

# **Buyer-Option Contracts Restored: Renegotiation, Inefficient Threats, and the Hold-Up Problem**

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## *Abstract*

“Buyer option” contracts, in which the buyer selects the product variant to be traded and chooses whether to accept delivery, are often used to solve hold-up problems. We present a simple game that focusses sharply on subgames in which the buyer proposes inefficient actions in order to improve his bargaining position. We argue for one of several alternative ways to model this situation. We then apply that modeling choice to recent models of the foundations of incomplete contracts and show that a buyer option contract is sufficient to induce first-best outcomes.

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## 1. INTRODUCTION

In recent years a large literature has emerged dealing with the hold-up problem, in which parties to a contract fail to invest adequately in the relationship for fear of opportunistic renegotiation by their partners. Much of the inspiration for this literature (reviewed in Tirole [1999]) comes from the work of Oliver Williamson (e.g., Williamson [1985]), and has tried to formalize his idea that the protection of relationship-specific investments lies behind much of what we see in contracts and industrial organization. The formal literature has swung back and forth between papers arguing that the hold-up problem is unavoidable and papers with clever contractual solutions to the problem. The literature begins with Hart and Moore's (1988) argument for the unavoidability of hold-up, which was answered by Nöldeke and Schmidt's (1995) presentation of option contracts as a solution to the problem and by Aghion, Dewatripont and Rey's (1994) more general analysis of renegotiation design.

Several papers have presented conditions under which contracting, including the use of option contracts, seems to be useless if renegotiation cannot be prevented. In particular, Che and Hausch (1999), Segal (1999), and Hart and Moore (1999) all present models in which contracts can achieve nothing more than the "null" contract of no contract at all, so that contracts are inherently incomplete. If the parties could commit not to renegotiate the contract, they could be induced to invest efficiently in the contractual relationship. Such commitment, however, is typically impossible, and the parties will renegotiate the contract based on information they obtain after the contract is signed. One party may threaten inefficient contract performance (or non-performance) in order to strengthen his bargaining position in the ensuing renegotiation. Anticipating such a threat, the other party will be unwilling to invest efficiently in the trading relationship.

We argue that buyer-option contracts can solve many of these apparent hold-up problems. In analyzing such contracts, however, the timing of moves and the details of the game's structure are very important. It is easy to confuse "having all the bargaining power" with the ability to take a unilateral action, and to confuse outside options with actions that shift the *status quo* point of a bargaining game. Our goal in this article is to distinguish clearly between alternative ways of modeling buyer-option contracts and to explore what these distinctions imply for models of incomplete contracts and the hold-up problem. In particular, we show that option contracts undermine the credibility of inefficient threats and thereby restore efficiency even when the buyer has all the bargaining power. We apply our analysis to two models of the foundations of incomplete contracts, showing that properly specified buyer-option contracts are sufficient to attain the first best.

Our focus on the details of the contracting process and timing is in the same spirit

as in Watson (2003). Both papers argue that the “reduced form” modeling approach of mechanism design can be misleading when applied without regard to the specific circumstances of the setting being modeled. The papers differ greatly in approach, however, our focus being on the “buyer-option” contract and its performance while Watson’s analysis is more abstract. Watson (2003) criticizes the “mechanism design with *ex post* renegotiation” (MDER) approach developed by Maskin and Moore (1999) as being incompatible with sensible extensive forms and effectively slipping in contractual incompleteness as an assumption. His purpose is to integrate specifics of the order of play into mechanism design and thus disclose which orders of play do not fit the situations being modeled. Though the flavor of his point is the same as ours, his approach and style are quite different—more technical, and in the style of general mechanism design rather than investigating particular settings and contracts.

The rest of the paper is organized as follows. Section 2 presents a simple game that distinguishes sharply between bargaining power and the ability to make credible threats and discusses three ways to model the game. Section 3 illustrates how Section 2’s distinctions apply in the context of nuisance suits and strategic choice of legal remedies. Section 4 applies our analysis to two prominent models of incomplete contracts, and argues that the bleak conclusions these models reach are overturned through the use of buyer-option contracts, though Section 5 shows that adding incomplete information to the model reduces the attractiveness of buyer-options contract. Section 6 concludes.

## 2. ALTERNATIVE MODELS OF UNILATERAL ACTION

In this section we present a simple game that allows us to distinguish clearly between bargaining power and the ability to make credible threats. To place matters in sharpest relief, we focus on the case where just one player has the potential to hold up the other player opportunistically and that same player has all the bargaining power. The hold-up problem is especially severe when the opportunistic player has more bargaining power, so this is a natural starting point for seeing whether contracts can avoid the hold-up problem. If contracts can head off opportunism here, they can also do it if bargaining power is more equal.

What does it mean for one of the players in a game “to have all the bargaining power”? Economists normally use the phrase to mean that one player wins the entire surplus in the equilibrium of a reduced-form bargaining game. Suppose two players are splitting a “pie” of size 1, and if they both agree to the split  $(s, 1 - s)$ , that is what each receives, but if they disagree, each gets a payoff of 0. The economic definition of player 1 “having all the

bargaining power” is that  $s = 1$ ; he gets the entire surplus.

A simple way to model this, which by now is standard, is to model bargaining as a game in which player 1 gets to make a take-it-or-leave-it offer. Thus, the game is

1. Player 1 offers a contract consisting of the split  $(s, 1 - s)$ .
2. Player 2 accepts or rejects the contract.
3. If player 2 accepts, the payoffs are  $(s, 1 - s)$ , and if he rejects they are  $(0, 0)$ .

The only subgame perfect equilibrium of this game has player 1 offering  $s = 1$  and player 2 accepting any offer  $s \leq 1$ . This is easily adapted to become a model of equal bargaining power if we add an initial chance move that determines which player gets to make the take-it-or-leave-it offer, with equal probabilities.

An advantage of economic theory over looser thinking about bargaining is that this definition of bargaining power distinguishes strong bargaining *power* from a strong bargaining *position*. Consider the following example:

**Bargaining Power Game:** *John is selling Mary a car. John values the car at \$2,000, its market price. Mary, however, values the car at \$22,000 because she likes that car and does not know where to find a good substitute. On the other hand, Mary is a patient and skilled bargainer, and always takes 90 percent of the surplus in her bargains with John. Thus, the price they agree upon is \$4,000.*

In common language, people would have a hard time deciding whether to say Mary had weak or strong bargaining power. Economists, however, would say that Mary is in a weak bargaining *position*, but she has strong bargaining *power*. This is a distinction of great value. Despite Nash (1952) and Rubinstein (1982), we are still uncomfortable in saying that there is a unique solution to simple pie-splitting games. We are much more comfortable in specifying the size of the pie, which is simply a function of tastes, technology, and past actions of the players. Thus, we often make reduced-form assumptions about a player’s bargaining power in a way that we do not make them about a player’s bargaining position. It is dangerous to move beyond assumptions that concern how surplus is split—a zero-sum activity—to assumptions that restrict real actions. Allowing a take-it-or-leave-it offer is perilously close to allowing any threat whatsoever to be credible, but we make the assumption in bargaining games as a simplifying assumption that we do not think is critical to the outcome.

Bargaining has many more complexities than this, of course, but it provides a good starting point for analyzing them. The idea of “bargaining position”, for example, involves

both the status quo and the outside options players have, as Sutton (1986) points out.<sup>1</sup> Even a small shift in the *status quo* point affects the bargaining outcome if there are no alternatives to dealing with each other, but if there are, it may be those alternatives that determine the threat point. For our present purposes, such subtleties do not matter. Rather, we have laid out this simplest of bargaining models to contrast it with the situation in the contracting models we will next analyze, in which one player has a unilateral option that affects the payoffs of both players. In later sections we will make the option more specific in the context of particular models, but for now let us analyze a generic version of the situation that we will call “The Basic Game.”

*The Basic Game.* If action A is chosen by time  $T$ , then player 1 receives amount  $a_1$  and player 2 receives amount  $a_2$ , with  $a_1 > 0, a_2 > 0$ , and  $a_1 + a_2 = 1$ . If action A is not chosen by time  $T$ , both players receive zero. Whether action A is taken is under the control of player 1. The two players are bargaining over how to split the surplus from action A being taken, and Player 1 has all the bargaining power.

The element that distinguishes the Basic Game from a typical pie-splitting game is action A, which is under the unilateral control of player 1. The game as we have described it may seem rather abstract. This is intentional, as we are interested in applying this general game structure to several different settings. However, a concrete example might be useful first.

*The Suicide Bomber Game.* At the close of contract negotiations between Players 1 and 2, Player 1 pulls out a bomb, cradles it in his arms, and turns the switch from “No explosion” to “Explode in 5 minutes.” He then tells Player 2, “Unless you give me an extra \$10,000, I will let the bomb blow the two of us to smithereens. I know you value your life at exactly \$10,000 (compared to the mere \$9,000 value I place on my own life),

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<sup>1</sup>Sutton (1986) uses the context of an infinite-horizon bargaining game. He presents a simple alternating-offers bargaining game in which Player II has an “outside option” with value  $s_2$  that is always available. If the players have equal bargaining power (which means equal discount factors in the Sutton model), then Player I receives  $\min\{1/2, 1 - s_2\}$ . As Sutton puts it (p. 714) “[E]ither Player II’s option exceeds what he would have obtained in the original game, in which case Player I needs to offer (marginally more than)  $s_2$  to “buy him off”; or else it does not—in which case the threat of having recourse to the outside option is empty, and it has no effect on the outcome.” Sutton’s conclusion about the outside option is similar to our conclusion about Action A: a threat to make oneself worse off is not a credible threat.

and since I am a very good bargainer, I know you will pay me the full \$10,000 to save your life. Pay up or die.”

In this example, Action A is for Player 1 to turn the switch back to “No explosion.” Player 1 controls Action A—he can unilaterally stop the bomb from exploding at any time, by twisting back the lever to “No Explosion.” The issue with which we will be concerned is how, if at all, the bomber’s threat should be considered to alter the bargaining process over the contract. In particular, can the bomber use the threat to extort a larger share of the surplus for himself? Or is the bomb threat irrelevant to the contract negotiations?

How should the Basic Game be modeled? Should action A be modelled as just one more element of player 1’s proposal to player 2? (Model 1 below) Or should it be possible for player 1 to take action A anyway if player 2 rejects his take-it-or-leave-it offer? (Model 2) Or, since player 2’s acceptance or rejection is supposed to be the last move in the bargaining subgame, should his decision to accept or reject be simultaneous with player 1’s ultimate decision about action A? (Model 3)

We will present structured analyses of each of these alternatives using the notation  $(X; s, 1 - s)$ , where  $X \in \{A, \emptyset\}$  indicates that either Action A is taken or no action ( $\emptyset$ ) is taken, and  $(s, 1 - s)$  indicates each player’s share of the surplus. We will assume Player 1 has all the bargaining power and represent bargaining as taking place via one take-it-or-leave-it offer by Player 1 to Player 2 with no time discounting. This allows us to represent the alternative models as simple extensive-form games and does not sacrifice generality with regard to the timing of the bargaining process, since all that matters is the final offer.<sup>2</sup>

Our interest is in how the timing of the bargaining process interacts with Player 1’s opportunity to exercise his unilateral option on Action A. There are three relevant dates for our purposes: the date on which the final decision on Action A must be made ( $T$ ), the last date on which the Player 2 can respond to a bargaining offer (which we will call  $t^{**}$ ), and the last date on which Player 1 can make a bargaining offer (which we will call  $t^*$ ). By definition, it must be that  $t^* < t^{**} \leq T$ . A key difference between the models below will be that in Model 2,  $t^{**} < T$ , while in Models 1 and 3,  $t^{**} = T$ .

**Model 1** (see Figure 1)

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<sup>2</sup>See, *e.g.*, Chapter 12 of Rasmusen [2001]. If time discounting is unimportant, the sequence of offers and replies before the final offer and reply is irrelevant, as is whether they occur in continuous or discrete time. The sequence could be alternating offers by the two players with Player 1 going last, three offers by Player 1, or even 200 offers by Player 2 followed by one offer by Player 1; in each case Player 1 would have all the bargaining power since he gets to make a final take-it-or-leave-it offer.

1. At time  $t^*$ , Player 1 offers a proposal saying that he authorizes action A if player 2 agrees to the split  $(s, 1 - s)$ .
2. At time  $t^{**} = T$ , Player 2 accepts or rejects the proposal.
3. If player 2 accepts, the payoffs are  $(s, 1 - s)$  and action A occurs. If he rejects, action A is not taken, and the payoffs are  $(0,0)$ .

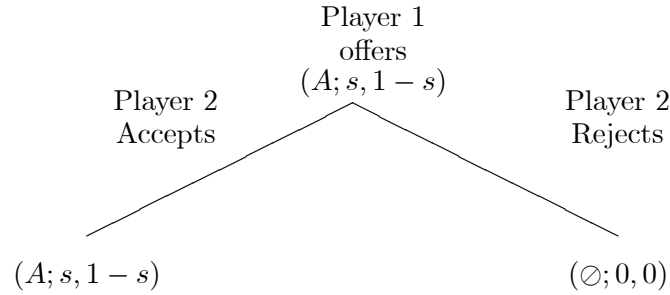


Figure 1: The Structure of Model 1

The unique subgame-perfect equilibrium in Model 1 is that Player 1 proposes the split  $(1,0)$ , Player 2 accepts any  $s \leq 1$ , and action A is taken.

### Model 2 (see Figure 2)

1. At time  $t^*$ , Player 1 offers a proposal saying that he authorizes action A if Player 2 agrees to the split  $(s, 1 - s)$ .
2. At time  $t^{**} < T$ , Player 2 accepts or rejects the proposal. If he accepts, the payoffs are  $(s, 1 - s)$  and action A occurs.
3. If Player 2 rejects the proposal, then at time  $T$  Player 1 chooses whether to unilaterally authorize action A. If he does, the payoffs are  $(a_1, a_2)$ , and otherwise they are  $(0,0)$ .

There is a unique subgame-perfect equilibrium outcome in Model 2: action A is taken and the split is  $(a_1, a_2)$ . A continuum of subgame-perfect equilibria support this outcome. Player 1 proposes any split with  $1 - s \leq a_2$ , and he authorizes action A unilaterally if Player 2 rejects the proposal. Player 2 accepts any offer with  $1 - s \geq a_2$ , and rejects otherwise.

This is the equilibrium because if Player 1 offers split  $(s, 1 - s)$  with  $1 - s < a_2$ , then Player 2 rejects the offer but Player 1 nevertheless takes action A. If Player 1 offers split  $(a_1, a_2)$ , then Player 2 is indifferent between accepting and rejecting Player 1's offer, but the outcome is the same in either case. Player 1 never makes an offer with  $1 - s > a_2$ .

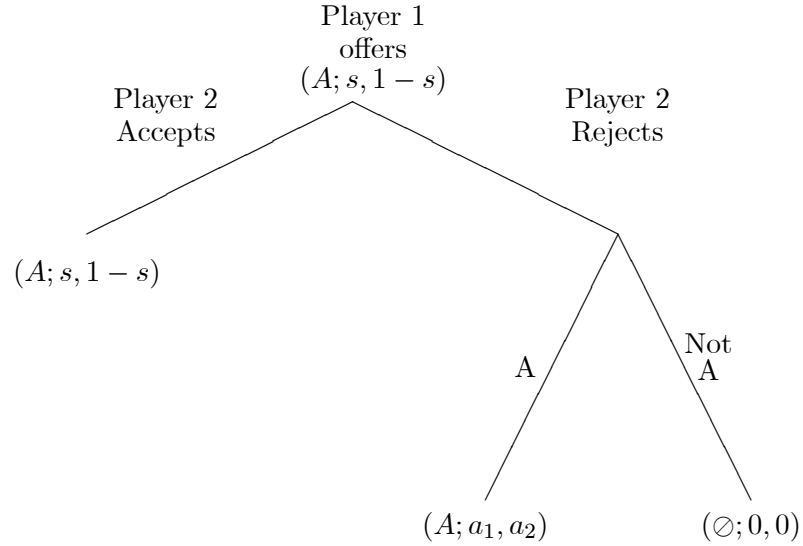


Figure 2: The Structure of Model 2

**Model 3** (See Figure 3)

1. At time  $t^*$ , Player 1 offers a proposal saying that he authorizes action A if Player 2 agrees to the split  $(s, 1 - s)$ .
2. At time  $t^{**} = T$ , two things happen simultaneously: (a) Player 2 accepts or rejects the contract, and (b) Player 1 chooses whether to unilaterally authorize action A or not.
3. If Player 2 has agreed to the contract, the payoffs are  $(s, 1 - s)$  and action A occurs (even if A was not independently authorized by Player 1). If Player 2 rejected the contract, then payoffs are  $(0, 0)$  unless Player 1 authorized A, in which case the payoffs are  $(a_1, a_2)$ .

Model 3 has two subgame-perfect equilibrium outcomes. In equilibria of type 3A, the equilibrium outcome split is  $(a_1, a_2)$ , Player 2 rejects Player 1's offer if it yields him less than  $a_2$ , and Player 1 authorizes action A in move 3 even if it was not part of the proposal in Move 1. Player 1's equilibrium strategy is to make any offer with  $(1 - s) \leq a_2$  and to authorize action A at time  $T$  regardless of whether the offer is accepted; Player 2 accepts any offer with  $(1 - s) \geq a_2$  and rejects otherwise.

In the unique equilibrium of type 3B, the split is  $(1, 0)$ , Player 2 accepts Player 1's offer of that split and authorization of action A, and Player 1 does not independently (and



redundantly) authorize  $A$  in move 3. Player 1's equilibrium strategy is to offer  $1 - s = 0$  and not to authorize action  $A$  at time  $T$ ; Player 2's strategy is to accept any offer with  $(1 - s) \geq 0$ .

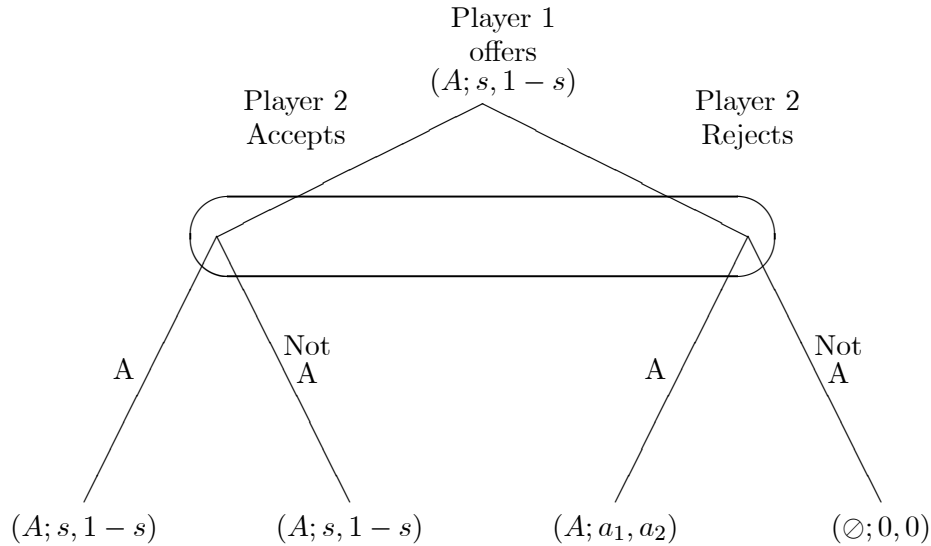


Figure 3: The Structure of Model 3

## 2.1 DISCUSSION OF THE MODELS

The attraction of Model 1 is that it preserves the simple idea that “all the bargaining power” means to be able to make a take-it-or-leave-it offer. However complicated the terms of the proposal may be, the modeler simply treats it as an indivisible unit and gives the weaker player the option only to accept or reject. Any alternative proposals or tentative actions before the last possible date of agreement are irrelevant, and by definition the players cannot take any actions after that date.

Model 1 is implicitly used in models of mechanism design with ex post renegotiation. There, the typical sequence of events is: 1. Contracting, 2. Investment, 3. Arrival of information, 4. A message game, 5. Renegotiation, and 6. Outcomes. Our “Basic Game” can be interpreted as including steps 4, 5, and 6, the play of the mechanism and the renegotiation. Player 1 sends a verifiable message to the court in response to some unverifiable event that he and Player 2 observe, and the court—which acts as the mechanism—carries out the terms of the agreement based on that message and on observable actions of the two players such as whether they accept delivery of a good. Renegotiation consists of both players agreeing to change the outcome after Player 1 sends a message that would result in inefficiency under the terms of the original mechanism. Model 1 implies that Player 1 may

have an incentive to send an inefficient message (“I will refuse to take action A unless you agree to the split  $(1, 0)$ .”) so as to initiate a renegotiation game in which he can capture all the surplus.<sup>3</sup>

We argue, however, that Model 2 is a better modeling choice. In Model 1, Player 1 is using a non-credible threat in effect, because action A is under his sole control, a unilateral decision. This is in contrast with splitting a surplus, a bilateral decision to which both players must agree or the surplus is lost.

Recall the Suicide Bomber Game. Is Player 1’s threat to detonate the bomb credible? No, not even if we say that he has all the bargaining power, unless by “have all the bargaining power” we are imposing conditions on what moves are allowed in a game. The problem is that Player 1 controls Action A all by himself. He can unilaterally stop the bomb from exploding, by twisting back the lever to “No Explosion,” even if Player 2 refuses to pay the \$10,000. If a player can unilaterally withdraw a threatened action, and can increase his payoff by doing so, then we should expect him to withdraw it. This is what we usually mean by “a non-credible threat”. If the threatened player refuses to be intimidated, the threatening player will bear a cost if he carries out his threat, and since carrying out the threat is entirely under his control, he will not do it. His bluff will be called.<sup>4</sup>

In light of the foregoing discussion, we argue that any reasonable model of the Basic Game must conform to what we will call the “axiom of unilateral action,” an axiom that rules out Model 1.

*Axiom of Unilateral Action:* In the Basic Game, Player 1 must have the option to make his decision on Action A unilaterally at any time up to and including time  $T$ .

The axiom does not distinguish between Models 2 and 3, which both satisfy it. The difference between them is that in Model 3 both decisions—player 1’s to independently take action A or not, and player 2’s to accept or reject—are crowded into the last time possible, time  $T$ , and hence are simultaneous. Equilibrium outcome 3A of Model 3 is the same as the equilibrium of Model 2, and equilibrium outcome 3B is the same as in Model 1. Equilibrium 3B, however, is made up of strategies that are weakly dominated for both players. Under

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<sup>3</sup>This is exactly the sort of situation studied by Ayres and Madison (1999), who discuss settings where parties threaten inefficient performance in order to enhance their bargaining power. Note that these authors do recognize that threats must be credible in the sense that the player making the threat is at least weakly better off if the threat is carried out.

<sup>4</sup>Matters are more complicated if there is a chance the suicide bomber obtains positive net utility from the explosion. We discuss the effects of incomplete information in Section 5 below.

no conditions does Player 1 do better by not authorizing A in Move 3 than by authorizing. He does worse by not authorizing if Player 2 rejects the contract. Under no conditions does Player 2 do better by accepting the (1,0) split than by rejecting. He does worse if player 1 authorizes A in move 3. Hence, we view Model 2 as the most appropriate way to represent the Basic Game.

We will show in the next section that acceptance of Model 1 implies acceptance of perverse conclusions in a variety of models commonly used in economics, and that the Axiom rules out these perverse results. Here, however, it may be useful to show the Axiom's radical implications in one influential context: the "mechanism design with *ex post* renegotiation" framework proposed by Maskin and Moore (1999).

Maskin and Moore (1999) use the following example to motivate their analysis. Two agents are affected by whether action  $a$ ,  $b$ , or  $c$  is chosen in state of the world  $\theta$  or  $\phi$ . We wish to find a mechanism that implements action  $a$  in state  $\theta$  and  $b$  in state  $\phi$ . Agent 1's preferences from worst to best are  $(b, c, a)$ . Agent 2's preferences from worst to best are  $(b, a, c)$  in state  $\theta$  and  $(c, a, b)$  in state  $\phi$ . Thus, if no renegotiation is possible, a mechanism that achieves  $(\theta : a, \phi : b)$  is to simply let Agent 2 choose between  $a$  and  $b$ .

But suppose we allow renegotiation. Assume that Agent 2 has control of the mechanism and has all the bargaining power. Maskin and Moore say that Agent 2 would then choose  $b$  in state  $\theta$ , even though that is Pareto-dominated by  $a$ . The reason is that he would then make Agent 1 a take-it-or-leave-it offer to renegotiate to  $c$ , and Agent 1 would accept. Thus, the buyer-option mechanism would fail to attain the desired result.

That story violates our Axiom of Unilateral Action. If the mechanism says that Agent 2 may revise his choice at any time until it would be too late to reverse the decision, then Agent 2's choice of  $b$  would not be a credible threat point. If Agent 1 refused to renegotiate in state  $\theta$ , Agent 2 would back down and switch his choice to  $a$ . Thus, a small revision to the mechanism—perhaps better termed a clarification—can achieve the first best.

### **3 LEGAL EXTORTION: NUISANCE SUITS AND THREATS OF INEFFICIENT PERFORMANCE OF CONTRACTS**

We will now explore the implications of the superiority of Model 2 in various economic and legal applications. In this section, we consider two legal settings in which one party may have incentives to threaten inefficient actions in order to extort payments from the other party. First, we discuss nuisance suits, as an example in which Model 2 reaches the result generally accepted by economists. Second, we examine the choice between injunctions and money damages as contractual remedies, which illustrates how legal rules determine

whether extortionary threats are credible. That done, we proceed in Section 4 to the more complicated situations of contracting with investment and possible renegotiation.

### 3.1 NUISANCE SUITS

We now present a simple model of nuisance suits in which we believe there will be no controversy over whether Model 2 is the most appropriate choice. In a nuisance suit, the plaintiff is suing the defendant in a case which has no probability of success if it goes to trial, provided that the defendant does pay to defend himself at trial. The plaintiff's only motivation is to induce the defendant to agree to a settlement offer and avoid the defense costs. In this case, the "Action A" of the Basic Game consists of dropping the lawsuit, which creates a surplus consisting of the avoided trial costs.

We will assume that the plaintiff has all the bargaining power. The sequence of events is:

1. Plaintiff sues Defendant.
2. Plaintiff makes a settlement offer to Defendant, in exchange for which Plaintiff agrees to drop the suit.
3. If the suit goes to trial, the plaintiff incurs costs of  $P$  and defendant incurs costs of  $D$ . The suit has zero probability of success, so no damages are paid.

If we accept the logic of Model 1, then Plaintiff can extract a payment of up to  $D$  from defendant by making the take-it-or-leave-it offer, "Accept a zero share of the surplus of  $P + D$  from avoiding trial, or go to trial." In contrast, the logic of Model 2 implies that division of the surplus is a separate issue from whether the action of dropping the suit will be taken, as a result of which the plaintiff will drop the suit if defendant refuses to pay extortion money.

In this stark setting, nuisance suits are not part of any reasonable equilibrium. The literature on nuisance suits takes the lack of nuisance suits in this simple model as its starting point, recognizing that a model needs additional features to generate credible threats and successful extortion. The literature considers a number of more sophisticated situations, and finds that nuisance suits can indeed emerge in equilibrium if, for example, there exists incomplete information about the plaintiff's "type," or if courts make predictable mistakes ( For a survey, see Rasmusen [1998]). But in this simple model, Model 2 is the appropriate representation, because the Plaintiff's threat to impose the costs of  $D$  and  $P$  on the defendant and himself is not credible.

### 3.2 SUCCESSFUL EXTORTION BASED ON COMMITMENT TO A LEGAL REMEDY

People do use the courts for extortion, but the extortionist's threat must be to do something which benefits himself, or it will not be credible. Judge Richard Posner, for example, has declined to grant an injunction for specific performance of a contract, explaining that "Probably, therefore, [the seller] is seeking specific performance in order to have bargaining leverage with [the buyer], and we can think of no reason why the law should give it such leverage." (*Northern Ind. Pub. Serv. Co. v. Carbon County Coal Co.*, 799 F.2d 265, 279-80 (7th Cir. 1986)). Although this case shows that extortion may fail because of an alert judge, it suggests that extortion can be credible enough that courts must worry about it.

Ayres and Madison (1999) analyze the kind of situation facing Judge Posner and further illustrate what happens in our Basic Game. Ayres and Madison's point of departure is an example based on *Peevyhouse v. Garland Coal & Mining Co.* 382 P. 2d 109 (Okla. 1962).

Suppose a miner has contracted to return the topsoil on a farmer's strip-mined land to its original position. The cost of moving the topsoil turns out to be \$30,000, even though the market value of the land would only rise by \$10,000 once the soil was returned. The farmer's gain from having the topsoil returned is not \$10,000, however, but only \$8,000, because he intends to keep living on the land rather than selling it. If the miner refuses to return the topsoil, the farmer can go to court and, we assume for the example, request either specific performance (the return of the soil) or money damages (the \$10,000 loss in market value).

The farmer has a strategic rationale for seeking specific performance, even though its benefit of \$8,000 is less than the benefit of \$10,000 from money damages. That is because the farmer would use his option to enforce the court's injunction as a bargaining chip to extract cash from the miner.

In terms of the Basic Game, Action A is the opportunistic farmer's choice to drop the request for specific performance. This would be efficient since enforcement of the injunction would cost the miner \$30,000 and only benefit the farmer by \$8,000. Dropping the injunction would increase joint surplus by \$22,000. Under the Nash bargaining solution where the parties split the surplus, each party would gain \$11,000 from the bargain. The miner's payment must also compensate the farmer for his \$8,000 in lost value from dropping the injunction, so the total payment from the miner would be \$19,000. This is what we expect the farmer to demand in return for dropping the injunction.

Can the miner expect the farmer unilaterally to take Action A and drop the request if the miner refuses to pay \$19,000? No—the farmer is better off getting the \$8,000 benefit

from specific performance than getting nothing. At this point, it is too late for the farmer to go back to court and ask for money damages instead, even though they would be greater; the law does not permit cases to be re-opened in this way. Thus, this example shows how an inefficient threat can be made credible by appropriately foreclosing the alternative option, money damages.

The example would turn out differently under a legal regime in which farmer had to seek money damages if the miner were to flout the injunction instead of asking the court to declare the miner in contempt and jail him until he complied. In this case, the farmer's threat to enforce the injunction would not be credible. The miner would know that the farmer would prefer the \$10,000 money damages from the flouted injunction to the \$8,000 from returning the soil.

The situation would not have arisen if the law had said that the farmer could only seek money damages (which is, indeed, the usual rule in contract law). Such a rule would protect the miner from extortion if the cost of returning the soil turned out to be unexpectedly high. Or, if the law allowed the parties to declare the remedy in advance in the contract, they would choose money damages to avoid extortion.

Ayres and Madison also mention the classic encroachment case of *Pile v. Pedrick*, 31 A. 646 (Pa. 1895). Pedrick built a factory wall with a foundation that mistakenly encroached onto Pile's land by about an inch. This is a case of property law, not contract law, so the common law does allow a court to require specific performance. The court offered Pile a choice of either money damages (which would be small) or a court order that Pedrick remove the wall (which would be very expensive for Pedrick). Pile asked for the court order. Pile's threat to enforce the court order was then credible; once he had made his choice, Pile no longer had the option of money damages. He did have the option to sell Pedrick the court order, however, and no doubt that is what he did.

These cases show how rigidities in the legal system can create opportunities for individuals to use inefficient threats for extortionary purposes. In both the cases discussed above, the legal rules violate our Axiom of Unilateral Action, and render inefficient threats credible. The cases underline how important it is for parties to be able to choose efficient clauses in a contract. In *Pile v. Pedrick* there was no contract: the interaction between the two parties was involuntary, so they had to rely on default legal rules, and those default rules were the ones for property, not contract. In the Peevyhouse example, however, if the law had allowed the parties to choose the enforcement rule in their contract they would have chosen money damages and the result would be efficient. In our next section, we will show the value of free contracting in avoiding the hold-up problem in investment.

## 4. TWO MODELS OF INCOMPLETE CONTRACTS

This section presents simplified versions of two prominent models that aim to show the ineffectiveness of contracting in certain settings with hold-up potential, *i.e.* that try to provide foundations for contractual incompleteness. We show how they relate to our Basic Game and illustrate the implications of the three modeling scenarios we discussed in Section 2. We conclude that the use of buyer-option contracts overcomes the contracting problems considered in these papers. As a result, we call into question whether the hold-up problem can explain contractual incompleteness in the ways it has so far been formally modelled.

Throughout this section, we will assume that Buyer, the opportunistic player, has all the bargaining power, in that he has the ability to make a take-it-or-leave-it offer. However, he also has a unilateral option that controls the trade decision. As in the Basic Game, we assume that one player— the Buyer— possesses the option up until time  $T$ . In Section 4.1, the option— action A—will be whether to accept delivery of the good; in Section 4.2, the option is to require Seller to deliver the efficient product variant or a different one.

### 4.1 THE CHE-HAUSCH MODEL OF COOPERATIVE INVESTMENT

Let us analyze a simplified version of the model of Che and Hausch (1999), who consider a situation of bilateral monopoly in which both parties can make investments. Their paper derives sufficient conditions for contracting to be worthless when renegotiation cannot be prevented. One such condition is that investments by the two parties are supermodular (*i.e.* have marginal social values that increase with the other party’s investment) and sufficiently cooperative (*i.e.* they primarily provide a direct benefit to the other party).<sup>5</sup> Perhaps the most natural example of cooperative investment is an investment by the seller that improves the quality of the product provided. Alternative sufficient conditions for contracting to be worthless are that only one party invests and the investment is purely cooperative, which is the situation in the model we will analyze here.

In the model, Seller is to provide a good to Buyer, and can invest  $e$  to improve the quality of the good. Once the investment has been made, production costs Seller a fixed amount  $c$ . Buyer obtains value  $V(e)$  from the good, with  $V'(e) > 0$ . The investment is thus what Che and Hausch term a purely “cooperative” investment, since it directly improves the payoff of the other player (the term “cross investment” has also been used for this). Buyer has all the bargaining power.

The sequence of moves is as follows:

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<sup>5</sup>For a model that more extensively looks at different kinds of “cross- investments” in which one player’s investment helps or hurts the other player, see Guriev (2003).

1. Buyer offers Seller a “buyer option” contract of the following form. Seller pays Buyer a fixed fee  $F$  upon signing the contract and produces the good. Buyer, on observing the quality of the good, decides whether to accept delivery at any time up to time  $T$ ; If Buyer accepts delivery, Seller is paid  $P^*$ .
2. Seller accepts or rejects the contract.
3. Seller invests  $e$ .
4. Buyer decides whether to accept delivery or not. If he accepts delivery, Buyer pays  $P^*$  to Seller and Seller incurs  $c$  in production cost.
5. If Buyer refuses delivery, then renegotiation can occur, *i.e.* Buyer can make a take-it-or-leave-it offer to Seller.
6. Seller decides whether to accept or reject the new offer.
7. If we follow Model 1, the game ends. If we follow Model 2, Buyer again decides whether to accept delivery, subject to any contract modifications mutually agreed upon in stages 5 and 6.

In this model, Action A is acceptance of delivery. The socially optimal investment maximizes  $V(e) - e$ , which requires  $V'(e^*) = 1$ . If renegotiation could be prevented, then this level of investment could be implemented simply by setting  $P^* = V(e^*)$ . Assuming trade is valuable, Buyer would accept delivery if  $e = e^*$  and Seller would be willing to make the investment. Surplus can be divided between the two parties by an appropriate selection of the fixed fee  $F \in (0, V(e^*) - e^* - c)$ . Since Buyer has all the bargaining power, he will make an offer of  $F = V(e^*) - e^* - c$ , which will leave the Seller indifferent about accepting the contract.

When renegotiation is possible, Model 1 implies the contract will result in extortion: even if  $e \geq e^*$ , Buyer will refuse delivery in stage 4. Then in stage 5 Buyer will make a take-it-or-leave-it offer of  $P = c$ . Anticipating this, Seller expects to only to recover his production cost,  $c$ , for the good and will not invest. He chooses  $e = 0$ .

Model 2, however, leads to a very different outcome. Suppose Buyer refuses delivery at stage 4, and then at stage 5 offers Seller price  $P = c$  in exchange for agreeing to delivery. What will happen if Seller now rejects Buyer’s offer? Buyer’s initial message was that Seller should not deliver the good. In Model 2, however, Buyer will “change his mind” and accept delivery according to the original contract terms, as he is entitled to do at any time up to



$T$ .<sup>6</sup> As a result, Seller is willing to invest in product quality, and the optimal investment can be achieved by setting  $P^* = V(e^*)$ .

Is it reasonable to assume that the contract can specify that the Buyer can decide whether to accept delivery up until time  $T$ , rather than being bound by an earlier refusal of delivery? This is equivalent to including in the contract the instructions that even if Buyer initially signs a document that says “I refuse delivery, ” he can unilaterally replace it up until time  $T$  with a document that says “I accept delivery according to the original contract terms if Seller has not delivered to you a document, with both our signatures on it, agreeing to revised terms.” Such a clause is well defined and easy to write, and neither party would have any reason to object to it.

## 4.2 THE HART-MOORE MODEL OF PRODUCT COMPLEXITY

Hart and Moore (1999) present a model of a buyer and seller who are contracting for production and delivery of a “special” widget.<sup>7</sup> They consider an environment in which it is impossible to know in advance which of  $N$  possible widgets will be desired, *i.e.* “special.” They argue that as  $N$  goes to infinity, the value of writing a contract goes to zero. In this section, we discuss a variant of Hart and Moore’s formulation in which the parties use a buyer-option contract.<sup>8</sup>

At the outset of the game, Buyer and Seller sign a contract. After the contract is signed, Seller invests  $\sigma$  in cost reduction. With probability  $\pi(\sigma)$ , the cost of the special widget is  $c_L$ , and otherwise it is the greater amount  $c_H$ . Buyer’s value for the special widget is  $v$ , which is greater than  $c_H$ . There are also  $N - 1$  generic widgets that might be produced, which have positive but trivial value for Buyer. Generic widget  $n$  has production cost  $g_n = c_L + (n/N)(c_H - c_L)$ , so the generic widget costs are spread evenly between  $c_L$  and  $c_H$ . The problem for Buyer and Seller is that by assumption the contract cannot specify either Seller’s investment  $\sigma$  or that the widget delivered be the special widget. Furthermore, it is only after Seller has invested in cost reduction that the parties learn which widget is the

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<sup>6</sup>One might think there would be an equilibrium in which Buyer was willing to refuse delivery because he is indifferent between accepting a good of quality  $V(e^*)$  at price  $P^*$  and refusing it, and that as a result, Buyer’s threat not to accept delivery would be credible. Such an equilibrium does not exist. If Seller anticipated that Buyer would refuse delivery when indifferent, Seller would choose  $e = e^* + \epsilon$ , for  $\epsilon$  arbitrarily small, so as to make Buyer strictly better off accepting delivery than rejecting.

<sup>7</sup>Their model is based on Segal (1999), but uses a specification that is much simpler to analyze.

<sup>8</sup>Hart and Moore (1999) point out that the somewhat unusual production process in their model avoids the criticisms of similar models raised by Maskin and Tirole (1999), or, less technically, Maskin (2002). Our criticism is unrelated to that debate.

special one; earlier, the best they can do is identify specific widgets by, say, color.<sup>9</sup> Thus, the initial contract could say, “Deliver the red widget,” but it could not say, “Deliver the special widget.” Even after the parties learn which widget is the special one, they cannot verify this in court.

We will assume that the buyer has all the bargaining power, e.g., the buyer can make the seller a take-it-or-leave-it offer. The sequence of events is as follows.

1. Buyer offers Seller a buyer-option contract that grants Buyer the right *ex post* to specify the widget to be delivered at any time up to  $T$ , and pays Seller amount  $F$  immediately (where  $F$  could be negative).
2. Seller accepts or rejects the contract.
3. Seller invests  $\sigma$  in cost reduction, and the probability the cost of the special widget is  $c_L$  instead of  $c_H$  is  $\pi(\sigma)$ .
4. The identity of the special widget is revealed to the parties.
5. Buyer specifies a widget to be delivered.
6. Renegotiation can occur, *i.e.* Buyer can make a take-it-or-leave-it offer to Seller.
7. Seller decides whether to accept or reject the new offer.
8. If we follow Model 1, the game ends. If we follow Model 2, Buyer may specify a different widget to be delivered, subject to any contract modifications mutually agreed upon in stages 5 and 6.

In this model, Action A is Buyer’s specification that he wants the special widget to be delivered. In the absence of a contract (under the “null contract”), Seller would choose investment level  $\sigma = 0$  and the two players would agree on a price of  $p = c_L$  or  $p = c_H$ , depending on the cost of the special widget. Buyer would be allowed to choose which widget he wanted, or, equivalently, to refuse delivery if he did not like the widget that Seller presented to him. Buyer would choose the special widget. This would be the equilibrium because Seller gains nothing by deviating to positive investment. In the bargaining over the price, Buyer will pay him no more than cost anyway, so there is no point in Seller trying to reduce the cost.

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<sup>9</sup>Hart and Moore (1999) also consider a case where even the color of the widget cannot be described in advance.

If, contrary to the assumptions, it were possible to include Seller's investment amount and the cost and identity of the widget in the contract, the first-best can be achieved. Buyer and Seller would agree to a price of  $c_L$  or  $c_H$  for the special widget, depending on its cost, with a requirement that Seller choose the first-best investment level,  $\sigma^*$ , and an upfront payment from Buyer to Seller of  $F = \sigma^*$ .

If the investment amount of widget identity cannot be specified in the contract but, contrary to the assumptions, renegotiation is not possible, the first-best can still be achieved. Buyer and Seller would agree to a price of zero for whichever widget the Buyer picks and an upfront payment from Buyer to Seller of  $F = \sigma^* + \pi(\sigma^*)c_L + (1 - \pi(\sigma^*))c_H$ , enough to cover both the first-best investment cost and the expected production cost for the special widget. Seller would find it in his self-interest to set  $\sigma = \sigma^*$  and Buyer would find it in his interest to choose the special widget for delivery.

Under the actual assumptions of the model, however, Hart and Moore argue that a contract can accomplish little. The best a contract can do is to specify in advance that one of the widgets (say, the red one) is to be delivered at a fixed price, say  $P_0$ . If in fact the red widget is the special widget, then the contract is performed as written. If not, the parties renegotiate so that the special widget is delivered. Because Buyer has all the bargaining power, Seller earns a zero share of the incremental surplus that is created by renegotiating from the undesired red widget to the special widget. Since he does not benefit from the cost of the special widget being low unless the red widget is the special widget, Seller has inefficiently low incentives to invest in cost reduction. He fails to capture the full benefits of his investment; indeed, he captures only a share  $1/N$  of those benefits, so as  $N$  goes to infinity, his share goes to zero. As a result, his investment goes to zero, as well, and the null contract is as good as any other contract.

Hart and Moore implicitly use Model 1 as the framework for their analysis. Buyer will not immediately select the special widget. Rather, if the special widget happens to have the low cost of  $c_L$ , Buyer will initially select the most costly generic widget— the “gold-plated” widget— which has cost  $c_H$  in the limit as  $N$  goes to infinity. He then extorts a payment from Seller in exchange for allowing Seller *not* to deliver the costly generic widget. Thus, under Model 1, when renegotiation cannot be prevented, contracting becomes valueless.

Applying Model 2 leads to very different conclusions. It implies that Buyer's extortion threat is not credible. Suppose the contract specifies delivery of the Buyer's choice of widget at price  $P_0$ , and that the special widget turns out to be the cheapest to produce. Seller would make  $P_0 - c_L$  if Buyer were to nominate the special widget. Suppose instead that Buyer proposes delivery of the gold-plated widget, which has cost  $c_H$ , and then offers

Seller a renegotiated price of  $P_1 = P_0 - (c_H - c_L)$ , leaving Seller with payoff  $P_0 - c_H$ . What happens if Seller rejects the offer? The contract requires delivery of the costly but worthless gold-plated widget. In Model 2, Buyer takes action A and “changes his mind,” ordering the special widget at time  $T$ . Thus, in Model 2, Buyer will specify the special widget and Seller will deliver it. Using Model 2, the simple “buyer option” contract is first best, even in a complex environment where it is impossible to determine *ex ante* which widget will be special *ex post*.<sup>10</sup>

The incomplete contracting papers we have re-examined in this section share the common structure of mechanism design models with *ex post* renegotiation. In both the Che-Hausch and the Hart-Moore models, the first-best could be achieved were the parties able to commit not to renegotiate. The possibility of renegotiation makes it impossible for the parties to recover the full marginal value of their investments, and hence underinvestment occurs. Furthermore, in both sections, the value of contracting goes to zero as certain parameters of the model go to their extremes.

We have argued that mechanisms with renegotiation are fundamentally changed when one contractual party has an option, *i.e.* can unilaterally determine the outcome of the mechanism. In effect, the ability of this party to unilaterally “change his mind” if the other party rejects a renegotiation overture undermines the option-holder’s threat to be opportunistic, and restores commitment to the original contract terms.

## 5 LIMITS TO THE USE OF BUYER-OPTION CONTRACTS

We have argued that buyer-option contracts can be powerful tools for alleviating hold-up problems. Nevertheless, such contracts are not a panacea. In particular, information problems threaten the efficiency of option contracts. For example, Edlin and Hermalin (2000) consider a model similar to that of Che and Hausch (1999) in which the trading opportunity is of unlimited duration. They argue the buyer then has incentives to delay exercising an option until it either expires or is “out of the money,” *i.e.*, financially unattractive for the

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<sup>10</sup>Watson (2003) presents a numerical example (his “Example 3”) intended to show that in the Hart-Moore model with *ex post* renegotiation, there exist settings in which contracts cannot implement the first best. His example does not violate our Axiom of Unilateral Action, but it is different from the Hart-Moore model because the source of inefficiency is not renegotiation. In Watson’s example, the seller’s investment does not simply reduce costs, but also generates an extremely high payoff to the buyer from making a suboptimal trade decision. This structure has the benefit of rendering credible the buyer’s threat to take an inefficient action. The difference from Hart and Moore is that the problem is not renegotiation. Even when renegotiation is ruled out by assumption, no contract could induce a high level of investment in the Watson example. It thus sheds little light on the role of renegotiation in the holdup problem.

buyer, at which point the buyer can engage in opportunistic renegotiation. However, they implicitly assume it is impossible to index the option's strike price to changing economic conditions, although the empirical literature provides numerous examples of successful price adjustment provisions in contracts.<sup>11</sup>

More serious are situations of incomplete information. Let us see what happens when we extend section 4.2's Hart-Moore model of product complexity to allow the seller to be uncertain about the buyer's preferences.

We have already seen that because of the difficulty of describing the product to be produced while giving the seller the proper incentives for investment, it is desirable to use a buyer option contract, allowing the buyer to refuse delivery if he is dissatisfied with the product. The real world does have such contracts, but under incomplete information they make the seller vulnerable to a different kind of manipulation than the problem Hart and Moore describe. What if the buyer tells the seller, after the contract is signed, that he wants a product that is very expensive to produce? That does happen with some probability in the Hart and Moore model, because the special widget may turn out to be expensive. Information is complete and symmetric, however, so in their model the contract price is high enough that on average the seller can break even, and the buyer is willing to pay that high price because he knows he might end up wanting a widget that is expensive to produce.

Suppose, however, that information were incomplete and asymmetric, so the buyer knew in advance whether he wanted an expensive widget, but the seller did not know whether he faced a buyer with that kind of expensive taste. All buyers would pretend to have inexpensive tastes, the seller would charge a price high enough to cover the probability of having to deliver to both kinds of buyers, and buyers with inexpensive tastes would decide not to buy. This adverse selection could result in the market breaking down completely. The buyer-option contract makes it a lemons market even though adverse selection was not originally a problem. As a result, the buyer and seller would abandon buyer-option contracts and instead use some inferior contract such as the null contract that does not leave the seller vulnerable to buyers with expensive tastes.

Formalization of this idea will make it clearer. Let us add the following wrinkle to the Hart-Moore model. With probability  $\theta$ , the buyer is "normal": his favorite widget is the special widget, with a value of  $v$  and a production cost of either  $c_L$  or  $c_H$ . With probability  $(1 - \theta)$ , however, he is "finicky" and his favorite widget is a "superspecial" widget that he values at  $\tilde{v} > v$  and which costs a fixed  $\tilde{c}$  to produce. At the time of contracting, the buyer's

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<sup>11</sup>For example, Joskow (1990) studies price adjustment clauses in coal contracts, emphasizing how few price renegotiations occurred in coal contracts even during periods with substantial changes in market conditions.

type is known to the buyer but not to the seller. As before, we assume that the buyer has all the bargaining power in the sense that he can make take-it-or-leave-it offers in contract negotiations. We will allow either  $\tilde{v} > \tilde{c}$ , or the opposite, in which case no trade should take place unless the buyer is normal. Crucially, assume that the superspecial widget's cost is very high relative to the value of the special widget:

$$v < \theta c_L + (1 - \theta)\tilde{c}.$$

The null contract works much as before: the seller will choose zero investment in cost reduction. Once the cost of the special widget is known, the normal buyer will offer to buy the special widget at a price equal to its cost, either  $c_L$  or  $c_H$ . The finicky buyer will either offer to buy the special widget at its cost, if the cost is  $c_L$  and  $(\tilde{v} - \tilde{c}) < v - c_L$  or the cost is  $c_H$  and  $(\tilde{v} - \tilde{c}) < v - c_H$ , or the superspecial widget at its cost of  $\tilde{c}$  otherwise.

In the original model, with complete information, the buyer-option contract specified that the buyer pay the seller  $\sigma^*$  plus the price  $p = \pi(\sigma^*)c_L + (1 - \pi(\sigma^*))c_H$  up front, and that the buyer choose which widget was to be delivered. Under that contract, the seller's profits would now be negative for large enough  $\tilde{c}$ , because with probability  $(1 - \theta)$  the buyer will be finicky and choose the superspecial widget regardless of its cost. For the seller's expected profit to equal zero, a pooling contract, offered by both types of buyers, must have a price  $p$  such that

$$p \geq \theta c_L + (1 - \theta)\tilde{c}.$$

This, however, is impossible under our cost assumption, because  $v < p$  and the buyer would prefer no contract at all. A buyer-option contract must therefore contain a price so high that only finicky buyers choose it—a price of  $p = \tilde{c}$ . Even the finicky buyers will find this no better than the null contract, and possibly worse (depending on the parameters and the special widget's realized cost). The buyer-option contract now fails as a solution to the problem of unverifiable product quality.

This model illustrates how incomplete information can exacerbate the hold-up problem by destroying the feasibility of buyer-option contracts. In such a setting, the parties must resort to other contractual arrangements that fail to support first-best levels of investment. The basic intuition of Hart and Moore (1999) is restored, but only because of the incomplete information.

## 6 CONCLUSION

The timing of moves and the details of the particular setting are critical when one party can take a unilateral action. This general point has been made before, *e.g.* by Sutton

(1986) in the context of bargaining theory and by Aghion, Dewatripont and Rey (1994) in the context of contract theory. Nevertheless, its implications are sometimes forgotten. In mechanism design models, in particular, a unilateral threat is sometimes taken to represent the outcome of a mechanism that sets the *status quo* point for subsequent renegotiation. We argue that such a modeling structure grants too much commitment power to the unilateral actor. Instead we advocate a modeling approach that treats the unilateral threat as an outside option that must improve the actor's payoffs if it is to be credible.

Our approach leads to radically different—and, we believe, more reasonable—outcomes in received economic models of nuisance suits and incomplete contracting. This is particularly important in hold-up models, where our approach implies a substantially smaller scope for hold-up than does the mechanism design approach. Indeed, we have seen that in models of the foundations of incomplete contracts, the first-best can be achieved through the use of buyer-option contracts.

We would like to see future work on contracts reflect a closer connection between theory and empirics in the style of, for example, MacLeod and Malcomson (1993). There is a large empirical literature on contracts grounded in the perspective of Williamson (1985), but additional work is needed to test the implications of alternative formal theories of contract. Our analysis suggests that buyer-option contracts ought to be observed empirically in settings with complex products or cooperative investments where the contracting parties have good information about one another. Where the parties possess incomplete information about each other, however, buyer-option contracts should be less prevalent. From the perspective of theory, there is a need for work that is grounded in the realities of contract. As we showed in section 3, legal rules can have strong implications for which inefficient threats are credible in particular settings. In addition, most information is neither costlessly verifiable nor fully non-verifiable; instead, information can be verified with increasing precision as more resources are lavished on verification. Similarly, renegotiation is neither instantaneous nor costless; accepting this reality may lead to extensive-form models that better reflect the type of contracts we see in use, as illustrated by Lyon and Huang (2002), Rasmusen (2001b), and Schwartz and Watson (2000).

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