $P_2$ , even selfish sellers prefer to honor the contract in the first period. Assuming that (19) binds, the optimal first period contract is identical to the second period contract, which is characterized by (16) and (17). An important point to note is that this contract is inefficient given the term  $\frac{(1-h)}{h} c'(Q_2)$  in (16) which drives a wedge between first and second best quality. The reason for this is that the buyer always has to pay the selfish seller a premium to induce her to cooperate in the first period.

The above solutions can be used to generate several propositions:

**Proposition 2:** *Buyers prefer contracts that provide buyers with discretionary latitude.*

*That is, buyers prefer the illusory promise to the discretionary bonus, and the discretionary bonus to the RPM.*



Proposition 2 is straightforward to show. Just substitute the optimal solutions (10) and (11) into the buyer's objective function in (9) to obtain profit under the bonus contract,  $\pi_b = R(Q) - c(Q) - \tilde{u}$ . Similarly, substitute (10\*) and (11\*) into the objective function in (9\*) to obtain profit under the illusory promise,  $\pi_l = R(Q) - c(Q) + c(\underline{q})$ . It is obvious that  $\pi_l > \pi_b$ . The profit under the RPM can be obtained by noting that the optimal quality consistent with (16), along with (17) can be substituted into the objective function (18) to obtain  $\pi_{RPM} = R(Q_{RPM}) - \tilde{u} - c(Q_{RPM})$ . Since this is identical to the profit for the bonus, contract with the exception that  $Q_{RPM}$  is lower, it must be the case that  $\pi_b > \pi_{RPM}$ . Hence, buyers also prefer contracts that leave their payment obligations discretionary.

**Proposition 3:** *Buyers are more likely to break promises and engage in rent-seeking under the more discretionary contracts.*

To show this, compare the threshold discount factors (12) and (12\*). Note that

$$\delta_l - \delta_b = \frac{c(Q) + \tilde{u}}{R(Q) - \tilde{\pi}} - \frac{c(Q) - c(\underline{q})}{R(Q) - c(\underline{q}) - \tilde{\pi} - \tilde{u}} = \frac{[c(\underline{q}) + \tilde{u}][R(Q) - c(Q) - \tilde{u} - \tilde{\pi}]}{[R(Q) - c(\underline{q}) - \tilde{\pi} - \tilde{u}][R(Q) - \tilde{\pi}]}. \text{ Note that}$$

all terms in brackets are strictly positive under our modeling assumption  $R(Q) - c(Q) - \tilde{u} - \tilde{\pi} > 0$  for  $Q = \bar{q}$ . Therefore  $\delta_l > \delta_b$ . Consequently, there is a smaller set of discount factors that will discipline selfish buyers under illusory promises. Under illusory promises, selfish buyers are less likely to mimic cooperative buyers and are more likely to engage in rent seeking. One can also see from equation (7\*) that if a buyer reneges, the seller earns  $-c(Q)$  ex post which is less than her reservation payoff of  $\tilde{u}$ . Hence, even in the absence of ex post inefficiency, sellers can

be made substantially worse off than if they did not contract in the first place. Under the RPM, the buyer retains no discretionary latitude so her unwillingness to break promises is trivially satisfied.

**Proposition 4:** *When buyer market power is increased, sellers' willingness to accept all contracts increases.*

To show this, suppose that there are  $m$  buyers and  $n$  sellers where  $\frac{m}{n} < 1$  so that there is concentration in favor of buyers. That is, there will be sellers left without contracts. If the seller rejects a contract, then there is a  $(1 - m/n)$  probability that she will not obtain another contract. Hence, her reservation utility must be modified so that

$$\hat{u} = \frac{m}{n} \tilde{u} + (1 - m/n) \bar{u} \text{ where } \bar{u} \text{ represents the scrap value of unemployed production}$$

assets. Note that  $\tilde{u} > \hat{u}$  so that concentration effectively decreases the reservation utility making it more likely that a seller will accept a given contract. A particularly interesting aspect of Proposition 4 is that concentration can potentially increase ex ante efficiency by increasing sellers' willingness to engage in trade. However, there is a dark side to this story, which is that, given sellers greater willingness to accept contracts, buyers' may offer more illusory promises so that the net efficiency effect of concentration is unclear. What is clear is that rent-seeking will increase. Indeed, it is not out of the realm of possibility to envision greater efficiency and lower seller welfare due to more rent-seeking.

**Proposition 5:** *Both self-enforcing illusory promises and contracts that provide buyers with partial discretion (e.g. discretionary bonus) are ex post efficient. Contracts that leave buyers with no discretion may not be ex post efficient.*

Proposition 5 follows from the fact that the buyer requests  $Q = \bar{q}$  under both illusory promise and discretionary bonus contracts. However, buyers request a lower level of quality under RPM contracts.

**Proposition 6:** *The illusory promise is less ex ante efficient than contracts that provide buyers with partial discretion.*

Proposition 6 follows from the fact that sellers are less likely to accept illusory promises which potentially decreases the number of trades. Under our assumptions, trade creates social surplus so a decrease in seller acceptance implies ex ante inefficiency. To show this, simply substitute the optimal solutions (10) and (11) into the seller's objective function (9i) to obtain,  $u_b = \tilde{u}$ . Similarly, substituting (10\*) and (11\*) into (9\*i) yields,  $u_l = -c(\underline{q})$ . It is clear that  $u_b > u_l$  and therefore, sellers prefer the discretionary bonus contract. Moreover, by Proposition 5, the two contracts are both ex post efficient. Thus, the lower acceptance rate of illusory promises implies that it must be less ex ante efficient than the discretionary bonus contract.

While we only provide an analytic model for three types of contracts, our experimental design allows subjects to endogenize a large set of contracts. For example, some contracts are allowed to incorporate a deduct,  $D$ , rather than a bonus. Other contracts may omit  $Q$  altogether so that subjects do not explicitly communicate a quality request. Explicitly modeling these possibilities is conceptually straightforward, though

tedious, but would not add additional insights and therefore are omitted . The main point of propositions 2-6 would continue to hold under these additional contracts.

### **Experimental Design**

The basic experimental platform will allow parties to choose the contractual form endogenously subject to exogenously imposed limits to contract enforcement. Both relational contracts and one-shot contracts are endogenously nested in the design. The advantage of this platform is that it allows us to examine how the institutional environment will affect both contract choice as well as efficiency and distribution. We also compare two additional treatments, one without market power where there is a balanced number of buyers and sellers and one with buyer market power where there are fewer buyers than sellers. The market power treatments were conducted for both the perfect enforcement and the imperfect enforcement treatments. Table 1 outlines the set of treatments.

In each experimental session, subjects were randomly assigned to be buyers (principals who proposed and offered contracts) and sellers (agents who can accept or reject contracts). The laboratory had room for twelve subjects per-session and a session was conducted if a minimum of six subjects showed up. A total of 342 subjects participated in 38 sessions. A typical session is comprised of 15 identical trading periods to enable repeated game effects. Thus, the total number of possible trades per-session is 15 multiplied by  $\frac{1}{2}$  the number of subjects in the non-market power treatments (RS1 and RS2). For example, if 12 subjects participated, there were six buyer and six sellers so there were six possible trades per round and 90 possible trades for the entire session.

Since not all sessions included twelve subjects, a total of 1290 trades were possible across the 18 non-market power sessions. In the market power sessions (RS1B and RS2B), there were typically fewer buyers than sellers. When there were an even number of subjects, there was typically two more sellers than buyers. For odd numbers of subjects, there was one more seller than buyer. There were a total of 72 subjects who participated in the market power sessions resulting in a total of 1080 possible trades. Within each of the 15 trading periods in each session, any buyer can trade with any seller although each buyer and seller was only allowed one trade per-round. Some sellers and buyers did not trade either because they did not reach contractual agreements or they decided not to trade for that period.

In each period, buyers and sellers trade one unit of a “good” which varies in quality. Higher quality increases buyers’ revenues. But producing higher quality also increases sellers’ costs. A buyer thus tries to induce high quality via a contract (a mutual promise, which may be enforceable) which specifies price and quality. The key institutional factor that we varied is the degree to which quality is verifiable and enforceable by a third-party. If quality is enforceable, then the parties can write a contract that stipulates a promised level of quality *and* to make it “binding.” A binding quality offer is analogous to a perfectly legally enforceable term – this term was enforced by the computer. In other words, if the parties agreed on terms and made them binding, they had no discretionary latitude to deviate from terms after agreeing to a contract. In RS1 and RS1B, quality can be perfectly and costlessly enforced. Therefore, quality can be directly specified in a contract and made binding in RS1. In RS2 and RS2B, quality

cannot be enforced and cannot be made binding. The buyer may still choose to include quality in the contract, but it cannot be made binding so that the seller is free to deviate from promised quality. The buyer must find informal ways, such as relational contracting, to ensuring that the seller delivers on promised quality.

After receiving approval from the local institutional review board, subjects were recruited from an e-mail list comprised of thousands of random draws from the entire student population of a large public university in the Midwest. The recruitment message described the activity as an economic decision making experiment, announced the length of the experiment to be about two hours, and provided information concerning the minimum (\$5) and typical range of payments (\$12 to \$35) for participation. Only subjects naïve to this protocol were enrolled and the protocol featured no subject deception. The experiment was programmed using “z-tree” software (Fischbacher 2007). Subjects were also asked to fill out short questionnaires, which took anywhere from five to twenty minutes to complete, to test subjects’ understanding of experimental instructions and to obtain information about subject characteristics (e.g. demographics, GPA, etc.). Subjects were informed that actual earnings depend upon the rules of the game and the participant’s and other participants’ actions. In addition, subjects started each contracting experiment with \$5 in their account balance in an addition to the \$7 in show-up fee. Average earnings were in the neighborhood of \$22 per subject per session. The fifteen periods of each contracting session took between 40 to 70 minutes to complete.

#### *Specific Details of the Experiments*

We now describe in detail the specifics of how buyers (principals) and sellers (agents) carried out their trades *within* each trading period. Each period represents the stage-game of a 15 period repeated game. Thus, each session can be considered an individual 15-period finitely repeated game. The sequence of events in a stage-game is as follows:

1. *Trading phase:* Buyer specifies a contract, which may include a quality request,  $Q$ , a promised fixed price,  $P$ , and/or a bonus/deduct,  $B/D$  conditional on quality outcomes. In RS1 and RS1B, the buyer may also specify whether all terms are binding. Binding terms are enforced by the computer. In RS2 and RS2B, quality cannot be enforced and made binding. Hence, bonus/deducts, which depend on quality, also cannot be made binding. Only  $P$  can be made binding. The buyer may also choose to omit terms, such as  $Q$ ,  $P$ , and/or  $B/D$ . The buyer can offer as many contracts as time permits (2 minutes) but can only trade with one seller per-period.<sup>1</sup> After a contract is specified, the buyer can offer the contract either as a private contract to a specific seller or a public offer that any seller in the marketplace can accept. If a private offer is made, only the seller receiving the offer is informed of the terms of the offer. Public offers are displayed to all other buyers and sellers. Private offers enable cooperation and long-term relationships to form, which lie at the core of relational contracting. For instance, if a buyer predicts benefits from contracting with a specific seller, the buyer can make a private offer to that seller rather than venture into the open market and hoping that

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<sup>1</sup> Pilot tests were conducted by allowing for 2.5 minutes (150 seconds). However, we observed that most of the offers were completed within a minute and a half so we shortened the trading phase to reduce the length of the experiment.

- that seller is the first to accept the offer. Sellers can only accept or reject offers. A buyer can make as many offers as desired in the trading phase, but once one offer is accepted, all other offers are withdrawn and no additional offers can be made. Similarly, once a seller accepts an offer, no other offers can be entertained. No buyers (sellers) are obligated to make (accept) offers during the trading phase.
2. *Quality Determination Phase:* Once a seller accepts a contract, s/he chooses the quality,  $q$ , to supply. Note that  $q$  denotes *actual* quality and  $Q$  denotes promised quality in the contract. If  $Q$  was specified as binding in the contract (RS1 and RS2B only), the computer ensures that the seller delivers  $q=Q$ . That is, the seller has no discretionary latitude to deviate. If  $Q$  was specified, but was not made binding, then the seller can choose  $q \neq Q$ . While sellers were deciding on  $q$ , buyers were asked to specify what quality level they *expect* the sellers to supply and how certain they are that these expectations would be fulfilled.
  3. *Price Determination Phase:* The buyer observes quality before making payments. If  $P$  is binding, the buyer has no discretionary latitude to deviate from the contractually specified price. If the fixed price is not binding, then the buyer can choose a an actual price,  $p$ , such that  $p \neq P$ . If bonuses/deducts are specified and made binding, then the computer ensures that the bonus/deduct is paid depending on whether quality obligations are met/not met. If bonuses/deducts are specified but not binding, then these become discretionary bonuses/deducts. While buyers were making their decision on  $p$  and bonuses/deducts, sellers specify what price/bonus/deduct they *expect* their buyers to choose and how certain they were



that the expectations will be fulfilled. Finally, income is calculated and the period ends. Each buyer knew what she and her seller made during the period, but did not know the earnings of other buyers and sellers in the market.

During the experiments, all trading takes place on networked computers enclosed in cubicles to eliminate between-subject visual contact. Anonymity is further preserved by assigning all subjects identification (ID) numbers. ID numbers are fixed across periods allowing subjects to develop and track reputations. In addition to the 15 periods, two practice periods were conducted prior to the “live” rounds. In order to minimize strategic carry-over from the practice to live rounds, all buyers and sellers were told that their ID numbers would be re-assigned after the practice rounds.

It is important to note that our experiment is a finitely repeated game. In theory, when the ending round is common knowledge and if it is common knowledge that all subjects are strictly self interested, then cooperation should not occur in any round. In this case, the one-shot predictions should hold in all fifteen rounds. Nevertheless, the theoretical model outlined earlier that postulates that the subject pool is a mixture of cooperative and selfish types, along with a number of past studies, have shown that cooperation still occurs in the early to middle rounds of finitely repeated games and only begin to breakdown near the ending period (e.g. Axelrod 1981; Andreoni and Miller 1993; Brown, Falk and Fehr 2004, Healy 2007, among others). Many of these experiments show that cooperation does occur and only begins to decline in rounds close to the end.

#### *Experimental Parameters*

The economic model is based on the theoretical model outline earlier. However, in order to implement the model for experimental purposes, it has to be parameterized. We parameterize our model as follows:  $R(q) = 10q$ ,  $\bar{\pi} = 0$ ,  $\bar{u} = 10$ ,  $\underline{q} = 1$  and  $\bar{q} = 10$ .

Moreover, we assume that  $c(q)$  is represented by the cost schedule outline in Table 2.

Note that marginal cost never exceeds “3” and the buyer’s marginal revenue is always “10”. Thus, marginal revenue always exceeds marginal cost, as was assumed in the theoretical model, so it would be socially efficient for parties to trade at  $q = \bar{q} = 10$ .

Round specific payouts are determined for buyers as follows:

$$(20) \quad \pi = \begin{cases} 10q - p - (I)b + (1 - I)d & \text{if an agreement is reached,} \\ 0 & \text{if no agreement is reached,} \end{cases}$$

where  $I$  is an indicator variable that takes the value of “1” if a bonus was chosen instead of a deduct. All payments are given in experimental points where subjects earn one dollar for 50 points. The seller’s profit is:

$$(21) \quad U = \begin{cases} p + (I)b + (1 - I)d - c(q) & \text{if an agreement is reached,} \\ \bar{u} = 10 & \text{if no agreement is reached,} \end{cases}$$

All subjects were told that they would earn experimental “profits” based on the payoff functions (20) and (21).

## Results

Propositions 1-6 provide a number of important predictions concerning subject behavior under various treatments. To recap, these propositions predict that buyers prefer increasingly discretionary contracts, that greater rent seeking is likely to occur under more discretionary contracts, that contracts that permit greater discretionary latitude to

buyers are less ex ante efficient in the sense that sellers are more likely to reject them, and that increasing buyer market power increases sellers' willingness to accept contracts which may imply that buyers will offer more discretionary contracts, which in turn, may lead to more rent seeking.

Given the number of options that the experimental design allows, it would be helpful to discuss some of the contract types that are allowable. The experimental design places very few restrictions on the types of contracts that can be offered. Buyers can design up to 45 different contracts in RS1 and RS1B, and up to 21 possible contracts in RS2 and RS2B. This is a formidable number of contracts to analyze individually so we group our contracts into a few broad categories that facilitate analysis of the propositions.

- *Complete Contracts:* Neither party has discretionary latitude to deviate from the contractual obligations. For example ( $P, Q, B/D$ ) are all binding.
- *Buyer discretionary contracts with no seller discretion:* Contracts that make the sellers' obligation binding ( $Q$  binding), but leave the buyer with some discretion on payment (e.g.  $P$  and/or  $B/D$  are discretionary).
- *Seller discretionary contracts with no buyer discretion:* Contracts that make all of the buyers' obligations binding but leave some discretion for the seller to deviate from quality obligations (e.g. RPM).
- *Seller discretion with partial buyer discretion contracts:* Sellers' obligation ( $Q$ ) not binding and buyer's payment partially binding. E.g. Binding  $P$  combined with discretionary bonuses or deducts.

- *Full discretionary contracts*: Contracts with no binding terms so both buyer and seller have full discretion. These are informal “handshake” agreements or illusory promises.
- *Null contract*: Do not specify any obligations. Akin to spot transactions.

Note that contracts that leave the seller with no discretion ( $Q$  binding) are only available in RS1/RS1B. In RS1/RS1B, a third-party can perfectly monitor and enforce quality, but in RS2/RS2B, the court cannot monitor or enforce quality. Contracts can only restrict actions and not strategies (complete plans of action for all possible contingencies). If quality can be monitored and enforced by a third party, then it is possible to either write a complete contract that directly specifies  $Q$  and makes it binding, or to condition bonuses or deducts on  $q$ .

Recall that Proposition 1 predicts that the optimal contract in RS1/RS1B is a complete contract that is fully efficient and leaves sellers with no rents above their reservation profits. Proposition 2 predicts that, buyers prefer contracts that allow for more discretionary latitude in RS2/RS2B. Table 3 reports summary statistics on contract data for the RS1 and RS1B treatments. Examining both the number of contracts offered and the number of trades that took place under the various contracts (number of accepted contracts), it appears that the patterns are broadly consistent with Propositions 1 and 2. In particular, under RS1, over 50% of offers were complete contracts, which resulted in 55% of trades taking place under complete contracts. Interestingly, when buyers did not specify complete contracts, they were most likely to specify contracts that left them with discretion but tied down the obligations of sellers (made  $Q$  binding). Indeed 35% of

offers were made under buyer discretionary/no seller discretion contracts and 33% of trades took place under these contracts. Buyers were unlikely to select other types of contracts. Hence, it appears that buyers were reluctant to leave sellers with any discretion. This is not surprising considering that buyers earned higher profits under contracts that tied down the sellers' obligations.

Under RS2, where the enforcement of  $Q$  is imperfect, buyers cannot tie down sellers' obligations so that sellers are inevitably left with some discretion. Then Proposition 2 predicts that buyers will prefer highly discretionary contracts. Bernheim and Whinston (1999) point out that when one party to a contract is left with discretion, it may be optimal to leave the other party with discretion in order to provide informal or strategic incentives. The summary data in Table 4 appear to be consistent with this prediction as buyers overwhelmingly made illusory promises which left them with maximum discretion (66%). This resulted in 55% of trades being executed using illusory promises. Buyers also preferred partially discretionary contracts (23% of offers resulting in 33% actual trades) to contracts that tied down their payment obligations (10% of offers leading to 11% of actual trades). A Wilcoxon Sign Rank<sup>2</sup> test used to determine whether the differences in percentage across contracts were statistically significant using each session as one independent observation confirmed differences across contract types ( $p < 0.01$ ). Thus, the preliminary data patterns appear to be consistent with the prediction of the theoretical model.

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<sup>2</sup> This is a non-parametric alternative to the t-test for correlated samples.

Proposition 4 predicts that when buyers have market power, then sellers' willingness to accept all classes of contracts should increase. A corollary prediction of proposition 4 might be that sellers will accept contracts with less favorable terms, such as contracts that have lower payments and/or provide more discretion to buyers. Indeed, the results in Tables 3 and 4 appear to be consistent with these predictions. Comparing RS1 results to RS1B results, note that acceptance rates appear to increase when market power is added, although there does not appear to be a major increase in the number of discretionary contracts used to execute trades. However, comparing RS2 to RS2B, it is obvious that market power has a substantial impact on contract choice. Note that acceptance rates dramatically increased across all classes of contracts. Moreover, the number of trades that were executed under illusory promises increased from 55% to 69%. In order to examine this issue formally, regression 1 in Table 5 presents the results of a probit regression using RS2/RS2B data where the dependent variable is a dummy that takes a value of "1" if a contract was accepted by a seller. The right hand side variables include contract types and an RS2B dummy along with interaction terms to determine the impact of market power. The base category is RS2 and the seller discretionary contract with no buyer discretion (e.g. RPM style contracts). There are two important results to note from this regression and they are highlighted below.

*Result 1: Illusory promises reduce the probability of acceptance (relative to the base case) by 0.116 ( $p < 0.05$ ).*

*Result 2: An increase in market power generally increases the probability that a seller will accept a given contract.*

Result 2 follows from the fact that the marginal effect of the RS2B coefficient is 0.428 ( $p < 0.00$ ) while at the same time, the interaction terms involving RS2B and a contract type are either not significant, or are only significant at the 10% level. Hence, sellers increased their willingness to accept seller discretion/no buyer discretion contracts but did not change their relative willingness to accept other contracts. Thus, it appears that sellers increased their willingness to accept all classes of contracts when market power is added.

Regression (2) of Table 5 provides insights into why buyers tend to gravitate toward more discretionary contracts particularly when market power is added. Note that the dependent variable is buyer profits and we would anticipate that if buyers are profit maximizers, they would choose the contract with the greatest impact on profits. The following result is highlighted.

*Result 3: In RS2, more discretionary contracts increase profits to the buyer relative to the seller discretion/no buyer discretion contract.*

Result 3 follows from the fact that the coefficients on the PBS and IP contracts are large, positive, and significant ( $p < 0.001$ ).

Proposition 3 predicts that buyers are more likely to break promises and engage in rent-seeking under more discretionary contracts. Regression 4 allows us to explore this hypothesis further. The dependent variable takes a value of “1” if a seller earned profits below her reservation level.

*Result 4: Illusory promises increase the probability that a seller will earn lower profits than her reservation profits.*

Result 4 follows from the fact that the marginal effect is 0.27 and significant ( $p < 0.00$ ).

Note that adding market power appears to also increase the probability of seller losses as the marginal effect on the RS2B dummy is 0.23. However, this coefficient is significantly different from zero only at the 10% level.

The censored regressions in table 6 are useful for investigating the predictions made in propositions 5 and 6. Regressions (1) and (3) use ex post surplus as dependent variables where ex post surplus is defined as  $\pi_B + U_S - 10$  since “10” is what a seller receives if she does not trade. The profits  $\pi_B$  and  $U_S$  are actual profits generated *after* a contract has been accepted. These profits monotonically increasing in quality,  $q$ . Ex ante surplus refers to expected surplus and is defined as  $p(\pi_B + U_S - 10)$  where  $p$  is the probability that an offer is accepted. Note that if a contract offer is rejected, then the surplus is zero. Thus, the way the dependent variable is defined for ex ante surplus is,

$$(22) \quad y = \begin{cases} \pi_B + U_S - 10 & \text{if contract offer is accepted} \\ 0 & \text{if contract offer was rejected} \end{cases}$$

The regressions were conducted both with (regressions 3 and 4) and without (regressions 1 and 2) contract terms included. Strictly speaking, Proposition 5 should be tested using regression 1 which does not include contract terms. This is because efficiency is driven by contract terms (e.g. level of  $Q$  and  $P$ ), which in turn, depend on contract type. Hence, contract terms are endogenous to contract type. However, including contract terms can provide some insights into the factors that drive some contract types to be more efficient than others.



*Result 5: Both illusory promises (IP) and contracts that provide buyers with partial discretion (PBS) are more efficient than contracts that provide buyers with no discretion. Moreover, there is no significant difference in ex post efficiency between IP and PBS contracts.*

Result 5 follows from regression 1 where both the PBS and IP coefficients are positive and significantly different from zero ( $p < 0.00$ ) which implies that both PBS and IP contracts generate more surplus than the base, no-buyer-discretion contract. This continues to hold when market power is added as the coefficient for  $PBS + RS2B \times PBS$  is positive and significant ( $p < 0.05$ ) and the coefficient for  $IP + RS2B \times IP$  is also positive and significant, though only at the 10% level. These results imply that the PBS and IP contracts are more ex post efficient than the base contract with and without market power. The test for the equality of coefficients for the PBS and IP contracts shows no significant difference ( $p = 0.61$ ). However, under market power, equality is rejected at 10% ( $p = 0.06$ ). Thus, overall, there is tentative support for Proposition 5.

*Result 6: There is tentative evidence that the illusory promise is less ex ante efficient than contracts that provide buyers with partial discretion.*

Proposition 6 can be examined using regression 2. First, note that the coefficient for PBS is larger than for IP. A test for equality, however, rejects equality at only the 10% level ( $p = 0.06$ ). The same test conducted with market power, which involves testing the equality of  $PBS + RS2B \times PBS$  and  $IP + RS2B \times IP$  also rejects equality at the 10% level ( $p = 0.09$ ). These results provide tentative support for Proposition 6.

## **Conclusion**

The preliminary results seem to support the theoretical model which predicts that, when buyers have the option of choosing discretionary contracts, they tend to favor these contracts in order to extract rents from the other party. This situation is exacerbated when buyer market power is added. When sellers are on the long side of the market so that some sellers will be unemployed, sellers are more willing to accept contracts. This provides buyers with greater freedom to structure contracts that are stacked in their favor. These contracts increase buyer profits but also increases the incidence of rent-seeking where sellers may earn profits below reservation levels. Efficiency-wise, when contracts are not third-party enforceable so that buyers always have discretion, then contracts that provide buyers with partial discretion are more efficient than contracts that provide buyers with either too little or too much discretion.

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**Table 1: Experimental treatments (names of treatments in boxes)**

|                        | <i>Perfect Contract Enforcement (q verifiable)</i> | <i>Imperfect Contract Enforcement (q not verifiable)</i> |
|------------------------|----------------------------------------------------|----------------------------------------------------------|
| <i>No Market Power</i> | RS1                                                | RS2                                                      |
| <i>Market Power</i>    | RS1B                                               | RS2B                                                     |

**Table 2: Quality cost table**

| <i>Quality</i> | 1 | 2 | 3 | 4 | 5 | 6 | 7  | 8  | 9  | 10 |
|----------------|---|---|---|---|---|---|----|----|----|----|
| <i>Cost</i>    | 0 | 1 | 2 | 4 | 6 | 8 | 10 | 12 | 15 | 18 |

**Table 3: Contract Offers, Acceptance Rates, Surplus and Distribution in RS1 and RS1B**

|                                                             | Number offered<br>(% of total) |               | Number Accepted<br>(% of total) |               | Acceptance rate |      | Ex Post Surplus Generated |       | Buyer Profits |       | Seller Profits |       | % of trades w/ seller profit below reservation |       |
|-------------------------------------------------------------|--------------------------------|---------------|---------------------------------|---------------|-----------------|------|---------------------------|-------|---------------|-------|----------------|-------|------------------------------------------------|-------|
|                                                             | RS1                            | RS1B          | RS1                             | RS1B          | RS1             | RS1B | RS1                       | RS1B  | RS1           | RS1B  | RS1            | RS1B  | RS1                                            | RS1B  |
| <i>Complete*</i>                                            | 579<br>(52%)                   | 410<br>(54%)  | 319<br>(54%)                    | 256<br>(52%)  | 55%             | 62%  | 64.97                     | 64.75 | 42.31         | 55.95 | 32.66          | 18.8  | <1%                                            | 6%    |
| <i>Buyer discretion/no seller discretion*</i>               | 391<br>(35%)                   | 274<br>(36%)  | 196<br>(33%)                    | 179<br>(36%)  | 50%             | 65%  | 64.25                     | 65.47 | 53.21         | 62.03 | 21.04          | 13.45 | 19%                                            | 38%   |
| <i>Seller discretion/no buyer discretion</i>                | 14<br>(1%)                     | 3<br>(<1%)    | 10<br>(2%)                      | 2<br>(<1%)    | 71%             | 67%  | 33.4                      | 9     | 5.7           | 2.5   | 37.7           | 16.5  | 0%                                             | 0%    |
| <i>Seller discretion/partial buyer discretion</i>           | 60<br>(5%)                     | 35<br>(5%)    | 23<br>(4%)                      | 31<br>(6%)    | 38%             | 89%  | 42.51                     | 40.42 | 34.22         | 43.94 | 18.30          | 6.48  | 35%                                            | 52%   |
| <i>Full buyer and seller discretion (illusory promises)</i> | 64<br>(6%)                     | 40<br>(5%)    | 40<br>(7%)                      | 27<br>(5%)    | 63%             | 68%  | 50.18                     | 40.81 | 37.92         | 44.3  | 22.25          | 6.51  | 35%                                            | 66.7% |
| <i>Null contract</i>                                        | 4<br>(<1%)                     | 4<br>(<1%)    | 0                               | 2<br>(<1%)    | 0%              | 50%  | 0                         | 4.5   | 0             | 14    | 10             | 0.5   | 0                                              | 100   |
| <b>Total</b>                                                | 1112<br>(100%)                 | 766<br>(100%) | 588<br>(100%)                   | 497<br>(100%) | 53%             | 65%  | 62.31                     | 61.73 | 44.71         | 56.37 | 27.60          | 15.36 | 10%                                            | 24%   |

\*This category applies only to RS1 and RS1B. These contracts are not available in RS2 and RS2B due to limits to enforcement.

**Table 4: Contract Offers, Acceptance Rates, Surplus and Distribution in RS2 and RS2B**

|                                                             | Number offered<br>(% of total) |              | Number Accepted<br>(% of total) |              | Acceptance rate |      | Ex Post Surplus Generated |       | Buyer Profits |       | Seller Profits |       | % of trades w/ seller profit below reservation |      |
|-------------------------------------------------------------|--------------------------------|--------------|---------------------------------|--------------|-----------------|------|---------------------------|-------|---------------|-------|----------------|-------|------------------------------------------------|------|
|                                                             | RS2                            | RS2B         | RS2                             | RS2B         | RS2             | RS2B | RS2                       | RS2B  | RS2           | RS2B  | RS2            | RS2B  | RS2                                            | RS2B |
| <i>Complete*</i>                                            |                                |              |                                 |              |                 |      |                           |       |               |       |                |       |                                                |      |
| <i>Buyer discretion/no seller discretion*</i>               |                                |              |                                 |              |                 |      |                           |       |               |       |                |       |                                                |      |
| <i>Seller discretion/no buyer discretion</i>                | 123<br>(10%)                   | 21<br>(3%)   | 67<br>(11%)                     | 19<br>(4%)   | 54%             | 90%  | 32.96                     | 33    | 16.22         | 18.84 | 26.74          | 24.16 | 3%                                             | 11%  |
| <i>Seller discretion/partial buyer discretion</i>           | 298<br>(23%)                   | 172<br>(25%) | 196<br>(33%)                    | 137<br>(26%) | 66%             | 80%  | 48.1                      | 54.72 | 28.12         | 37.38 | 29.97          | 27.34 | 3%                                             | 14%  |
| <i>Full buyer and seller discretion (illusory promises)</i> | 837<br>(66%)                   | 491<br>(70%) | 323<br>(55%)                    | 362<br>(69%) | 39%             | 74%  | 53.55                     | 50.34 | 40.99         | 47.94 | 22.56          | 12.4  | 23%                                            | 45%  |
| <i>Null contract</i>                                        | 17<br>(1%)                     | 15<br>(2%)   | 1<br>(<1%)                      | 6<br>(1%)    | 6%              | 40%  | 50                        | 27.5  | 34            | 27.17 | 26             | 10.33 | 0                                              | 67%  |
| <b>Total</b>                                                | 1275                           | 699          | 588                             | 497          | 46%             | 71%  | 49.37                     | 50.6  | 33.85         | 43.89 | 25.52          | 16.71 | 14%                                            | 36%  |

\*This category applies only to RS1 and RS1B. These contracts are not available in RS2 and RS2B due to limits to enforcement.

**Table 5: Regressions examining the impact of contract type competition**

|                                                                     | <i>Dependent Variable</i>                                    |                                                      |                                                      |                                                                |
|---------------------------------------------------------------------|--------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------|
|                                                                     | (1)<br><i>Probit (seller<br/>accepts contract)<br/>dF/dX</i> | (2)<br><i>GLS with Buyer<br/>Profit as Dep. Var.</i> | (3)<br><i>GLS with Seller<br/>Profit as Dep. Var</i> | (4)<br><i>Probit (seller<br/>profit below<br/>reservation)</i> |
| <i>Constant</i>                                                     |                                                              | 15.22***<br>(4.28)                                   | 26.73***<br>(1.91)                                   |                                                                |
| <i>RS2B dummy</i>                                                   | 0.428***<br>(0.088)                                          | 3.26<br>(6.49)                                       | -3.11<br>(4.32)                                      | 0.23*<br>(0.086)                                               |
| <i>Partial buyer<br/>discretion/seller<br/>discretion (PBS)</i>     | 0.133*<br>(0.07)                                             | 11.71***<br>(3.45)                                   | 3.37**<br>(1.60)                                     | 0.001<br>(0.11)                                                |
| <i>Illusory promise<br/>dummy (IP)</i>                              | -0.116**<br>(0.054)                                          | 24.25***<br>(2.85)                                   | -3.68<br>(3.33)                                      | 0.27***<br>(0.08)                                              |
| <i>Null contract<br/>dummy (NC)</i>                                 | -0.486***<br>(0.097)                                         | 17.13***<br>(2.68)                                   | -0.44<br>(2.17)                                      | 0.50*<br>(0.26)                                                |
| <i>RS2B × PBS</i>                                                   | -0.294*<br>(0.146)                                           | 6.27<br>(5.86)                                       | 0.249<br>(4.78)                                      | 0.003<br>(0.13)                                                |
| <i>RS2B × IP</i>                                                    | -0.11<br>(0.147)                                             | 3.59<br>(6.00)                                       | -6.96<br>(4.94)                                      | -0.06<br>(0.12)                                                |
| <i>RS2B × Null<br/>contract</i>                                     | 0.048<br>(0.244)                                             | -9.66<br>(6.46)                                      | -12.83<br>(10.99)                                    | Omitted due to<br>perfect collinearity                         |
| <i>Period</i>                                                       | -0.015<br>(0.012)                                            | -0.31<br>(0.70)                                      | 0.66<br>(0.39)                                       | -0.001<br>(0.01)                                               |
| <i>Period squared</i>                                               | -0.00<br>(0.0006)                                            | 0.05<br>(0.04)                                       | -0.07***<br>(0.02)                                   | 0.0009<br>(0.0008)                                             |
| <i>Sum of coefficients<br/>for PBS and<br/>RS2B × PBS</i>           |                                                              | 17.98***<br>(4.55)                                   | 3.62<br>(4.49)                                       |                                                                |
| <i>Sum of coefficients<br/>for IP and<br/>RS2B × IP</i>             |                                                              | 27.84***<br>(5.31)                                   | -10.65***<br>(3.55)                                  |                                                                |
| <i>Sum of coefficients<br/>for NC and<br/>RS2B × NC</i>             |                                                              | 7.48<br>(5.75)                                       | -13.28<br>(10.93)                                    |                                                                |
| <i>χ<sup>2</sup>(1) Test for the<br/>equality of PBS<br/>and NC</i> | 7.45***<br>(p=0.0064)                                        |                                                      |                                                      | 19.64<br>(p=0.00)                                              |
| <i>χ<sup>2</sup>(2) test for<br/>joint significance<br/>of RS2B</i> | 32.17***<br>(p=0.00)                                         | 3.33**<br>(p=0.03)                                   | 2.20<br>(p=0.11)                                     | 11.26**<br>(p=0.01)                                            |
| <i>R-square</i>                                                     | 0.108                                                        | 0.118                                                | 0.187                                                | 0.144                                                          |

Note 1. Regressions have robust standard errors adjusted for clustering on sessions (in parentheses). For probits, reported coefficients are marginal effects ( $\Delta$  probability for small change regressor). The base category is Seller discretionary contract with no buyer discretion and RS2.

Note 2. \*\*\*, \*\*, \*Indicates the estimate is significantly different from 0 at the 1%, 5%, and 10% levels, respectively. There were 1974 obs. for regression (1) and 1111 obs. for the other three regressions.

Note 3. \*, \*\*, \*\*\* signifies that coefficients are significantly different from zero at 10%, 5% and 1% levels.

**Table 6: Censored Regressions for Surplus in RS2 and RS2B**

|                                                                           | (1)<br><i>Ex post<br/>Surplus</i> | (2)<br><i>Ex Ante<br/>Surplus</i> | (4)<br><i>Ex Post<br/>Surplus</i> | (3)<br><i>Ex Ante Surplus</i> |
|---------------------------------------------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-------------------------------|
| <i>Constant</i>                                                           | -3.02<br>(9.86)                   | -78.04***<br>(19.51)              | -28.99**<br>(12.62)               | -151.59***<br>(23.92)         |
| <i>RS2B dummy</i>                                                         | -2.49<br>(12.75)                  | 33.83**<br>(15.93)                | -4.86<br>(11.53)                  | 31.22**<br>(15.75)            |
| <i>Partial buyer<br/>discretion/seller<br/>discretion (PBS)</i>           | 20.10***<br>(5.12)                | 34.65***<br>(13.00)               | 11.62**<br>(5.44)                 | 30.31***<br>(12.02)           |
| <i>Illusory promise<br/>dummy (IP)</i>                                    | 23.75***<br>(7.24)                | 0.68<br>(11.82)                   | 20.22***<br>(7.95)                | -7.87<br>(9.63)               |
| <i>Null contract<br/>dummy (NC)</i>                                       | 24.67***<br>(7.38)                | -65.21<br>(40.45)                 | 86.58***<br>(11.56)               | 32.24<br>(43.31)              |
| <i>RS2B × PBS</i>                                                         | 11.43<br>(15.11)                  | -6.45<br>(26.48)                  | 11.22<br>(12.59)                  | -6.26<br>(25.68)              |
| <i>RS2B × IP</i>                                                          | -5.28<br>(12.25)                  | 6.11<br>(18.97)                   | -1.72<br>(11.82)                  | 15.05<br>(17.14)              |
| <i>RS2B × Null<br/>contract</i>                                           | -29.33<br>(18.29)                 | 25.92<br>(44.34)                  | -28.92*<br>(15.48)                | 26.57<br>(40.42)              |
| <i>Time of offer (in<br/>seconds)</i>                                     | 0.43***<br>(0.07)                 | 0.93***<br>(0.178)                | 0.25***<br>(0.05)                 | 0.67***<br>(0.13)             |
| <i>Contracted Q</i>                                                       |                                   |                                   | 6.01***<br>(1.02)                 | 7.31***<br>(2.29)             |
| <i>Contracted P</i>                                                       |                                   |                                   | 0.24***<br>(0.08)                 | 1.07***<br>(0.22)             |
| <i>Contracted B/D</i>                                                     |                                   |                                   | 0.09*<br>(0.06)                   | 0.17<br>(0.12)                |
| <i>Private offer<br/>dummy</i>                                            |                                   |                                   | 8.53***<br>(1.99)                 | -12.17***<br>(3.39)           |
| <i>Sum of coefficients<br/>for PBS and<br/>RS2B × PBS</i>                 | 31.53**<br>(14.27)                | 28.20<br>(22.81)                  | 22.84*<br>(11.82)                 | 24.04<br>(22.99)              |
| <i>Sum of coefficients<br/>for IP and<br/>RS2B × IP</i>                   | 18.46*<br>(10.24)                 | 6.79<br>(14.41)                   | 18.50**<br>(9.08)                 | 7.18<br>(14.45)               |
| <i><math>\chi^2(1)</math> Test for the<br/>equality of PBS<br/>and IP</i> | 0.26<br>( $p=0.61$ )              | 3.48*<br>( $p=0.06$ )             | 2.68*<br>( $p=0.10$ )             | 5.47**<br>( $p=0.02$ )        |
| <i><math>\chi^2(1)</math> test<br/>PBS+RS2B × PBS=<br/>IP+RS2B × IP</i>   | 3.63*<br>( $p=0.06$ )             | 2.97*<br>( $p=0.09$ )             | 0.98<br>( $p=0.32$ )              | 2.06<br>( $p=0.15$ )          |
| <i>N</i>                                                                  | 1111                              | 1974                              | 1111                              | 1974                          |

Note 1. Regressions are censored regressions with robust standard errors adjusted for clustering on sessions in parentheses. The base category is the fixed price contract. Regressions also include period and period squared variables to control for learning effects over time.

Note 2. \*, \*\*, \*\*\* signifies that coefficients are significantly different from zero at 10%, 5% and 1% levels.

Note 3. Robust standard errors adjusted for clustering on sessions are contained in the parentheses below the coefficients.



