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**Contracting between Sophisticated Parties:
A More Complete View of
Incomplete Contracts and Their Breach**

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Abstract

We consider the design of sales contracts when, at the time the contract is signed, there is uncertainty about the seller's cost and the buyer's valuation for the good to be traded. The distribution of these variables depends on the parties' relation-specific investments. We show that efficient investment and trade are attainable under a number of information structures if the parties can renegotiate after the uncertainty is resolved. This renegotiation is *structured* by the initial contract in a natural way: one party essentially names a price and the other decides whether to trade at that price. Our results suggest that *specific performance* — court-mandated compliance with the contract — is the optimal remedy for breach of contract. We further demonstrate that with *ex ante* symmetrically informed parties there is no benefit to court-imposed restrictions on private contracts. With *asymmetrically* informed parties, however, there may be a benefit to restrictions, as we illustrate through examples.

CONTRACTING BETWEEN SOPHISTICATED PARTIES: A MORE COMPLETE VIEW OF INCOMPLETE CONTRACTS AND THEIR BREACH¹

1. INTRODUCTION

In this paper, we examine how the choice of legal framework in which private contracts are negotiated, executed, and enforced affects the efficiency of these contracts. We consider the following situation, which has received considerable attention from both economists and legal scholars. One party, *the seller*, agrees to produce and deliver some good or service to a second party, *the buyer*, in return for a specified monetary payment. At the time this agreement is made, there is uncertainty about the seller's cost and the buyer's valuation. Moreover, one or both parties may be called upon to make investments that effect the distributions of these variables and which have value only in this relationship (what are known in the literature as *reliance investments*). For instance, the seller might construct special production facilities useful solely to meet the needs of a specific buyer.

The early studies of sales contracts placed *ad hoc* restrictions on the types of contracts that could be written. Typically, the contracts were restricted to setting a fixed quantity, a fixed price, and damage measures to be paid if either side "breached" the contract by failing to trade at the fixed price. A central concern of this literature was with the damages a party should be assessed for breach of contract, with attention being limited to damage measures thought to be simple or seen in practice. Seminal papers, such as Barton [1972] and Goetz and Scott [1977], recognized that some acts of breach are economically efficient, while others are not; and they sought to see which damage measure served best to induce breach if and only if it were efficient.

Shavell [1980] pointed out that damages for breach would affect not only the ex post

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incentives to breach, but also the ex ante incentives to make reliance investments. In fact, as Rogerson [1984] showed, it may be that the *only* effects of the damage measure are on investment levels. If the parties are free to engage in renegotiation and the resulting bargaining is efficient, then the pattern of breach will be efficient regardless of the damage measure used. The damage measure does, however, affect the division of rents, which influences the incentives to make reliance investments. Rogerson found that adding renegotiation on top of a simple fixed-price contract with a limited damage clause still led to inefficient equilibrium reliance investments.

The force of these papers' conclusions is limited by the arbitrary restrictions they impose on contracts. In general, these papers fail to allow the parties to use fully the information available to them. In particular, these papers tend to give little consideration to how prices can be updated as the parties learn about the values of relevant variables. By allowing for contract renegotiation, Rogerson [1984] went part of the way in examining how the parties can incorporate information learned after the signing of the initial contract. But as we noted, renegotiation, in itself, does not implement the first best in the setting he analyzed.

In this paper, we examine how the parties can write an initial contract that structures any future renegotiation in a way that does provide incentives for efficient investment. We focus on a class of contracts in which the parties set up a price schedule, but the actual price is chosen after the uncertainty is resolved. Rather prosaically, we call these contracts *fill-in-the-price mechanisms*. The initial contract is incomplete since the price is initially "left blank" and is "filled in" only later by the seller through what might be termed *structured renegotiation*. We show below that fill-in-the-price contracts can support first-best outcomes in a variety of settings in which the fixed-price contracts considered by earlier authors cannot. This finding suggests that earlier authors' restrictions of fixed-price contracts and limited damage measures were inappropriate, at least for the information structures that they specified.

Recently, several authors have looked at sophisticated sales contracts and the possibility of renegotiation. Konakayama et. al. [1986] is the paper closest to our own. They approached the

writing of a sales contract from a mechanism design viewpoint.² For the case of one-sided reliance in which each party's gain from trade remains his or her private information, they found a mechanism (which can be interpreted as a fill-in-the-price contract) that implements the first-best outcome. Our work goes beyond theirs in that we allow for two-sided reliance investments, and we examine several alternative information structures.

Among these alternative information structure is one that lately has attracted much attention: The buyer and seller learn each other's gain from trade (as well as their own), but they are unable to verify this information before the third party responsible for contract enforcement (hereafter, the "court"). In the parlance of contract theory, the gains from trade are *observable but unverifiable*. Hart and Moore [1988] and Aghion *et al.* [1989] examined the case of two-sided reliance with observable-but-unverifiable gains to trade.³ Hart and Moore explicitly considered the effects of renegotiation and concluded that, in a broad set of circumstances, the first best is unattainable. Critically, they assumed if trade does not occur, the court has absolutely no information about who vetoed it. We drop this assumption and find that the first best is attainable in the case of observable-but-unverifiable gains from trade. Like us, Aghion *et al.* found that the first best is attainable. Their approach, however, would, in the context studied here, rely on contracts that call for random quantities to be traded. Such contracts strike us as unnatural, and our approach does not rely on random quantities.

Even more recently, Rogerson [1990] has taken a traditional mechanism-design approach to examine the general problem of n agents each of whose utility depends on a collective choice, his type, and the amount of money he receives. For the private values and the observable-but-unverifiable values cases, Rogerson proved that a mechanism achieving first-best investment levels and the first-best collective choice exists. Although independently derived, our results that the first-best outcome can be achieved in these two cases should nonetheless be seen as

² Stole [1990] also employs a mechanism-design approach, but in his paper there is no investment by either side.

³ MacLeod and Malcomson [1990] also examined a buyer-seller relationship with observable-but-unverifiable gains from trade. Unlike the other papers in this literature, they assumed that trade is ongoing during the renegotiation process.

applications of Rogerson's more general results. However, as Rogerson noted, the mechanism-design approach allows contracts that fare poorly with respect to three criteria: simplicity, ease of enforcement, and robustness to renegotiation. The contracts we derive are straightforward and have natural interpretations. In terms of the demands placed on the courts, the information required to enforce these contracts is no greater than that required to enforce fixed-price sales contracts. Finally, for the private values case, our contract is robust to renegotiation. Thus, we see our work on these two information structures as complementary to Rogerson's.

Our analysis is not confined to the two polar cases of private values and observable-but-unverifiable values. Loosely speaking, we show that when the contracting parties both receive informative-but-imperfect, private signals of one another's gains from trade, there is no fill-in-the-price contract that will support the first-best outcome. One might suspect that if one used contracts that were still more sophisticated, then once again the first best could be attained. We show, however, that if there is no fill-in-the-price contract that can support the first best, then there is no balanced, sequential mechanism (i.e., a balanced mechanism in which the two parties alternate sending messages) that can do so either.

In addition to analyzing the equilibrium choice of contract, we also address the question of whether there is an efficiency justification for public restrictions on private contracts. Courts often place limitations on private contracts (e.g., damage clauses covering breach of contract are restricted). A common reaction to legal restrictions on contracts is that they cannot improve efficiency. Either the restrictions are not binding, in which case they have no effect, or they are binding, in which case they prevent the parties from doing as they wish. As we show, this intuition is essentially correct when the parties are symmetrically informed *at the time of contracting*. But when the parties are asymmetrically informed at the time that the initial contract is signed, there are cases in which restrictions rules can improve efficiency. The implications of these general findings for public policy toward damages for breach of contract are discussed below.

The paper proceeds as follows. In the next section, we set up the basic analytical framework. In Section 3, we analyze what contracts would be chosen by the private parties in the

absence of any judicial restraints. In Section 4, we examine public restrictions on private contracts. The paper closes with a brief conclusion.

2. A MODEL

We consider the following situation. There is a single seller and a single buyer who must decide whether to exchange one unit of some indivisible good. Initially, both parties are taken to be risk neutral. The buyer's payoff is:

$$U(r,x) = xb - r - T.$$

where x is the quantity exchanged (equal to either 0 or 1), b is the buyer's (dollar) valuation for the good, r is the level of reliance investment in which the buyer engages, and T is the net monetary transfer from the buyer to the seller. b is distributed with density $f(\cdot ; r)$. We assume that the support of f has a finite upper bound and non-negative lower bound for all values of r .

The seller's payoff is:

$$\pi(s,x) = -cx - s + T,$$

where c is the seller's opportunity cost of the good and s is the seller's relationship-specific investment. Note that by writing payoffs this way, we are assuming that any scheme is balanced, so that the payment made by the buyer is equal to the payment received by the seller. c is distributed with density $g(\cdot ; s)$. We assume that the support of g has a finite upper bound and non-negative lower bound for all values of s .

Initially, we can think of the contracting process as having three stages. In the first stage, the buyer and seller sign a contract specifying a monetary transfer as a function of the state of nature realized and actions taken by them in the second stage. In the third stage, monetary transfers are made according to the terms specified in the contract. It is also in the third stage that the court may be called upon to enforce the contract. Throughout our analysis, we assume that the court responsible for enforcing the contract between the buyer and seller is selfless and non-strategic (in particular, we abstract away from issues of collusion). Figure 1 illustrates the

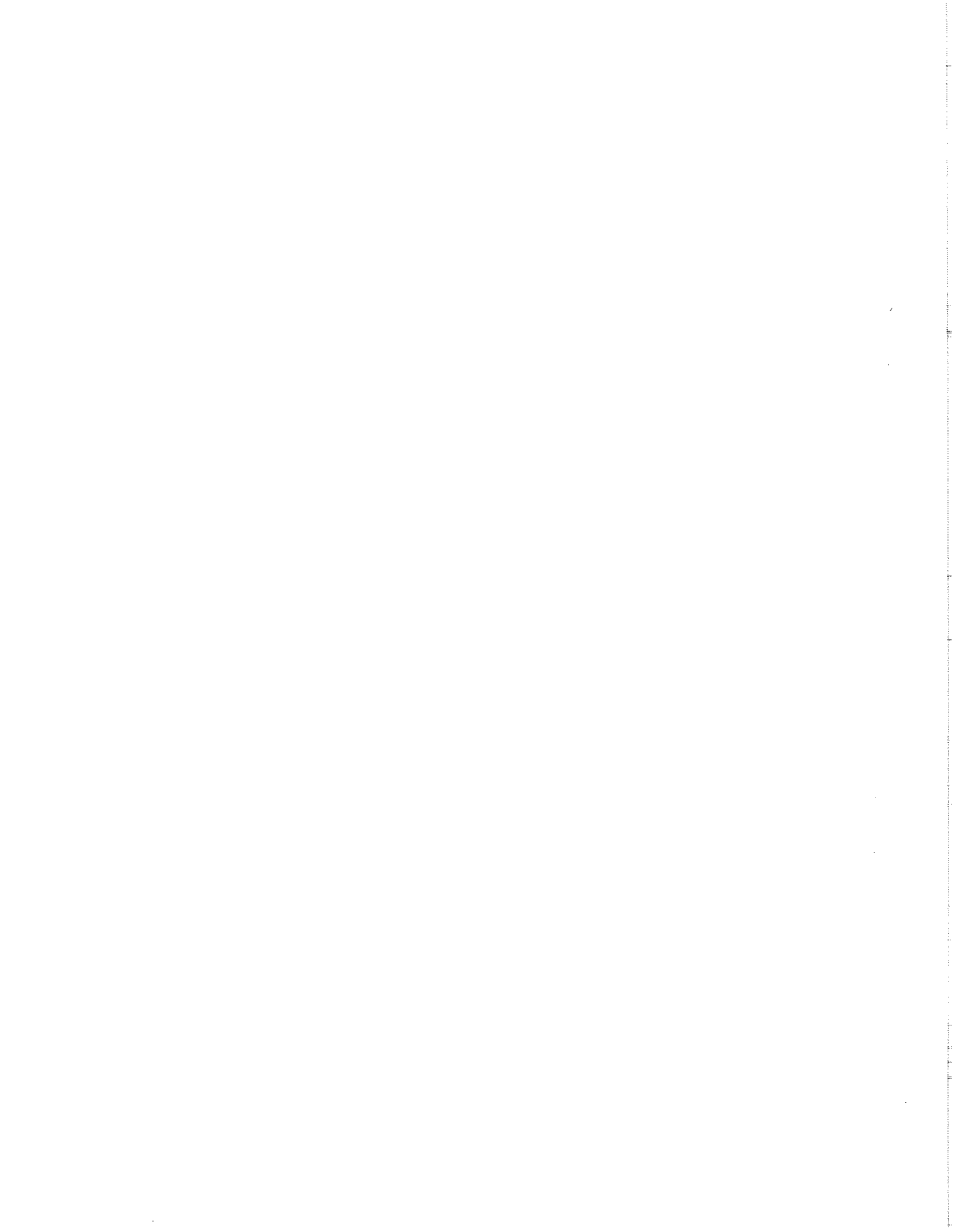
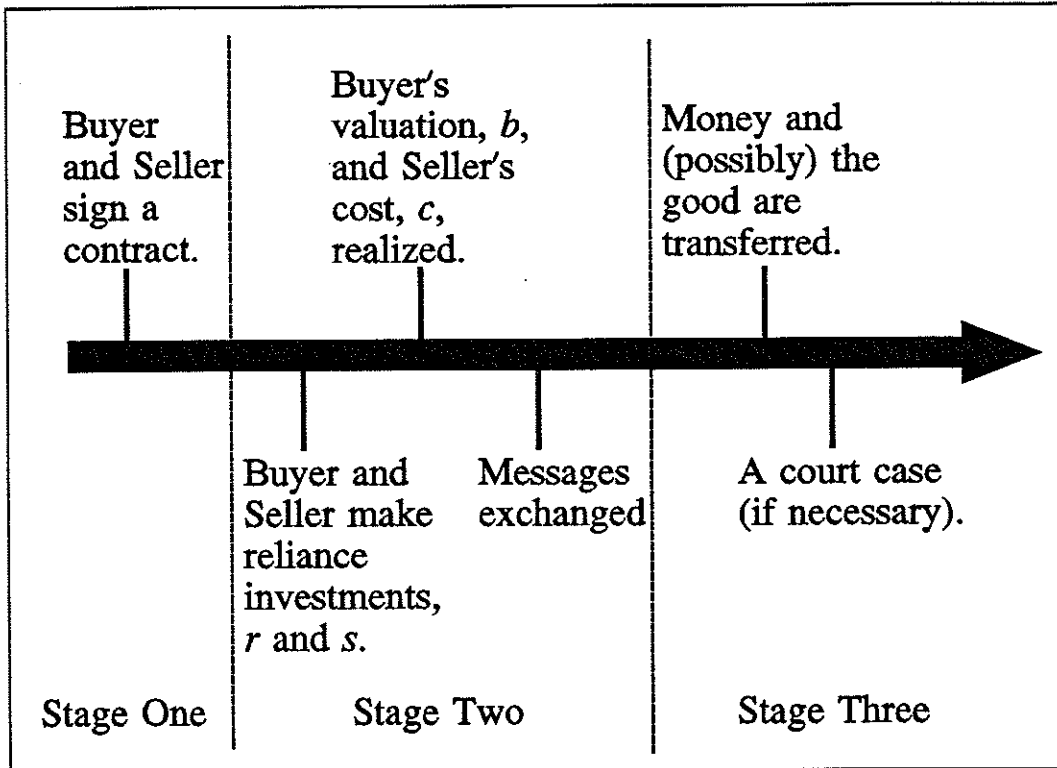


FIGURE 1

The Sequence of Events



time line for this game.

Before considering what contract the parties will write, it is useful to specify the first-best outcome as the complete-contract benchmark. If the parties could costlessly write a complete contract, then the efficient outcome could be supported as a Nash equilibrium by writing a forcing contract that penalized any party that failed to do its part of the first-best outcome.

Clearly under the first-best it must be the case that the parties exchange the good if and only if $b \geq c$.⁴ Given this trading rule, the two investment levels should be chosen to

$$\underset{r, s}{\text{maximize}} \int_0^{\infty} \int_c^{\infty} (b-c) f(b; r) g(c; s) dbdc - r - s.$$

For convenience, we assume that the first-best investment levels, r^* and s^* , are unique. Note that when both parties are risk neutral, the ex post distribution of rents is of no consequence from an efficiency perspective.

Working with this model, we can now ask two basic questions: (1) What do equilibrium contracts look like? and (2) Are there efficiency benefits from court-imposed restrictions on contracts?

3. EQUILIBRIA WITH UNRESTRICTED CONTRACTS

We begin by characterizing the equilibrium when courts place no limits on the terms of private contracts. To have a full model of equilibrium contracting, we need to specify the bargaining that takes place in the initial contracting stage. In this section, our attention will be restricted to situations in which the two parties are symmetrically informed at the time of initial bargaining, and we will simply assume that the bargaining results in an efficient outcome.

Since the information structure is critical to the results obtained, it is important to be clear about that structure right from the start. We need to specify the information sets of three parties: the buyer, the seller, and the court. We assume that the court knows absolutely nothing about the

⁴ Throughout this paper, we will not waste time by explicitly noting that the parties are indifferent between trading and not when $b = c$, nor will we distinguish among outcomes that differ only when $b = c$.

investment levels or the realizations of c and b -- the opposite of the first-best, complete-contract situation in which the court observes all four variables.⁵ We will make a variety of assumptions about the information sets of the buyer and seller.

First, suppose that both the buyer and seller observe r , s , c , and b . Since the court has absolutely no information about the values of these variables, they are "observable but unverifiable." When the two contracting parties have better information than does the court, it is natural to ask whether the parties can effectively use this information in their contract. A common view in the contract theory literature is that they cannot because contracts based on unverifiable information are unenforceable (see Hart [1987] for a survey). In our opinion, this view is misleading. It is correct to argue that a court cannot enforce contractual contingencies based on information unknown to it. But under reasonable conditions, the parties can write a contract that, in effect, makes the monetary transfer contingent on unverifiable information.

One approach is to set up a direct revelation mechanism in which the contracting parties reveal their private information to the court. When the information is common knowledge between the two parties, the contract could specify that they go to court and simultaneously announce that information to the court. The court would then have the two "shot" if their reports disagreed. As is well known, there is a Nash equilibrium in which both parties report truthfully. But, as is also well known, this mechanism has difficulties, including: 1) possibly more compelling equilibria exist; 2) the mechanism is unbalanced; and 3) the mechanism is not robust to situations in which the two parties have different private information. Recently, Rogerson [1990], building on the work of D'Aspremont and Gerard-Varet [1979], Cremer and Riordan [1985], and Moore and Repullo [1988], has shown that direct revelation mechanisms that do not suffer from these difficulties exist.

⁵ There has been some study of the intermediate cases in which the court observes a subset of these variables or has imperfect information about them. Gibbons and Murphy [1987], for instance, can be interpreted as studying the case where b and c are common knowledge between the buyer and seller, but the court has only an imperfect signal of their values. Hermalin and Katz [1991a] can be seen as considering the case of one-sided reliance investment where the investment level is effectively known to both the buyer and seller but imperfectly known to the court. Finally, Demski and Sappington [1991] can be seen as dealing with two-sided *sequential* investment where the investment levels are (immediately) known to both the buyer and seller, but not to the court.

In our opinion, courts typically do not serve as direct revelation mechanisms (although perhaps they should). Presenting evidence in court is much different from simply sending messages and being rewarded according to some preset payment schedule. We believe it is important to restrict attention to mechanisms that can be given natural interpretations. The class to which we restrict our attention are *balanced, sequential mechanisms*. Under a balanced, sequential mechanism, one party sends messages (e.g., announces a price) to which the other party replies (e.g., by announcing whether he will buy). The monetary transfer from buyer to seller and the quantity to traded are functions of these messages.

We restrict attention to sequential mechanisms for two reasons. One, most commercial intercourse consists of sequential-speech "conversations" (indeed, as a practical matter, it may be difficult to implement simultaneous speech mechanisms). Two, there is an important subclass of sequential mechanisms with a particularly "natural" structure -- fill-in-the-price mechanisms. Under a fill-in-the-price mechanism, the parties initially agree to a transfer schedule, T , that is a function of the transactions price and quantity. Once the values of c and b are realized, one party announces a price, p . After the chosen price has been announced, the other party chooses the quantity to be traded, x . The seller receives a net payment of $T(p,x) = A(p) + px$. We refer to $A(p)$ as the *base transfer schedule*.

For the case of observable-but-unverifiable variables, there is a fill-in-the-price contract that supports efficient trade and investment levels as its unique perfect Bayesian equilibrium. This contract works as follows. The seller announces the price. Based on this price, the buyer chooses whether to purchase the good, and he pays the seller $xp + A(p)$, where

$$A(p) = - \int_0^p \{p-c\}g(c; s^*)dc + t,$$

and t is a constant that reflects the division of rents between the two parties.

Proposition 1: *Suppose that the buyer and seller are risk neutral and that both the buyer's valuation of the good and the seller's cost of production are observable but unverifiable. Then under the contract mechanism described above, there is a unique perfect Bayesian equilibrium. In this*

equilibrium, each party makes the first-best level of investment and trade is efficient.

Proof: Whatever the seller's investment and reporting strategy, perfection requires that the buyer purchase the good if $b > p$ and refuse it if $b < p$. This fact, coupled with the fact that

$$\partial T(p, x) / \partial p = x - \int_0^p g(c; s^*) dc,$$

tells us that the seller's profit is increasing in p for all $p < b$ and decreasing in p for all $p > b$.

Suppose that, when $p = b$, the buyer purchases the good if and only if $b \geq c$. Then the seller's best response is to set $p = b$. In fact, if the seller is to have any best response, then the buyer must purchase the good if and only if $b \geq c$ when $p = b$ (otherwise there will be an "open-interval problem"). Note that nothing so far depends on the actual levels of the buyer or seller's investment.

Now, consider the buyer's investment strategy. Given the seller's pricing strategy and the buyer's purchasing strategy, the buyer chooses

$$r \in \operatorname{argmax} \int_0^\infty \int_0^b \{b-c\} g(c; s^*) dc f(b, r) db - r,$$

the program for the buyer's first-best reliance level (conditional on the seller's first-best reliance level). By assumption, this program has a unique solution, r^* , which, therefore, is the unique perfect investment strategy.

Lastly, consider the seller's investment strategy. Given her price-setting strategy and the buyer's purchase and investment strategy, the seller chooses

$$s \in \operatorname{argmax} \int_0^\infty \int_0^b \{b-c\} g(c; s) dc f(b, r^*) db - \int_0^\infty \int_0^b \{b-c\} g(c; s^*) dc f(b, r^*) db - s.$$

Since the second double integral is independent of s , the seller's investment problem is equivalent to the optimization program for the first-best level of seller investment, which, by assumption, is unique. **QED**

We can understand this mechanism intuitively as follows. Since the seller sets the price, she has monopoly power and thus sets the price equal to the buyer's valuation (which, recall, she

knows). Although this pricing leads to efficient trade, the problem is that the seller captures all of the realized surplus and the buyer captures none of it. This creates a disincentive for the buyer to invest, so the base payment level, $A(p)$, must be designed to restore the buyer's investment incentive. This is done by setting $A(p)$ equal to the *expected total* surplus when the buyer has a valuation of p and the seller makes the first-best level of reliance investment in cost reduction. Since price equals valuation in equilibrium, the buyer has the proper incentives to raise the expected value of b through his reliance investment. As constructed, $A(p)$ is independent of both the seller's actual reliance investment and the realization of her cost. The seller, therefore, ignores $A(p)$ when choosing her reliance investment. This, coupled with the fact that the seller captures all of the *realized* surplus at the margin, means she faces the proper incentives to invest ex ante.

Before continuing, it is useful to note what assumptions we are making about the court's ability to observe the private parties' *actions*. As already stated, we assume that the court cannot observe any signal of the values of the investment levels, r and s . We do, however, assume that the court can observe the terms of contract, the seller's announcement of p , the buyer's choice of x , and whether the seller delivers the good in accordance with the buyer's wishes.⁶

It is worth considering whether this mechanism is renegotiation-proof. The answer is no if the buyer has any bargaining power in renegotiation: By threatening to trade inefficiently, the buyer will be able to force renegotiation and, because he has bargaining power, capture some of the realized surplus. Note, however, that the seller never has an incentive to renegotiate: Since she captures all the surplus on the margin, she cannot receive more than what she receives in the equilibrium of the game without renegotiation.

Now, turn to the other extreme in which the level of relationship-specific investment

⁶ In fact, all we require is that the court have *any* information at all about who vetoed trade. The parties know who vetoed trade, and thus they know the distribution of the court's ruling. If the parties can engage in pretrial bargaining, and the court's ruling is correlated with the truth, then the parties can structure their contract (contingent on the court's ruling) such that the vetoing party will have a much weaker threat point in this pretrial bargaining. As shown in Hermalin and Katz [1991a], in many circumstances, it is possible to structure the contract in a way that the equilibrium of the pretrial settlement yields the same outcome that would obtain if the court could observe who vetoed trade.

made by each party remains that party's private information and only the buyer learns the realization of b , while only the seller learns the realization of c . Under this information structure too, there exists a fill-in-the-price contract that achieves the first best.⁷ Once again, the seller announces a price, p , after the values of c and b are realized, and the buyer then chooses whether to purchase the good and makes a payment according to the schedule $T(p,x) = A(p) + xp$. The difference is that now

$$A(p) = \int_p^\infty \{b-p\}f(b; r^*)db + t,$$

where t is again a constant reflecting the division of rents.

Proposition 2: *Suppose that the buyer and seller are risk neutral and that neither party can observe the other party's reliance investment or his or her value of exchanging the good. Then under the contract mechanism described above, there exists a perfect Bayesian equilibrium in which each party makes the first-best level of investment and trade is efficient.*⁸

Proof: Whatever the seller's investment and reporting strategy, a best response for the buyer is to purchase the good if and only if $b \geq p$. Suppose that buyer is pursuing this purchase strategy and makes reliance investment r^* . Given c , the seller chooses the price that maximizes

$$\pi^*(p) \equiv A(p) + \int_p^\infty \{p-c\}f(b; r^*)db,$$

since in equilibrium she believes that $r = r^*$. Differentiating with respect to p , we obtain

⁷ If there were no investment, then the fact that there is a mechanism that ensures efficient trade follows from D'Aspremont and Gerard-Varet [1979]. Indeed, Riordan [1984] provides such a mechanism for the case of no investment. In his mechanism, the seller essentially announces a price and the buyer decides how much to buy (Riordan allows for a continuous amount of the good to be traded). Our mechanism can readily be generalized to cover continuous transactions quantities (see footnote 9 below), and thus it can be seen as extension of Riordan's mechanism to the presence of reliance investments. Independently, Rogerson [1990] has also shown that Riordan's mechanism can be so extended.

⁸ This equilibrium need not be unique. In particular, equilibria with mutual *underinvestment* may exist. On the other hand, pre-game communication may serve to eliminate Pareto-inferior equilibria such as these.

$$d\pi^*(p)/dp = - (p - c)f(p; r^*).$$

Clearly, the first derivative is positive for all $p < c$, equal to 0 for $p = c$, negative for all $p > c$. Hence, setting $p = c$ is a best response.

Now consider the seller's investment strategy. Given the seller's pricing strategy and the buyer's posited strategy, the seller chooses

$$s \in \operatorname{argmax} \int_0^\infty A(c)g(c; s)dc - s,$$

which is exactly the optimization program for the first-best level of seller investment.

Lastly, consider the buyer's investment strategy. Given the seller's strategy and the buyer's purchasing strategy, the buyer chooses

$$r \in \operatorname{argmax} \int_0^\infty \int_c^\infty (b-c)f(b; r)g(c; s^*)dbdc - \int_0^\infty A(c)g(c; s^*)dc - r.$$

The second integral is independent of r and the first one is the maximand in the program for the first-best reliance level. **QED**⁹

As with the first scheme, the seller is in a monopoly position. Unlike the first scheme, however, she is ignorant of the buyer's valuation. Thus the usual monopoly tension between price as a means of allocating the good and as a means of extracting surplus arises. Trade will be efficient, however, if the base payment schedule is structured to give the seller incentives to price at marginal cost. But then the base payment must also provide incentives for efficient investment (since $p = c$ in equilibrium, the prospect of making sales cannot itself provide these investment incentives). These objectives are met by setting the base payment equal to the *expected total* surplus when the seller has cost p and the buyer makes the first-best level of reliance investment.

⁹ One can readily generalize Proposition 2 and its proof to the case of continuous transactions quantities. Simply define $B(x, b)$ as the total dollar benefits enjoyed by a buyer of type b from the consumption of x units of the good, and define $C(x, c)$ as the total cost incurred by the a seller of type c to produce x units of the good. Finally, define $S(b, c) \equiv \max_x B(x, b) - C(x, c)$. $S(b, c)$ is the first-best surplus level when the buyer is of type b and the seller is of type c . One can now use an exact analogue of the proof of Proposition 1 to show that the first-best outcome can be supported by a mechanism in which the seller reports p , and the buyer chooses x and pays $\int_0^\infty S(b, p)f(b; r^*)db + t + C(x, p)$.

Provided she prices at marginal cost, the seller has the proper incentive to make the optimal cost-reducing investment. Moreover, she will wish to price at marginal cost, because if she prices above marginal cost, her base payment is reduced by both the reduction in consumer surplus and the deadweight loss, while she captures back only the reduction in consumer surplus. Given that, in equilibrium, the seller prices at marginal cost, the buyer captures all the *realized* surplus at the margin, and he, thus, has the proper incentives to make the optimal reliance investment.

Unlike the observable-but-unverifiable case, the fill-in-the-price mechanism for the private values case is renegotiation-proof.

Proposition 3: *The efficient equilibrium outcome described in Proposition 2 remains an efficient equilibrium outcome even if the buyer and seller can renegotiate after learning their valuations.*

Proof: We may assume that the seller must state a price, since the contract could include a clause stating that failure to state a price is equivalent to setting a price equal to the minimum possible cost. Given that the seller names a price, p , the buyer can do no worse in renegotiation than how he would do by accepting if $b \geq p$ and rejecting if $p > b$. If the seller announces $p = c$ (i.e., does not deviate), then there will be no renegotiation: Since the buyer captures the realized surplus on the margin, he can do no better than to trade efficiently, and given that trade is efficient, there is nothing to be gained from renegotiation. Suppose the seller deviates. If $b \geq c$ and $p \leq b$, then the most the seller can receive is $p - c + A(p)$. Similarly, if $b < p$ and $b \leq c$, then the most the seller can receive is $A(p)$. If $b > c$ and $p > b$, then the most the seller can receive is $A(p) + \lambda(b,c,p)(b - c)$, where $\lambda(b,c,p)$ represents the seller's expected share of the surplus created by renegotiation (ignoring any costs of bargaining). As long as the seller does not possess all the bargaining power, $\lambda(b,c,p) < 1$. Moreover, there may be direct costs of bargaining or the bargaining may be efficient. Finally if $b < c$ and $p \leq b$, then the most the seller can receive is $p - c + A(p) + \lambda(b,c,p)(c - b)$. To summarize, the expected maximum the seller can receive from announcing p and renegotiating the contract is

$$R(p) \equiv A(p) + \int_p^\infty \{p - c\} f(b;r^*) db + \int_c^p \lambda(b,c,p)\{b - c\} f(b;r^*) db.$$

Note $R'(p) = [\lambda(p,c,p) - 1](p - c)f(p;r^*) + \int_c^p \lambda_p(b,c,p)(b - c) f(b;r^*) db$. Hence, if $\lambda(b,c,p) \equiv 1$, then the seller would receive the same expected profit regardless of the p she announced. When $\lambda(b,c,p)$ is everywhere less than 1, the seller's expected profit is less than when $\lambda(b,c,p) \equiv 1$ *except* when $p = c$. It follows that the seller can do no better than announce $p = c$ even when renegotiation is possible. **QED**

Although there are relatively simple contracts that attain the first-best outcome in the two cases examined thus far, it is important to note that these cases are extreme in at least two dimensions. Firstly, the information structures are extreme: either each private party sees everything that the other one sees, or he or she sees nothing. It clearly is important to consider intermediate cases in which the two parties have imperfect, but informative, signals.

Imperfect signals about r or s present no obstacle to the attainment of the first-best since the parties correctly infer the values of r and s in equilibrium anyway.¹⁰ Instead, it is imperfect signals about b and c that are potential problems. Notice, however, that these problems arise only if the signals are private as well as imperfect. If the seller's imperfect signal of b were verifiable, then it would be straightforward to make the mechanism described in Proposition 2 contingent on this signal, thus attaining the first best. Even imperfect private signals are only a problem if both sides have them: Clearly, nothing would change in Proposition 2 if the buyer were the only party with an imperfect private signal. Since there exists a mirror mechanism in which the buyer fixes the price and the seller decides to trade, there would also be no problem if only the seller had an imperfect private signal. After all of these extensions, we are left with the following case to consider: the seller has an imperfect, but informative, private signal of b and simultaneously the buyer has an imperfect, but informative, private signal of c .

Before formally examining this case, we need a precise definition of *informative*. We say that a signal α of variable a is informative if there are two values of the signal, $\alpha_1 \neq \alpha_2$ such that the distribution function for a conditional on $\alpha = \alpha_1$ differs from the distribution function for a

¹⁰ Strictly speaking, one must assume that the supports of these signals are independent of r and s . If the supports shift with r and s , then signals may matter depending on how players update their beliefs about b and c in response to out-of-equilibrium realizations of r and s .

conditional on $\alpha = \alpha_2$ over a set of a that has positive measure.

Proposition 4: *Suppose that the buyer and seller are risk neutral, the seller receives an informative private signal, β , of the buyer's valuation such that the support of b conditional on β is independent of β , and the buyer receives an informative private signal, γ , of the seller's cost such that the support of c conditional on γ is independent of γ . Then there does not exist a fill-in-the-price contract (i.e., one party sets the price and the other decides whether to trade) that yields the first-best investment levels and efficient trade.*

Proof: Given the perfection requirement on the buyer's behavior, the seller chooses p to

$$\underset{p}{\text{maximize}} A(p) + (p - c) B(p, \beta),$$

where

$$B(p, \beta) \equiv \int_p^{\infty} f(b; r^* | \beta) db$$

$B(p, \beta)$ is monotone decreasing in p and thus differentiable in p almost everywhere. Moreover, for all c , the derivative of $(p - c) B(p, \beta)$ with respect to p exists at $p = c$ and equals $B(c, \beta) > 0$. Hence $A(p)$ must be everywhere decreasing to support the first best. (If not, then there would exist a value of c such that the maximum over p of $A(p) + (p - c)B(p, \beta)$ did not occur at c and thus trade would be inefficient for some realizations of b .) Since $A(p)$ is monotone decreasing, it too must be differentiable almost everywhere.

Now, since the support of b is independent of the value of β , the first-order necessary condition for efficient trade to be incentive compatible is that

$$A'(p) = -B(p, \beta) \text{ for all } \beta \text{ and almost every } p,$$

which cannot be satisfied since β is an informative signal.

A similar proof shows that the buyer cannot be the one to fill in the price. **QED**

As long as fill-in-the-price contracts achieve the first-best outcome, it is difficult to object to our restriction to this subclass of mechanisms. But when the first best cannot be

achieved, one must ask whether the restriction is significant: Could a contract from a larger set achieve the first best for the imperfect-private-signals case? Using the fact that the first-best entails a deterministic trading rule for $b \neq c$, the next proposition shows that for the class of balanced, sequential mechanisms, the answer is: No.

Proposition 5: *Suppose that the buyer's valuation is equal to the seller's cost only on a set of measure zero. If there is a balanced, sequential mechanism (i.e., a mechanism in which one side sends messages, then the other side replies) that achieves a first-best outcome, then there exists a fill-in-the-price mechanism that achieves a first-best outcome as well.*

A proof of Proposition 5 is given in the Appendix.

Propositions 1 and 2 also are extreme in terms of the private parties' attitudes toward risk: Both the buyer and seller are risk neutral. Generally, there are two roles for long-term contracts (i.e., those signed before the values of b and c are realized). One is to provide a good investment environment; the other is to share risk. When both parties are risk neutral, only the first role arises. When one of the parties is risk averse, the contract must play both roles simultaneously and the first-best is more difficult to obtain.

To see this fact, consider the following simple example. Suppose that at the time of contracting c is known to all, but b is a random variable whose later realization will remain the buyer's *private* information, and that the buyer's payoff is

$$U(r,x) = u(xb - r - T),$$

where $u'' < 0$. When the seller is risk neutral and buyer is risk averse, the distribution of rents matters: Under the first best, payments should be such that $xb - r - T$ is a constant across realizable outcomes. Thus, in order to obtain the first best, the buyer must either directly or indirectly reveal the value of b . But since the first best entails $x \in (0,1)$ for all outcomes, there can be at most two values of T (realized along the equilibrium path) if the incentive compatibility constraint for reporting b is to be satisfied. Hence, $xb - r - T$ cannot in general be constant across all realizable outcomes if there are two or more values of $b > c$; the first-best outcome is

not generally attainable when the buyer is risk averse.

4. PUBLIC RESTRICTIONS ON PRIVATE CONTRACTS

The courts can play several important roles to facilitate contracting between two private parties. Perhaps the most important distinction between the court and the private parties is that the court possesses coercive power; a power that can be used to expand the set of enforceable contracts. For example, when the court enforces their contract, the parties can commit to a contract in which $A(p) + px > b$ for some values of b along the equilibrium path. Absent court enforcement, the buyer would always back out of the contract if such a value of b were realized.

In addition to expanding the set of feasible contracts, courts can and do place limits on the set of contracts that they consider valid and enforceable. In this section, we address the issue of whether such limits can enhance efficiency. Since some limitations are needed just to have contracts -- property rights, for instance -- we must be careful to make clear the sort of limitations with which we are concerned. We assume that the courts have defined a rule for determining the initial ownership of property. The limitations that concern us are conditions placed on the monetary transfers associated with a sale or transfer of ownership. For example, under the *penalty doctrine* courts are unwilling to enforce privately written clauses that impose "punitive" damages for breach of contract.

A. GENERAL OBSERVATIONS

When contracts are costlessly written and negotiated, and the private parties would agree to a first-best contract if left on their own, it is clear that court-imposed restrictions cannot improve matters and may well make things worse by making the first-best outcome unattainable. But what if it is costly to negotiate and write private contracts, or if the parties do not agree to a first-best contract? Even here one must be careful to assess whether the court can improve matters by limiting the contracts available to the private parties. In particular, *if the parties reach a second-best efficient contract and do so in a way that minimizes bargaining costs, then the courts*

can do no better than to leave the set of contracts unrestricted.^{11,12}

This observation borders on being a tautology. To give it some content, we need to establish conditions under which unconstrained private contracting will give rise to a second-best efficient outcome. Some additional notation is helpful. Let $U(C)$ and $\pi(C)$ denote the expected equilibrium utility levels under the contract C for the buyer and seller, respectively. A given set of contracts generates a collection of feasible utility pairs, the *utilities-possibilities set*.

Throughout, we assume that the *set of feasible contracts is invariant across rounds of bargaining*.

Strict Tradeoff Condition: *Consider any two contracts, C_0 and C_1 . If $U(C_1) \geq U(C_0)$ and $\pi(C_1) \geq \pi(C_0)$, with at least one inequality holding strictly, then there exists a contract, C_2 , such that $U(C_2) > U(C_0)$ and $\pi(C_2) > \pi(C_0)$.*

This condition states that the efficient frontier of utility allocations is downward sloping. The following lemma states one set of conditions under which it will be satisfied.

Lemma 1: *If each party is either risk neutral or is risk averse with utility equal to a negative exponential function of wealth, and lump-sum transfers are feasible, then the Strict Tradeoff Condition is satisfied.*

The proof of this result is in the Appendix. Absent the assumption about the principal and agent's utility functions, one would have to worry about income effects, and the above proof (which relies on lump-sum transfers) would not work.

It turns out that whether the private parties reach a second-best contract depends critically on the distribution of information at the time the initial contract is signed. We begin by

¹¹ It is sometimes argued that mandatory contracts are desirable because they save the parties the cost of designing their own contracts. This argument, however, provides a justification only for *standard* contracts, not for *mandatory* ones. One must still explain why the parties cannot be allowed to incur the costs of designing their own contracts if they so desire.

¹² We are implicitly assuming that the court could not costlessly restrict the parties to choosing what would otherwise be the equilibrium contract. If the court's costs of identifying this contract were lower than the private parties' minimal bargaining costs, such restrictions could be efficient. For a variety of reasons, however, it is hard to see how such an argument could serve as a credible basis for a policy that restricted private contracts.

considering what happens when the parties are symmetrically informed at the time that they reach the initial agreement. The following result is a restatement of Proposition 2 in Kreps [1990, p. 561]:

Proposition 6: *Suppose that the two parties are symmetrically informed and bargain by making alternating offers with costs of delay due to discounting. Moreover, suppose that the Strict Tradeoff Condition is satisfied and the utilities-possibilities set is convex, compact, and contains at least one point that both parties strictly prefer to no agreement at all. Then there is an essentially unique subgame perfect equilibrium and bargaining ends in the first round with agreement on a Pareto-efficient contract.*

We use the qualifier "essentially unique" to capture the fact that there may be more than one contract that yields the unique equilibrium utility levels.

Proposition 6 gives us conditions under which the legal system can do no better than to place no restrictions on the set of contracts from which the private parties may choose. The following corollary expresses these conditions in terms of the contract space and the parties' utility functions.

Corollary to Proposition 6: *Suppose that there is a finite set of feasible contracts and either: (1) the Strict Tradeoff Condition is satisfied and an offer consists of a probability distribution over this set; or (2) both parties are risk neutral and lump-sum transfers in any amount are feasible. If there is at least one contract that both parties strictly prefer to no agreement at all, then there is an essentially unique subgame perfect equilibrium and bargaining ends in the first round with agreement on a Pareto-efficient contract.*

Proof: Either set of conditions guarantees that the utilities-possibility set satisfies the conditions in the hypothesis of Proposition 6. (Use Lemma 1 for the risk-neutral case). **QED**

The conditions in the hypothesis of Proposition 6 are sufficient to guarantee the uniqueness of the subgame perfect equilibrium. It is a simple matter to prove that uniqueness

implies efficiency, and we record this fact in the following lemma:

Lemma 2: *Suppose that the two parties are symmetrically informed and bargain by making alternating offers with costs of delay due to discounting or per-round fixed costs. If there is an essentially unique subgame perfect equilibrium in the contract bargaining game, it is efficient.*¹³

As others have pointed out, when there are multiple equilibria that yield differing utility levels, subgame perfection alone is not enough to rule out inefficient equilibria.¹⁴ We present a simple example of this phenomenon in the Appendix. This example relies on a sort of bootstrapping to sustain inefficiency: Each party is afraid that if it proposes an efficient outcome then the continuation game will be played under an equilibrium that is highly unfavorable to that party.

When there are multiple equilibria, we need a refinement of subgame perfection to rule out inefficient outcomes. There are two forms the inefficiency may take. One, the parties might agree to an inefficient contract. Two, they might delay reaching an agreement for one or more rounds.

Monotone Acceptance Condition: *Suppose that at some date a party would accept an offer of contract C_0 , and suppose that another contract, C_1 , would yield that agent a higher expected utility level. Then if the party would accept contract C_0 at that stage in the bargaining, he or she also will accept contract C_1 .*

Stolen Thunder Condition: *Suppose that equilibrium entailed one party's making offer C in round t on the equilibrium path for some $t > 1$. Then he or she would accept an offer of C by the other party in round $t - 1$.*

Both of these conditions strike us reasonable ones for bargaining games of *complete* information. We prove the following result in the Appendix.

¹³ The proof is straightforward and we omit it here.

¹⁴ For an overview of these issues see Binmore, Osborne, and Rubinstein [1990].

Proposition 7: *Suppose that the two parties are symmetrically informed and bargain by making alternating offers with costs of delay due to discounting or per-round fixed costs. If the Strict Tradeoff, Monotone Acceptance, and Stolen Thunder conditions are satisfied, and there is at least one contract that both parties strictly prefer to no agreement at all, then bargaining ends with their agreeing to a Pareto-efficient contract in the first round of bargaining.*¹⁵

By Lemma 1, one could replace the *Strict Tradeoff Condition* in the statement of Proposition 7 with the requirement that each party is either risk neutral or is risk averse with utility equal to a negative exponential function of wealth and lump-sum transfers in any amount are feasible.

Propositions 6 and 7 suggest that there is little reason to believe that public restrictions on private contracts will improve efficiency when there are no externalities and the parties are symmetrically informed at the time of initial contracting. When the private parties are asymmetrically informed at the time of contracting, there is much less reason to believe that they will reach a second-best efficient contract, and the possibility arises that restrictions on private contracts could enhance efficiency in some circumstances. Aghion and Hermalin [1990] showed that contract restrictions may, in fact, enhance efficiency when initial informational asymmetries are present.¹⁶ When one party is better informed than the other, the terms asked for in the contract can reveal information, so the better-informed party can have an incentive to signal information through the terms for which he asks.¹⁷ For example, a railroad's customer might be

¹⁵ Both Propositions 6 and 7 can be modified by dropping the *Strict Tradeoff Condition*. The only difference is that then the parties will agree to a contract whose payoffs differ from the second-best payoffs by at most one round's worth of bargaining costs. This explains Friedman's [1989] finding that private parties may choose inefficient damage measures (relative to the class of allowed damage measures) when one side makes a take-it-or-leave-it offer (i.e., when later rounds are infinitely costly) and no lump-sum transfers are allowed.

¹⁶ Most previous evaluations of contract restrictions based on the efficiency criterion (e.g., Aghion and Bolton [1987], Chung [1989], and Rubin [1981]) were motivated by a concern for externalities (i.e., effects on third parties) rather than informational asymmetries.

¹⁷ The idea that the terms of a contract can be used to signal information is a well-known one in contract theory. Examples include Leland and Pyle [1977], who explain the financial structure of the firm in this way, Aghion and Bolton [1987], where an incumbent monopolist can signal information through the terms of an exclusive-dealing contract; Hermalin [1988], where contract length is a signal; and Spier [1989], where asking for a risk-sharing contract can signal information.

reluctant to announce the great importance that he places on the delivery of a shipment for fear that the railroad would then charge a much higher rate. But, then, the railroad may not take sufficient care to ensure timely delivery.¹⁸ Inasmuch as this signalling can lead to distortions in the contract (distortions that are undesirable from an ex ante perspective), restrictions on contracts that correct for these distortions can be valuable.

B. DAMAGES FOR BREACH OF CONTRACT

We can explore these issues further by considering court-imposed limits on damages for breach of contract in more detail. To do so, we first need to identify precisely what constitutes a damage clause and a restriction on it. In fact, we must confront the basic question of what is meant by breach of contract. Notice that the fill-in-the-price contracts analyzed above do *not* call for specific quantities to be transferred. Hence, breach by the buyer does *not* mean simply failing to accept delivery of the good; refusing delivery is one of the contingencies covered by the contract. Breach means a failure to make the *payment* called for by the contract.¹⁹ Thus, the issue here is much like the question of what it means for a securities buyer to breach a call option.

Whenever a contract is complete over the set of actions other than payments, the only form of breach is for one party to fail to make the monetary transfers called for by the contract. Once one has defined breach of contract in this way, the treatment of so-called "breach" of contract really becomes a question of limitations on the monetary transfer functions specified in private contracts.

Propositions 6 and 7 indicate that the parties will implement second-best contracts if they

These papers have not, however, examined the implications for the enforcement of contracts.

¹⁸ These, roughly, are the circumstances surrounding the famous case of *Hadley v. Baxendale*.

¹⁹ Note that there is an issue in the above mechanisms concerning 'breach' by silence; i.e., the seller refuses to announce a price or the buyer refuses to say whether he will buy. This 'breach' can be eliminated by expanding the mechanisms so that silence by the seller is equivalent to announcing some fixed price, and silence by the buyer is equivalent to agreeing to buy. There is also the possibility of 'breach' by the seller not delivering the good after the buyer agrees to buy it. This can be dealt with by expanding the mechanism to include an arbitrarily large transfer from seller to buyer to be paid if the seller fails to deliver the good.

are symmetrically informed at the time of contracting and the courts place no restrictions on what contracts they can write. In the specific context of breach of contract, this finding supports the view that courts should adopt a standard of *specific performance*. It is important to be clear about what we mean by specific performance here. As with the definition of breach, specific performance does *not* mean ordering a specific quantity to be traded. For example, suppose that the buyer and seller had signed a fill-in-the-price contract under which the *buyer* named the price and the *seller* chose the quantity. Moreover, suppose that the seller refused to deliver the good or pay the amount specified. Under a rule of specific performance, the court would respect the seller's decision not to supply the good, but would force him to make the appropriate payments so that the net transfer from the buyer to the seller was $A(p)$.

Our earlier analysis indicates that if mandatory damage measures are to be efficiency enhancing, the private parties must be asymmetrically informed at the time of contracting.²⁰ There are essentially three types of distortions that can arise from inefficient damage clauses: (1) inefficient transactions quantities; (2) inefficient risk sharing; and (3) inefficient investment levels. Below, we present two simple examples that illustrate how distortions (1) and (2) can arise, and how certain restrictions on damage measures could mitigate these distortions. Whether restrictions could limit inefficient investment remains an open question.

Example 1 (Inefficient Transactions Quantities): We begin by supposing that both parties are risk neutral, the seller makes no investment, and $c = 1.9$. There are two types of buyer, and each type is equally likely. The buyer knows his type at the time of initial contracting, but the seller does not. It is, however, common knowledge that for type-1 buyers, $b = 4$ with probability .5 and $b = 0$ with probability .5, while for type-2 buyers, $b = 3$ with probability .5 and $b = 1$ with probability .5. The value of b is realized after the contract is signed and is the buyer's private

²⁰ The notion that the presence of asymmetric information justifies the penalty doctrine has received more attention in the legal literature than in the economic literature (e.g., Clarkson et al. [1978]). Unlike our explanation, however, this work has focussed on the possibility of one party's being fooled or making a mistake at the time of contracting. The examples below suggest that restrictions on private contracts can be efficiency enhancing even when the parties are fully rational and are not "fooled" in equilibrium.

information. To close the model, we need to specify a contract bargaining process. In models with asymmetric information, the form of the process can have a strong effect on the results. Here, we suppose that seller makes a take-it-or-leave-it offer to the buyer at the initial contract stage. However, this offer can consist of a menu of contracts from which the buyer then chooses.

If we are to limit damages, we need to have some notion of what constitutes a damage clause in a fill-in-the-price contract. When the contract has the form $T(x) = px + A(p)$, one might interpret $A(p)$ as the penalty for breach by the buyer, at least in the case where the buyer is the one who chooses the transactions quantity. We will compare the unconstrained market equilibrium values of p and $A(p)$ with the outcome that arises when the value of $A(p)$ is restricted.

Consider, first, the equilibrium when there is no restriction on the $A(p)$ term in any contract of the menu the seller offers. It can be shown that in equilibrium the seller makes a take-it-or-leave-it offer with the following options for the buyer: contract 1 with

$$A_1(p) = \begin{cases} 0 & \text{if } p = 4 \\ -10 & \text{if } p \neq 4, \end{cases}$$

and contract 2 with

$$A_2(p) = \begin{cases} 2 & \text{if } p = 0 \\ -10 & \text{if } p \neq 0. \end{cases}^{21}$$

Faced with this menu, type-1 buyers chooses contract 1, while type-2 buyers choose contract 2. Neither type of buyer earns any expected surplus. Notice that, given contract 2, a type-2 buyer takes delivery of the good even when $b = 1$ since the seller will set $p = 0$; the parties agree to a contract that induces inefficient transactions quantities. While inefficient, this contract serves as a sorting device.

Now suppose that the court limits the set of damage clauses that it will enforce. One standard seen in the courts and economics journals is that of *reliance damages*. Under this

²¹ Actually, a family of contracts will work. But they are equivalent in terms of transaction quantities and expected surplus.

standard, damages for breach by the buyer are limited to the seller's reliance investment, which here is 0.²² Given our interpretation of damages in a fill-in-the-price contract, under this standard, the private parties are restricted to contracts with $A(p) = 0$.

Trivial calculations establish that the seller will offer a single contract with a fixed price of $p = 3$ (recall that the seller never learns the buyer's valuation of the good). Both types of buyer will accept the contract and will take delivery of the good if and only if their realized values of b are greater than c . Thus restricting the damages to zero leads to more efficient trade. In this particular example, there is a private value to the sorting (the seller's profits are increased), but there is no direct social value from the sorting. Banning the use of high damages undoes the sorting and increases total surplus.

Example 2 (Inefficient Risk Bearing): Aghion and Hermalin [1990] provide an example showing that the unconstrained market equilibrium can result in an inefficient allocation of risk. They consider, *inter alia*, a risk-neutral buyer and a risk-averse seller, and we can interpret their example as follows. The buyer's value of the good is $b = b_0$. There are two types of seller, and each type is equally likely. The seller knows her type at the time of initial contracting, but the buyer does not. It is, however, common knowledge that type- i sellers have cost $c = c_0 < b_0$ with probability ρ_i and $c = c_1 > b_0$ with probability $1 - \rho_i$, where $\rho_1 > \rho_2$.

Since the seller is risk averse, the first-best outcome would require that she receive a fixed profit. In terms of fill-in-the-price contracts, the first-best contract would have equilibrium payoffs equivalent to

$$A(p) = \begin{cases} k & \text{if } p \in \{c_0, c_1\} \\ -10 & \text{if otherwise,} \end{cases}$$

where k reflected the division of surplus between the two parties, and the seller named the price

²² We note in passing that the reliance standard is problematic at best when the seller can engage in positive levels of investment. If the investment level is unverifiable, then how is the standard enforced? And if the seller's investment level is verifiable, then why can't the private parties write a contract that specifies the reliance level directly? The existing literature on breach of contract does not adequately address this issue.

while the buyer chose the quantity. Note that the most that a buyer would be willing to pay is $k^* \equiv (b_0 - c_0)(\rho_1 + \rho_2)/2$.

Now, consider the equilibrium contract. A type-1 seller -- who is more reliable in terms of her likelihood of providing the good -- can demand a higher payment if she convinces the buyer she is type-1. Hence, she has an incentive to signal she is reliable by offering a contract that lowers her net payment if she fails to supply the good at a price of c_0 . This is a plausible way to signal because the expected cost of the rebate is greater the less reliable the seller is. The cost of signalling in this manner is that the risk-averse seller can end up bearing considerable risk.

To see that a prohibition on signalling can enhance welfare, note that a reliable seller might prefer the full-insurance pooling equilibrium -- although the payment is less than under a separating equilibrium, she avoids the excessive risk bearing. Of course, she cannot simply suggest the full-insurance pooling contract because the buyer might interpret this offer as a signal that the seller was unreliable. If, however, signalling is limited by restrictions on damages paid by the seller, then the seller's offer of a pooling contract is no longer informative. Consequently, the buyer will treat every seller as if she were of average reliability. Both types of seller are better off: an unreliable seller now looks average, while a reliable seller avoids the additional risks imposed by costly signalling.

We have argued that, in the absence of externalities, the role of the courts should be limited simply to enforcing specific performance when the private parties are symmetrically informed at the time of contracting. The two examples just presented, however, demonstrate that there can be scope for the courts to improve matters by restricting private contracting when the private parties are asymmetrically informed at the time of initial contracting. Unfortunately, each of these examples could be modified to show that there are other cases in which the restrictions considered here serve to lower, rather than raise, welfare. Whether workable rules can be developed to distinguish between restrictions that raise welfare and those that lower welfare remains to be seen.

6. CONCLUSION

We have demonstrated that structured renegotiation can serve as a natural and powerful mechanism for contracting on otherwise uncontractible information. In comparison with traditional analyses of sales contracts, which emphasize simple-fixed price contracts with penalties for failing to trade, our work shows that a little contractual sophistication can go a long way. Even a class of very simple contracts like fill-in-the-price agreements can be quite powerful. We have also argued that the role of the courts in limiting private contracts should itself be limited when the parties are sophisticated actors.

One might argue that our faith in renegotiation, structured or otherwise, is misplaced on the grounds that we have assumed that any contract renegotiation is perfect and costless, while in fact renegotiation may engender several types of costs. These costs may be direct transactions costs. Or they may be the losses due to the delay that can occur when bargaining takes place under incomplete information. Further, renegotiation can increase risk if the parties' bargaining power at the time of renegotiation is unknown at the time that the initial contract is signed -- to the extent that a party's payoff depends on the outcome of renegotiation, which itself depends on the distribution of bargaining power at the time of renegotiation, the possibility of renegotiation introduces additional uncertainty.²³ Finally, there is a growing literature that explores how renegotiation can lower welfare by undermining commitment.²⁴

It clearly is correct to argue that renegotiation is imperfect and sometimes may even lower welfare. But one should not take this argument too far and conclude that a court-imposed ban on renegotiation would raise welfare. The recognition of renegotiation costs implies instead that the courts should be willing to enforce private contracts that have clauses stating that no renegotiation

²³ The *Alaska Packers' Association v. Domenico* case illustrates this problem: the appellant (A.P.A.) hired the libelants as sailors and fishermen. Once the fishing season had begun and the libelants were in a remote Alaskan port, where their bargaining power was obviously greater, they stopped working and demanded higher wages. The appellant agreed, but later reneged. The court ruled in the appellant's favor and disallowed the renegotiation.

²⁴ Examples include Hart and Tirole [1988], Dewatripont and Maskin [1990], and Fudenberg and Tirole [1990].

will be allowed.²⁵

We close with the following observation. While there is no guarantee that contracts entailing structured renegotiation can attain the first best, they can improve efficiency over contracts that do not allow for filling in the blanks. This suggests that it is a mistake to think that efficiency requires initial contracts to be complete. Ayres and Gertner [1989] argue that courts should structure contract enforcement rules in such a way that private parties have an incentive to leave no gaps in the contracts that they sign. Our analysis suggests that this view needs to be redirected. It may well be more efficient to allow the parties to leave gaps in their initial contract that are later closed through renegotiation. Such an approach may economize on the cost of writing the contract and may be the only way in which to incorporate unverifiable information or deal with the inherent vagueness of language.

²⁵ For further discussion see Hart and Moore [1988] and Hermalin and Katz [1991b].

APPENDIX

Proof of Proposition 5: Consider $\langle T(m_s, m_b), x(m_s, m_b), M_s, M_b \rangle$, a balanced, sequential mechanism, where $m_s \in M_s$ is the message sent by the seller and $m_b \in M_b$ is the message sent by the buyer. By the revelation principle, we may assume that M_s is the set of possible types for the seller and M_b is the set of possible types for the buyer, where types can be multidimensional (*e.g.*, the seller's type could be her cost and the value of her private signal of the buyer's valuation). By hypothesis, the mechanism is efficient and thus $x(m_s, m_b) \in \{0, 1\}$ for all m_s and all m_b -- if not, there would be a type pair for which trade would be random, which would be inefficient.²⁶ Suppose the seller moves first in this mechanism. Having received a message m_s , the buyer chooses a reply to

$$\begin{aligned} & \text{maximize } bx(m_s, m_b) - T(m_s, m_b) \\ & m_b \in M_b \end{aligned}$$

Let $m^a(m_s)$ denote a value of m_b that minimizes $T(m_s, m_b)$ given that $x(m_s, m_b) = 1$ (if there is no m_b such that $x(m_s, m_b) = 1$, then define $T(m_s, m^a(m_s))$ to be an arbitrarily large number). Let $m^r(m_s)$ be a value of m_b that minimizes $T(m_s, m_b)$ given that $x(m_s, m_b) = 0$ (if there is no m_b such that $x(m_s, m_b) = 0$, then define $T(m_s, m^r(m_s))$ to be an arbitrarily large number).²⁷ Clearly, there is no loss of generality in restricting the buyer to announcing either that he accepts the good, in which case he pays $T(m_s, m^a(m_s))$, or that he rejects the good, in which case he pays $T(m_s, m^r(m_s))$, with the buyer accepting the good if and only if

$$b \geq T(m_s, m^a(m_s)) - T(m_s, m^r(m_s)) \equiv p(m_s).$$

²⁶ Actually, some care is required since an efficient mechanism can call for random trade when $b = c$. However, since $b = c$ is an occurrence with measure zero, requiring deterministic trade when $b = c$ cannot affect the investment decisions. Consequently, there is no loss in assuming that the mechanism is deterministic with respect to trade if it is efficient.

²⁷ If the minima do not exist, let $T(m_s, m^a(m_s))$ and $T(m_s, m^r(m_s))$ be the appropriate infima. It is straightforward to show that T must be bounded and thus such infima exist.

Define $\tilde{A}(m_s) \equiv T(m_s, m^r(m_s))$. We are done if we can show that any two messages, m_s and m'_s , that are *sent in equilibrium* and which map into the same price (i.e., $p(m_s) = p(m'_s)$) must also map into the same base transfer (i.e., $\tilde{A}(m_s) = \tilde{A}(m'_s)$). But given that they map into the same price, they must map into the same base transfer, since otherwise the seller would never send the message that mapped to the smaller base transfer. Therefore, there is no loss of generality in assuming that the seller announces p instead of m_s , where the set of possible prices is $p(M_s)$.

A similar proof can be applied when the buyer moves first. **QED**

Proof of Lemma 1: Suppose that $U(C_1) \geq U(C_0)$ and $\pi(C_1) \geq \pi(C_0)$, with at least one inequality holding strictly. The assumption that each party is either risk neutral or has a negative exponential utility function ensures that there are no income effects in the incentive constraints; thus lump-sum transfers can be used to pass money back and forth. Hence, there exists a contract, C_2 , differing from C_1 simply by an lump-sum transfer, such that $U(C_2) > U(C_0)$ and $\pi(C_2) > \pi(C_0)$.

An Example of an Inefficient Equilibrium

The following example illustrates the fact that the *monotone acceptance condition* is needed to ensure efficiency when there are multiple subgame perfect equilibria. Suppose that there are four potential contracts: $\{C_1, C_2, C_3, C_4\}$ such that

$$\pi(C_1) < \pi(C_2) < \pi(C_3) < \delta\pi(C_4)$$

and

$$U(C_4) < U(C_2) < U(C_3) < \delta U(C_1)$$

Notice that contract C_2 is Pareto inefficient. It is a simple matter to verify that there exists a subgame perfect equilibrium supporting C_1 (in all rounds, both parties offer C_1 , the buyer accepts only C_1 , and the seller accepts any contract) and another supporting C_4 (in all rounds, both parties offer C_4 , the seller accepts only C_4 , and the buyer accepts any contract). Moreover, the following strategies support C_2 as a subgame perfect equilibrium outcome:

In the first round, the buyer proposes C_2 .

In the first round, the seller accepts either C_2 or C_4 . If buyer offers either C_1 or C_3 in the first round, the seller rejects and the continuation equilibrium is the one supporting C_4 .

If the buyer offers C_2 or C_4 in the first round and the seller rejects the offer, then the parties play the continuation equilibrium supporting C_1 .

Proof of Proposition 7: Consider a candidate equilibrium in which the resulting contract, C_0 , is not second-best efficient. By the definition of inefficiency and the *Strict Tradeoff Condition*, there exists a contract, \hat{C} , such that $U(\hat{C}) > U(C_0)$ and $\pi(\hat{C}) > \pi(C_0)$. The party proposing the offer that is accepted in the candidate equilibrium could do better by proposing contract \hat{C} . By the *monotone acceptance* assumption, if the other party would accept C_0 , then it must accept \hat{C} . So, by contradiction, C_0 must be second-best efficient.

Moreover, the *Stolen Thunder Condition* implies that the parties must agree to C_0 in the first round because otherwise the party accepting C_0 in equilibrium would simply propose it one round earlier. **QED**

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