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**Economic and Legal Aspects of
Costly Recontracting**

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Abstract

This paper explores how the opportunity to recontract affects investment and trade in contractual relationships when it is assumed that renegotiation is costly. In this world, recontracting retains much of the benefit that has been ascribed to it, including the realization of any surplus that is available ex post. Costly recontracting also mitigates the well-known drawback, that parties who expect to renegotiate sometimes cannot credibly commit to invest efficiently. This is because the attractiveness of renegotiation decreases in recontracting costs. We show that the optimal contracting environment often involves moderate recontracting costs, which balance the beneficial and detrimental effects of renegotiation. Our result stands in contrast to those derived in common models that assume unrealistically either that recontracting costs are zero or that they are infinite. We discuss implications for the design of legal institutions, governance systems, and contractual form.

1. Introduction

Legal and economic views of renegotiation diverge substantially. Contract law will not enforce a renegotiation that merely redistributes wealth (for example, by exploiting sunk cost investment)[1]. Otherwise, the law encourages recontracting for two reasons: First, the modified contract is thought better to reflect the parties' intentions because it was made in light of more current circumstances. See Snyder (1999). Second, renegotiation can be ex post efficient because it permits the parties to realize gains that would have been lost under the original

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[1]When enforcement is costly, the party with the best outside option may refuse to perform unless the other party agrees to raise the recalcitrant party's payoff. Contract law bars these modifications either on the ground that to exact them is to practice economic duress or on the ground that the new payoff promise is without consideration. These legal rules are efficient if parties who anticipate being exploited in a renegotiation would underinvest.

contract. See Johnston (1994). The law's preference for renegotiation is so strong that a term in the initial contract that prohibits recontracting is unenforceable. In contrast, economists often assert that the ability to recontract can distort incentives, even when it creates value ex post. For example, in Holmström's (1982) analysis of team production with unverifiable effort, first best incentives can be provided to all agents *only* if the team can commit to discard its output in some contingencies (an ex post waste). Further, literature on the "hold up" problem has tied investment distortions to the inability of parties to commit to trade with one another after investment has been sunk. See Klein, Crawford, and Alchian (1978), Williamson (1979), and Grout (1984). More generally, economists have identified settings in which recontracting may be useful and settings where recontracting has a detrimental effect. However, neither the economics nor contract law literatures have emphasized distinctions between recontracting's beneficial and detrimental roles, and for the most part these literatures continue to take an analytical perspective that focuses only on the polar cases of recontracting: costless renegotiation on one hand, complete inability to renegotiate on the other. In this paper, we take a more nuanced view, which differentiates among the positive and negative effects of recontracting and addresses the middle ground of recontracting cost.

Recontracting has several benefits and one drawback. On the downside, as just said, the ability to recontract can adversely affect ex ante incentives by allowing parties to renegotiate out of low value outcomes, the specter of which might otherwise have induced efficient investment. Recontracting costs can be a deterrent to such renegotiations because recontracting becomes less attractive as its costs increase. We denote this deterrent effect of transaction costs the *sabotage value* of costly recontracting.[2]

Renegotiation also has benefits, the values of which low recontracting costs can enhance. First, renegotiation permits the realization of ex post surplus, which we call the *ex post value* of recontracting. Second, renegotiation can allow *flexibility* in contracting, whereby contractual

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[2]The literature on contracting with unverifiable information generally deals with the detrimental effect of renegotiation. In addition to the papers noted above, see Hart and Moore (1988) and Tirole (1999). In models of "renegotiation design," such as that of Aghion, Dewatripont, and Rey (1994), parties would want to bar modification of their renegotiation mechanism.

terms are tailored to individual contingencies. As Huberman and Kahn (1988) demonstrate, this flexibility can help manage risk while maintaining incentives in a principal-agent relationship.[3] Flexibility also helps economize on contracting costs, to the extent that parties can wait to see what contingency arises before specifying terms. Finally, renegotiation can use ex post bargaining power to motivate ex ante efficient investment. The parties can ensure recontracting by omitting from their enforceable contract some element that is necessary for later completion of valuable trade, necessitating renegotiation to complete the deal. Anticipating power in the ensuing renegotiation, parties may have the incentive to make relation specific investments. We refer to this third benefit as the *power value* of recontracting.[4]

This paper studies the trade-off between the sabotage, ex post, and power values of recontracting. We analyze a setting where both parties — seller and buyer — can make primarily cooperative, unverifiable relation specific investments.[5] Unlike many contract theory models,

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[3]Also see Hermalin and Katz (1991).

[4]This benefit was also studied by Huberman and Kahn (1988), and later by Noldeke and Schmidt (1995). In some contracting settings, especially where revelation mechanisms and specific performance are possible, first best investment and optimal risk sharing can be supported through a mix of the power and flexibility values. For example, in Chung's (1991) analysis of incentive problems with risk neutrality, the ability to renegotiate gives the agents flexibility to adjust terms of trade to suit ex post conditions. By giving one party all the power in ex post renegotiation, and setting the default terms properly, both parties are induced to invest efficiently. It has been noted that allocating bargaining power in such a way as to create efficient investment incentives is difficult to do. See also the work of Demski and Sappington (1991), MacLeod and Malcomson (1993), Aghion, Dewatripont, and Rey (1994), Edlin and Reichelstein (1996), Che and Hausch (1999), and Segal and Whinston (1999).

[5]In contract theory, an investment is "cooperative" if it benefits the investor's contract partner. Thus, a seller investment that will increase the value of a good to the buyer is cooperative. An investment is "self" if it benefits the investor. For example, a seller can invest to lower her costs. Until recently, analysts assumed self investment when focusing on the problem of inducing efficient investment, but we agree with De Fraja (1999) that "in most examples two-sided direct externalities would seem the rule rather than the exception (thus, an improved design for the aeroplane fuselage would reduce the production cost for the engine manufacturer, and vice versa; smart microchip design helps software houses and good operating software reduces hardware design cost...." De Fraja at 23-24. For another example, see "The Recovery Accelerates", New Steel 28, 35 (Janaury, 2000) ("Steelmakers now routinely are involved in the decision phase of the car; service centers also are involved in the process.") Che

renegotiation here is costly; an infinite cost represents a ban. The parties' investments influence the value of the traded good to the buyer: if both parties in the model choose a high investment level, a high value for the good is realized stochastically; if one or both choose a low investment level, a low but positive value is realized with certainty. Because parties invest before the trade value is realized, that this value always is positive implies that trade always is efficient. The ability to renegotiate ensures that the parties will trade under any contract. Our concern here is whether a contract exists that also will induce the parties to invest efficiently and avoid transaction costs.

Whether a contract is optimal, and whether the optimal contract will induce efficient investment, depends on recontracting costs and whether the realized trade value is verifiable (in which case the parties can condition prices on this value). In the case of verifiable values, when the marginal gain from choosing the high investment level is sufficiently great, a set of prices exists that will induce both parties to invest efficiently without the need to recontract. Under these prices, at least one of the parties always will prefer to trade ex post. Hence, given that the court is expected to enforce the contract, the parties have no strict preferences over recontracting costs.

Positive recontracting costs, however, can help to induce efficient investment when the marginal gain of investment is not so large. In this circumstance, a contract that is designed to be renegotiated only when realized value is low is attractive for two reasons. First, the contract creates an incentive for parties to invest efficiently by increasing the wedge between the parties' payoffs in the high and the low value contingencies. This is because the payoff in the low value contingency is reduced by the recontracting cost, thereby increasing the marginal gain from high investment. Second, the contract preserves frictionless trade in the high value case while permitting the parties to realize a gain in the low value case. This is significant because high investment in the model does not guarantee that high value is realized.

When the realized trade value is unverifiable, parties cannot write a court-enforced contract with price conditioned on this value. We show that, as a consequence, incentives for

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and Hausch (1999) also argue that cooperative investment is common.

high investment may rely on a contract scheme that involves renegotiation in some contingencies. In some cases, it suffices to specify trade-contingent prices which induce recontracting only when the realized trade value is low. In other cases, the optimal contract induces renegotiation under both trade values, actuating the power value of recontracting to support high investment.[6]

This analysis teaches three positive lessons. First, parties have preferences over recontracting costs. In fact, parties generally would like intermediate recontracting costs (that are neither too large nor too small). The preference for larger costs exists because recontracting costs increase the marginal return to high investment when parties adopt a contractual scheme that induces renegotiation when the trade value is low. On the other hand, there is a preference for small costs because high investment sometimes yields low trade value, in which case costly renegotiation dissipates the trading gain. In cases where the parties rely on the power effect (achieved by inducing renegotiation in every contingency), the parties want recontracting cost to be as small as possible because its surplus dissipating effect always is felt. There are also situations where the parties can support high investment without recontracting, in which case they would not object to infinite recontracting costs.

Parties who anticipate these differing, and sometimes countervailing, effects will try to plan their relationship so as to increase recontracting cost or lower it, depending on their situation. For example, parties for whom it is optimal to preserve the ability to recontract in some states of the world may want to erect costly but surmountable barriers to renegotiation. Requiring the approval of the parties' senior executives to change a deal illustrates this phenomenon. Our analysis thus predicts and may help to explain impressionistically observed governance structures that make it more costly to recontract than to permit the original deal to go forward.

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[6]The modeling exercise here complements the work of Ramey and Watson (1999), who study dispute resolution in long-term relationships. They show that high dispute resolution costs create an incentive for parties to avoid disputes by cooperating in their productive interaction. Costly dispute resolution, that is, has sabotage value. The optimal dispute resolution system in their model often will have intermediate costs because relationships can be preserved when these costs are not too high.

Our second positive lesson, in line with earlier papers, is that when realized values are unverifiable parties have incentives to endogenize bargaining power the better to exploit the power value of recontracting. Third, we show that under some parameter values no contract will induce efficient investment. This supplies a motive for vertical integration, a conclusion that Che and Hausch also reached in their cooperative investment model and others such as Grossman and Hart (1986) have emphasized. Finally, we note in a methodological vein that contract theory models commonly assume for tractability either that renegotiation is costless or that the parties cannot renegotiate at all. The three lessons just summarized imply that the resultant gains in analytic convenience come partly at the cost of obscuring the desirable incentive effects of costly recontracting.

Our analysis implies that contract law should abandon its strong preference for recontracting. If it were to do so, then three reforms seem apt. First, the law should enforce the parties' original deal, which means that courts should honor clauses that ban renegotiation either always or in specified cases.[7] Second, the state should attempt to develop contract law rules that will make renegotiation costly when typical parties would want it to be. We later show that parties will prefer high to low recontracting costs in a majority of contexts. This suggests that the law should erect default barriers to renegotiation. For example, a modification should be made unenforceable unless it is in writing or the initial contract waives the writing requirement. Regrettably, the law today attempts to facilitate recontracting. Although section 2-209 of the Uniform Commercial Code permits merchants in sales contracts to provide that modifications must be in writing, courts have held that "no oral modification clauses" are unenforceable if a

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[7]Whether a no renegotiation clause can be enforced depends on the technology of interaction. Our model studies the setting (common in the real world) in which the opportunity for parties to trade a non-monetary good expires by the time the court intervenes in the contractual relationship. The role of the court, therefore, is to mandate monetary transfers as a function of verifiable behavior (including whether the good was traded) according to the parties' contract. A no renegotiation clause in the parties' original contract, if enforced, allows either of them to reinstate the original contract following any modification, and it will be the case that at least one of the parties wishes to do so. Thus, an attempt at contractual modification will have no effect on the actual transfers imposed by the court, implying no change in the incentives that govern whether trade occurs.

party relies on an oral modification.[8] Since a party commonly will take some action after modification discussions, reliance likely will be easy to establish. In addition, contracts restricting modification are held to be waived if the parties engage in arguably conflicting, unwritten practices.[9] As a consequence, if two parties have permitted modifications in the past, they may be disabled from restricting modifications in the future. These legal rules are questionable in light of this paper's analysis. Our third normative implication follows from the result that the contracting schemes developed here will fail if courts do not enforce the verifiable payments and transfers that the contracts require. Hence, as with current mechanism design approaches to motivating efficient investment, the analysis here also supports a broad specific performance rule.

Part 2 below begins with an example that illustrates our central results. Part 3 sets out the basic model, in which ex post value is verifiable and investment is cooperative. Part 4 derives results for this case. Part 5 models the unverifiable values case and also discusses two other extensions: when investment is partly "self" in nature and when the seller's costs are random (so that it is possible for ex post trade to be inefficient). Part 6 is a conclusion.

2. An example

A seller and buyer agree to trade a single unit of a good. After the contract is made, each party makes an unverifiable investment — high or low — that will influence the value of the good to the buyer. If both parties make the high investment, the good will have a high value with probability q and a low, but positive, value with probability $1 - q$; if either or both make the low investment, the good will have the low value with certainty. In addition to direct investment costs, a party may incur an opportunity cost from investment conditional on the other party's high investment. As an example, assume that the buyer can make a large investment in the contractual relationship or in another contractual relationship, but not in both (more broadly, the

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[8]See Wisconsin Knife Works v. National Metal Crafters, 781 F.2d 1280 (7th Cir. 1986).

[9]Section 2-209(4) encourages such holdings by providing that while "an attempt at modification" may not be successful given a clause that requires a writing, the attempt "can operate as a waiver."

buyer is capacity constrained). Let high investment for the seller be discovering a better product design and high investment for the buyer be discovering the potential commercial applications of the design. Then, the buyer may have a choice whether to purchase an improved version of the product from the seller and invest heavily in marketing it, or to purchase the original version and sell it in the normal way, while using the knowledge the buyer obtained from the seller's high investment to make a major commitment with another producer. An opportunity cost to the buyer of choosing a high investment level in the contractual relationship is the foregone profit from dealing with the seller's competitor. The buyer will invest heavily in the current deal only if the expected gain will exceed the direct and opportunity cost.[10]

After the parties choose their investment levels, the verifiable value of the good is realized. The parties then can renegotiate the terms of their contract. Renegotiation is costly, so parties who renegotiate capture only the portion s ($0 \leq s \leq 1$) of the surplus obtained through renegotiation. The number s represents the direct transaction costs paid by the parties to alter their contract; these costs may be associated with the legal system (for example, complicated requirements for recognition of a recontract) or the governance structure of the contracting relationship. Values of s near zero or one also can be interpreted as policies of the court disallowing and allowing recontracting, respectively. In the next stage, the parties trade or not.

We begin by considering a benchmark contract that specifies trade, regardless of the realized value of the good, at a price that is conditioned on the trading value. Parties would never renegotiate such a contract so it does not matter whether recontracting is permitted or not. In this setting, efficient investment can be sustained if the marginal gain from high investment is great enough. For example, suppose that the probability of a good outcome if both parties choose the high investment level is $q = .6$; the trade value of a good outcome is 50; and the value if one or both parties choose the low investment level is 20. Let each party's combined cost of high investment, both direct and opportunity, be 7. On these parameter values, the marginal expected

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[10]An opportunity cost exists because investment in the model here is cooperative. As a consequence, a party sometimes could exploit his contract partner by using the partner's investment elsewhere. Note that this opportunity cost can exist only when the partner has chosen the high investment level.

gain from high investment is .6(50 – 20) = 18, which exceeds the total cost of 14. The expected gain also can be made to exceed the cost for each party by appropriately conditioning the price on realized values, so both parties can be induced to make the high investment. For example, if the trading price for a high outcome is 37 and for a low outcome is 20, the buyer's expected gain from high investment would be .6[(50 – 20) – (37 – 20)] = 7.8 > 7. Letting the direct total cost of high investment be 8, the total expected gain from the illustrative contract (relative to the case of no trading relationship) will be .6(50) + .4(20) – 8 = 30. This calculation omits opportunity costs because a party's outside opportunity arises from low investment *only* when the party's contract partner invests high; thus, the opportunity cost does not reflect a value that can be obtained when both invest low or if the parties do not contract initially. To summarize, the parties in this example will write a contract that is not renegotiated and both will make the high investment.

Next let the high realized value be 40. Then the marginal gain from high investment without recontracting falls to .6(40 – 20) = 12, which is less than the total cost, and the benchmark no-renegotiation contract (specifying trade in every contingency) cannot induce high investment. However, if recontracting could be banned altogether, then the parties could support high investment with a contract that specifies *no trade* when low value is realized.[11] The payoff to the low value outcome would then be zero and the expected marginal gain from high investment would be .6(40 – 0) = 24, which exceeds the total cost. The sabotage value thus creates an incentive to invest, but in this instance the sabotage value of high recontracting cost is outweighed by the ex post value of low recontracting cost so the illustrative sabotage contract is not optimal. To see why, realize that the total gain under the contract is the expected marginal value of high investment less its cost, or 24 – 8 = 16. The parties would prefer a contract that mandates trade in both contingencies but does not support high investment; such a contract would yield 20, the low value outcome, which the parties can realize without recontracting.

Intermediate recontracting costs can balance the sabotage and ex post values by inducing

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[11]The court, we now assume, can observe the good's value to the buyer, and so can refuse to enforce a recontract made when this value is low. The contract under analysis can be called a "sabotage contract" because a recontracting ban is equivalent to having infinite recontracting costs.

high investment but still allowing the parties to realize some surplus in the low value contingency. To illustrate this result, continue to assume that the high realized value is 40, but now assume that recontracting is permitted and that the parties can keep $s = .8$ of the surplus generated by renegotiation; the remainder is exhausted in transaction costs. Begin with a contract specifying no trade when the realized value is low. Under this contract, the parties will recontract in the bad contingency, and divide the gain of $.8(20) = 16$. Recall that the probability of a good outcome if both parties choose high investment levels is .6. Then relative to the case in which recontracting is banned altogether, the marginal gain from high investment falls to $.6(40 - .8\cdot20) = 14.40$, which still exceeds the high investment cost of 14. Of particular importance, the expected value of this contract is $.6(40) + .4(.8\cdot20) - 8 = 22.40$, which is greater than the 20 value the parties would realize by choosing the low investment level under the benchmark contract.

The contract that relies on intermediate recontracting costs is optimal relative to the contract that is designed never to be renegotiated (when the high value is 40) because the recontracting cost increases the wedge between the high and low value outcomes, thereby increasing the incentive to invest efficiently. This contract also is optimal relative to the sabotage value contract because it does not throw away all value (by banning trade) when the realized value is low. A contract that is designed to be renegotiated only when value is low will not work, however, when recontracting costs are too small. On the parameters in the example, if the parties could keep 90% of the renegotiation gain, the expected marginal value of high investment under this contract would fall to $.6(40 - .9\cdot20) = 13.20$, which is lower than the investment cost.

When the good's realized value is observable to the parties but unverifiable to a court, a contract cannot condition prices on it, and this will preclude the contractual forms discussed above. The parties, however, can choose prices conditional on whether the parties trade or not (a trade decision will always be verifiable). Then, if each party would have some but not too much bargaining power in a renegotiation, the parties sometimes could induce high investment. To see how, let the contract give the buyer the option to trade. The contract also can set the trade and no trade prices such that the buyer will exercise his trading option only when the high value is

observed. The parties will renegotiate if value is low because trade would still generate a positive gain.

If the buyer chooses the high investment level with this contract, he will receive the difference between the good's high value and the price with probability q; and he will receive a share of the gain from trading the low value good with probability $1 - q$. The buyer's share is determined by transaction costs and the buyer's ex post bargaining power. If the buyer chooses the low investment level, he will receive his share of the gain from trading the low value good with certainty. A buyer with too little or too much bargaining power in the renegotiation will not choose the high investment level. To see why, return to the example above, in which the high value is 40, the low value is 20 and the parties would split 80% of the low value trading gain. Now set the trading price at 25 and the no trading price at 5, and once again let the buyer's cost of high investment be 7. Under these parameters, choosing the high investment level would generate a positive expected value for the buyer if the buyer had any ex post bargaining power at all. Further, the buyer would do better choosing the high investment level rather than the low unless the buyer could acquire more than 52% of the low value trading gain.[12] The seller also would do better investing high rather than investing low and would earn a positive expected return under the illustrative contract. The value of the contract would be 22.40, which again exceeds the value of a contract that would generate low investment for sure. Once more, however, if recontracting costs were to absorb only 10% of the low value trading gain, this deal would fail as well. Therefore, in the case of unverifiable trading values, contracts can induce efficient investment only when the transaction cost and bargaining power parameters fall within

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[12]To see how these conclusions are derived, let π_B denote the share of the ex post gain that the buyer could acquire in a renegotiation ($0 \leq \pi_B \leq 1$). Then realize first that a buyer who chose the high investment level, when the seller also invests high, will receive the difference between the high value and the trading price with probability q, or $.6(40 - 25) = 9$, plus the (negative) no trading price and his share of the recontracting gain with probability $(1 - q)$, or $.4(-5 + .8 \cdot 20\pi_B)$, or $-2 + 6.4\pi_B$, less his investment cost of 7. Hence, the buyer's expected payoff from high investment is $9 - 2 - 7 + 6.4\pi_B = 6.4\pi_B$. Investing high thus would have positive expected value for the buyer if $\pi_B > 0$. A buyer that invests low pays the no trading price of 5 and receives his share of the recontracting gain, which is $\pi_B(.8 \cdot 20)$, for a total payoff of $-5 + 16\pi_B$. The buyer thus would choose the high investment level if $6.4\pi_B \geq -5 + 16\pi_B$, or if $.52 \geq \pi_B$.

particular ranges. Further, high investment relies on giving the buyer the incentive to sabotage (implying renegotiation) when value turns out to be low.

3. The Basic Model

At **time 1**, a seller and buyer write a contract to trade a single unit at time 5. The contract specifies prices that are conditioned on verifiable values and regulates whether and when the parties can recontract. At **time 2**, the parties simultaneously and independently choose a level of investment from the set $\{h,l\}$, where h is high investment. In the investment phase, the parties get the following immediate payoffs: (a) If both invest low, each receives 0; (b) If both invest high, they incur costs c_S and c_B (for the seller and buyer, respectively); (c) If the seller invests high but the buyer invests low, the seller incurs the cost $f_S > 0$, and the buyer receives the opportunity gain described above, which is denoted $g_B \geq 0$; (d) If the buyer invests high but the seller invests low, the buyer incurs the cost $f_B > 0$, and the seller receives $g_S \geq 0$. The parties may observe these investments but cannot verify them to a court.[13]

At **time 3**, a random event occurs that, together with the parties' investments, determines the value of realized trade. In particular, the good's realized value can be high, denoted a, or low, denoted b. If both parties chose the high investment level, the high value a will be realized with positive probability q; if one or neither invests high, the low value b will be realized with certainty. These numbers satisfy the inequalities $a > b > 0$ and $0 < q \leq 1$.

The parties know the distribution of possible values and can observe the realized value, which we initially assume is verifiable. It is sometimes plausible to assume verifiability. When the seller has a stable customer base or is a long time player in an industry, the seller may be able to prove at acceptable cost what the buyer's value from the seller's product is in likely ex post

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[13]The numbers f_B and f_S capture the cost of investment plus the loss incurred due to the other party taking his outside opportunity. For example, suppose the parties engage in a joint venture, whereby the seller's investment provides information about his production technology that may prove useful to the buyer in a relationship with an alternative seller. Then f_S is the sum of the seller's direct investment cost, c_S, and whatever loss the seller incurs as a result of the buyer's interaction with another seller. For simplicity, we suppose that $g_S - f_B$ and $g_B - f_S$ are smaller than the expected surplus in the current relationship, meaning that taking an outside opportunity is inefficient.

circumstances. The assumption also may be plausible when the parties negotiate over quality in sufficient detail that a seller could conveniently prove the buyer's valuation in common cases.[14] In other situations, it is implausible to suppose that value is verifiable, and we treat these cases in Part 5 below.

At **time 4**, the parties observe the realized value and then may recontract. If they do, they incur a positive cost in the form of a share $(1 - s)$ of the joint benefit of renegotiation. This cost exists because it takes parties time to redo a deal, they may have to involve attorneys, and they must comply with any formalities that the initial contract, their governance structures, or the law create. Recontracting cost is treated as a share of ex post value because parties commonly devote more resources to a deal when more is at stake.

At **time 5**, the seller decides whether to deliver the good and the buyer decides whether to accept delivery. If the parties trade, the seller earns the specified contract price less the seller's time 2 sunk cost and the buyer earns the good's value less the buyer's time 2 sunk cost. If the parties do not trade, the buyer earns no immediate payoff and the trading opportunity is lost. All time 5 actions are verifiable.

At **time 6**, a court or arbitrator compels transfers between the parties on the basis of verifiable information and the initial or renegotiated contract, if the parties have not voluntarily performed at time 5. Note that since the trading opportunity expires after time 5, the court cannot directly force trade or reverse it at time 6. However, the court can impose transfers contingent on the trading outcome, and these transfers can be specified by the parties (in contracting at times 1 and 4) to induce trade or no trade.

We make two technological assumptions. First, $b > 0$, which implies that trade always is efficient (the parties' costs have been sunk by time 5). This implies that the parties will

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[14]The buyer knows its value, and thus often could make out a prima facie case regarding value in court. A seller would not condition a contract on value, however, if it could not itself verify value in important cases or otherwise establish sufficient data relevant to value to disprove a buyer's assertions. Regarding our observability assumptions, it will turn out in equilibrium that when parties use contracts that anticipate recontracting, they will renegotiate only when value happens to be low. Hence, in the model a seller that knows the distribution of values necessarily knows the realized value.

renegotiate if the contract specifies no trade when the realized value is *b*. Second, $q(a - b) > c$, which implies that high investment always is efficient (the marginal gain exceeds the cost). At issue is whether the parties can write a contract that will induce high investment and whether any such contract will require positive transaction costs to implement. We answer this question by applying the notion of sequential rationality (i.e., backward induction), and we suppose that joint decisions are resolved according to the generalized Nash bargaining solution. In particular, the seller and buyer have bargaining weights π_S and π_B respectively, where $\pi_S + \pi_B = 1$. Note finally that time 1 and time 4 actions are joint: the parties agree on the initial contract or not, and recontract or not. The other actions (choosing an investment level and deciding whether to trade) are individual.

4. Inducing high investment when value is verifiable

4.1 Optimal contract schemes

The parties' enforceable contract can specify transfers contingent on the realized value *v*; whether the seller delivers the good; and whether the buyer accepts and pays. We represent this contract as a pair of functions *p* and *t* that map the realized value *v* into a price the buyer pays to the seller and that govern whether or not the parties trade. In the model, a contract that sets $t = 1$ for either or both realizable values indicates that the parties are to trade (standard contract law damages will induce performance when trade would be efficient, which is the case here under both trade values). A contract that sets $t = 0$ for a realizable value indicates that the court should not enforce trade; in this case, the parties prefer to recontract (with no trade as the default) before the trading opportunity arises. Under these assumptions, the seller will deliver only when the initial or renegotiated contract sets $t(v) = 1$. The purpose of recontracting is to modify the *p* and *t* functions.

We begin with times 4, 5 and 6. At the beginning of time 5, the realized trade value is either $v = a$ or $v = b$. From this time, the seller receives the price $p(v)$ and the buyer the net value $t(v)v - p(v)$. Turning to time 4, the parties always prefer to trade because both possible realized values, *a* or *b*, are positive and all costs have been sunk. If the original contract specifies $t(v) = 0$ (no trade) the parties thus recontract, choosing prices that split the trading gain (the realized *v*)

according to their relative bargaining power. The seller thus would receive $p(v) + \pi_S sv$ and the buyer would obtain $- p(v) + \pi_B sv$. The parties will not recontract if the contract specifies $t(v) = 1$ because this contract requires trade; hence, a renegotiation could not increase joint value.

We now turn to times 1, 2 and 3 to ask whether there is a contracting scheme that will support high investment, and what the value of the relationship would be under that scheme. Contracting schemes can be classified according to whether the parties are induced to recontract or not. This yields four contracting schemes:

> I: $t(a) = t(b) = 1$ — the parties trade regardless of the good's realized value;
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> II: $t(a) = 1$; $t(b) = 0$ — the contract requires trade when the good's value is high but not
>> when it is low, in which case the parties recontract;
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> III: $t(a) = t(b) = 0$ — the contract specifies no trade, regardless of the good's value, so the
>> parties always recontract;
>
> IV: $t(a) = 0$; $t(b) = 1$ — the contract requires trade in the low value case and induces
>> renegotiation in the high value case.

We next analyze incentives for the four schemes and show that scheme I or scheme II dominate schemes III and IV.

Scheme 1: Under this scheme, the contract sets a price for the high and the low value good, and the parties always trade. The buyer will choose the high investment level h at time 2 if the expected gain exceeds the gain from choosing low investment l:

$$q[a - p(a)] + (1 - q)[b - p(b)] - c_B \geq b - p(b) + g_B .$$

The right hand side of this inequality is the value to the buyer of choosing a low investment level under the assumption that the seller will invest high. This inequality simplifies to

$$q(a - b) - q[p(a) - p(b)] \geq c_B + g_B .$$

The left hand side of the inequality is the marginal net gain from investing high and the right hand side is the buyer's total cost. A similar analysis shows that the seller will choose a high investment level if

$$q[p(a) - p(b)] \geq c_S + g_S .$$

Recalling that the prices $p(a)$ and $p(b)$ are arbitrary, we can sum these constraints to see that there is a price specification that will satisfy both parties' incentive conditions if and only if

$$q(a - b) \geq c + g .\qquad\qquad (1)$$

The left hand side of this inequality is the marginal gain from high investment and the right hand side is the total cost: $c = c_S + c_B$ and $g = g_S + g_B$. When the parties use contracting scheme I and (1) holds, the value of their relationship will be $qa + (1 - q)b - c$. If (1) fails, parties who use a scheme I contract will choose the low investment level and realize b. Using a scheme I contract could be optimal relative to other contracting schemes, however, even if (1) will fail because the contract prevents gains from being dissipated in renegotiation.

Scheme II: Under this scheme, the parties recontract only when realized value is low ($v = b$). Given that the seller chooses the high investment level h, the buyer also will select h if

$$q[a - p(a)] + (1 - q)[\pi_B sb - p(b)] - c_B \geq \pi_B sb - p(b) + g_B .$$

The left hand side of this inequality is the buyer's net gain from choosing the high investment level less the direct cost. If high value is realized (with probability q) the parties do not recontract and the buyer realizes the difference between value and price. If the low b value is realized (with probability $1 - q$), the parties renegotiate and the buyer receives the share of b that transaction costs permit and his bargaining power can command, less the buyer's direct investment cost and the price the contract sets for the low value case. If the buyer chooses the investment level l, then low value is realized for sure, and the buyer gets his share of that value plus any gain that the seller's high investment conferred on it; this is the right hand side. The inequality simplifies to

$$q(a - \pi_B sb) - q[p(a) - p(b)] \geq c_B + g_B .$$

A similar analysis shows that the seller will choose the investment level h if

$$q[p(a) - p(b) - \pi_B sb] \geq c_S + g_S .$$

Summing these constraints, there is a specification of prices that will satisfy both parties' incentive conditions if and only if

$$q(a - sb) \geq c + g .\qquad\qquad (2)$$

The left hand side of (2) is the expected marginal gain from high investment under contracting scheme II — the high value less the low value partly diminished by recontracting costs, times the probability that choosing h will produce a. The right hand side is the total cost. When (2) is satisfied, the value of the parties' relationship under the scheme II contract will be $qa + (1 - q)sb$

– *c*. Otherwise, the value is *sb*.

      Scheme III: Under this scheme, the parties always recontract. An analysis similar to the one above shows that this scheme will induce high investment when $qs(a - b) \geq c + g$. In this event, the value of the parties' relationship will be $s[qa + (1 - q)b] - c$.

      Scheme IV: In this scheme, the parties recontract only when the realized value is high. Efficient investment can be sustained under this contract if and only if $q(sa - b) \geq c + g$. The value of the relationship then is $qsa + (1 - q)b - c$.

      The left hand side of (1) is larger than the left hand sides of the incentive constraints under schemes III and IV while the right hand side of all three constraints is the same, making a scheme I contract easier to implement. In addition, when the constraints are satisfied, the value of the relationship is greater under scheme I than under either scheme III or IV. Scheme I thus dominates these schemes. It is more difficult to satisfy the incentive constraint for a scheme I contract than for a scheme II contract (the left hand side of (1) is smaller than the left hand side of (2), but scheme I generates a greater joint value (because the parties' never recontract). We next analyze when the parties will use a scheme I or a scheme II contract, but summarize the discussion to this point in

Proposition 1: Parties may be able to induce high investment when the realized value is verifiable under contracts that do not require recontracting or permit it only when the traded good's realized value is low. Contracts that are designed to be renegotiated in other circumstances are not optimal.

      The scheme I contract is best of all because parties who use it waste no costs in recontracting. The scheme II contract is next best because it requires recontracting only when the good has low value. Since transaction costs are proportional to value, these costs are lower under this contract than under the contracts of schemes III and IV, which require recontracting either always or in the high value case.

4.2 When will parties choose a scheme I or a scheme II contract?

Proposition 1 shows that parties always will use a scheme I contract when its incentive condition is satisfied because the contract would then maximize joint value. Hence, the question is when parties would prefer a scheme I contract whose high investment incentive condition is not satisfied to a scheme II contract. The parties, that is, must choose between a contract that would yield low value with certainty but waste no costs in recontracting and a contract that will generate a higher expected return but is renegotiated with positive probability. To analyze this choice, we begin with a case that is characterized by the following condition:

$$q(a - b) < c + g < qa . \qquad (*)$$

When (*) holds, the incentive condition for the scheme I contract fails (see (1)), but the expected value of a high realization exceeds the cost of producing it. Given (*), the scheme II contract would generate a greater expected gain if transaction costs are low enough to permit the parties to keep a sufficient share of the recontracting gain when they choose the high investment level but realize low value. The expected joint value of a scheme II contract is $qa + (1 - q)sb - c$, which implies that the contract will have a higher expected value than b when $s \geq K$, where

$$K = \frac{[b + c - qa]}{(1 - q)b} .$$

Condition (*) implies that $K \leq 1$.

The scheme II contract cannot induce high effort, however, unless its incentive condition (2) is satisfied; and this requires that recontracting cost be high rather than low (that s be small). In particular, condition (2) is satisfied when $s \leq L$, where

$$L = \frac{[qa - c - g]}{qb} .$$

Condition (*) implies that $L > 0$. Further, we have $K < L$ if and only if condition (**) holds, where

$$q(a - b) \geq c + (1 - q)g . \qquad (**)$$

Regarding this condition, the first term on the right hand side is the total direct cost of high investment. A party that chooses the high investment level loses the opportunity to benefit from the other party's high investment by investing low, but this would be perceived as a loss only if

both parties did invest efficiently but low value nevertheless occurred; for a party could always have realized his share of the low value and possibly also his "passive" benefit g_i by not investing high initially. The second term on the right hand side of (**) is the total expected value of this potential loss from high investment; and the condition itself says that the expected marginal gain from high investment (the left hand side) must exceed the total cost in order for parties to use a scheme II contract.

To summarize, the surplus maximizing condition for choosing a scheme II contract when the incentive condition for scheme I would fail requires $s \geq K$; and the incentive condition for inducing high effort under the scheme II contract requires $s \leq L$. This yields

Proposition 2: When condition (*) holds, the parties will adopt a scheme II contract if and only if $K \leq s \leq L$. An s that satisfies this inequality exists if and only if condition (**) holds.[15]

The Introduction sketched the intuition for this Proposition. High recontracting costs have good incentive effects: the parties want to exert high effort to avoid incurring them. This is the sabotage value. On the other hand, high recontracting costs have poor uncertainty effects: because the high value occurs stochastically, the parties know that they may have to recontract, and then they do not want transaction costs to dissipate the recontracting gain. This is the ex post value of small renegotiation costs. When recontracting costs are too high, the parties thus will use a scheme I contract, that generates low value with certainty but avoids recontracting. Parties also will choose this contract when recontracting costs are too low because then the scheme II contract would generate an insufficient incentive to choose the high investment level. As a consequence, when the expected marginal gain from choosing a high investment level is neither too large nor too small, an intermediate level of recontracting cost is necessary to induce high investment.

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[15]The model here has the property that when the incentive constraints are satisfied, there exist sets of prices that would give each party positive expected value from a contract. Hence, we focus on the incentive constraints.

4.3 Optimal Recontracting Costs and Means of Achieving Them

Our analysis demonstrates that recontracting costs affect the value of contractual relationships, so parties have preferences over these costs. Further, recontracting costs may be influenced by the law and the parties. The law could bar renegotiation in specific settings, which amounts to an infinite recontracting cost ($s = 0$). To achieve intermediate costs, the state can erect surmountable barriers to renegotiation by raising the level of required legal formalities. For example, a recontract must be in writing; or there must be a cooling off period before the recontract becomes legally operative unless a party can establish exigent circumstances; and the parties nonwritten actions cannot establish a modification as a matter of law.

However, the law cannot choose rules that would satisfy Proposition 2 exactly because the K and L values include investment cost, and investment is assumed here to be unverifiable. Nevertheless, courts can play a constructive role by facilitating the parties' own specification of costs. The parties can include in their contract a clause designating when recontracting is allowed and when it is not allowed. They can also choose procedures that make renegotiation more or less costly, depending on the economic parameters the parties face. Importantly, as Propositions I and II show, the law would enhance efficiency if it enforced the parties' contract as written.

The parties may also influence recontracting costs through their choice of governance structure, which is credible as long as the governance structure cannot be easily changed at the parties' whim. An interesting example of a naturally arising barrier to recontracting is a firm's capital structure. Under the scheme II contract, parties recontract in the low value case. Some buyers may value goods less when they experience financial distress. Also, the more complex the buyer's capital structure, the higher are the transaction costs of recontracting when the buyer is insolvent, for the seller must obtain the consent of more parties to a new deal. Hence, complex capital structures sometimes can create efficient investment incentives.

Exploring in detail the parties' and the law's attempts to control s is beyond the scope of this paper, but we can identify the optimal level of s that parties would choose if they could.

<u>Proposition 3:</u> When conditions (*) and (**) both hold, the optimal s satisfies $q(a - sb) = c + g$

and the parties choose a scheme II contract. If (**) fails to hold, the parties choose a scheme I contract and the value of their relationship does not depend on recontracting cost.

Proof: The parties do not recontract under a scheme I contract so the expected value of their relationship is independent of recontracting costs. The optimal level of recontracting costs solves the minimum incentive condition for a scheme II contract, which is $q(a - sb) = c + g$. To raise s above this level would induce the parties to choose a low investment level while to lower it would waste part of the contracting gain without improving the parties' incentives. If the value of s that satisfies this equality is substituted into the expression for the expected value under a scheme II contract and condition (**), now assumed to hold, is used, it can be shown that the expected value of using a scheme II contract exceeds the low value b that a scheme I contract would generate with certainty.

We conclude this part with a few additional notes.

Remark 1: Optimal contracts sometimes involve renegotiation. Propositions 2 and 3 show that intermediate levels of recontracting cost often are optimal. Also, parties will choose contracts that permit costly modification with positive probability because such contracts can have good incentive properties.

Remark 2: An extreme view that the opportunity to renegotiate necessarily worsens or necessarily enhances investment incentives does not hold in a model such as ours, because recontracting has both positive and negative effects. To see how the negative effect can dominate, let $q = 1$ so that high trade value is realized with certainty when both parties choose the high investment level. Then the incentive condition for the scheme I contract becomes $a - b > c + g$, which is relatively easy to satisfy. Scheme I would fail, however, if there are large spillovers in the investment phase: that is, if the benefit to each party of choosing a low investment level conditional on the other party investing high (g) is sufficiently large.

A scheme II contract can be optimal in this case if the high value good exceeds the cost of high investment. To see how, let $a \geq c + g \geq a - b$ (so that a scheme I contract could not induce high investment). When $q = 1$, the incentive condition for scheme II (condition (2)) becomes $a - sb \geq c + g$, and this now is satisfied by assumption when $s = 0$. Intuitively, when $q = 1$,

recontracting is unnecessary to realize ex post surplus since, when both parties choose *h*, the realized trade value always is high. Recontracting thus is useful only because of its deterrent effect, so it is best to set *s* = 0, that is to have infinite recontracting cost. Proposition 2 shows that setting *s* = 0 is not optimal when *q* < 1, however. In this circumstance, the parties know that they may have to recontract regardless of how efficiently they invest. Parties with this knowledge would reject infinite recontracting costs. In sum, if renegotiation *always* is bad, the state's role can be limited to enforcing party agreements not to recontract;[16] but that role can be larger under the more realistic assumptions that renegotiation is costly and that optimal investments sometimes yield suboptimal outcomes.[17]

Remark 3: We have assumed that a contract between the seller and buyer specifies transfers between them conditional on verifiable information. Since recontracting costs are so important in our model, one may wonder whether the parties can emulate these costs by specifying "money burning" (or payments to a third party) in some contingencies, rather than merely transfers. In fact, recontracting costs are still vital, for without them the parties would (at time 4) renegotiate out of throwing away resources, rendering such a contract scheme no more useful than the class we have studied. Thus, the analysis of our basic model is complete.

5. Costly recontracting under relaxed assumptions

5.1 Recontracting when realized trade value is unverifiable

A contract cannot condition trading prices on the good's realized value to the buyer if this value is unverifiable. Without the ability to condition prices on realized values, the parties must rely on indirect means. These means flow from the fact that in the model here trading decisions actually serve as options. By specifying court-enforced transfers as a function of the parties' individual trading decisions, the parties can be given the incentive to consummate trade only

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[16]This is suggested in Jolls (1997).

[17]When there are no spillovers in the investment phase (that is, *g* = 0) then a scheme I contract always is optimal in the model because we assume that $q(a - b) > c$. The parties then do not care about *s*. That *g* = 0 is a strong requirement, however, and even then a scheme I contract, as we show below, cannot induce high investment when value is unverifiable.

when the realized trade value is high, thereby making price sensitive to the trade value. Sabotage is more important in this setting, because the parties are induced to forego trade (which destroys value) when the trade value is low.[18] In addition, in some cases the power value of recontracting emerges and carrots, rather than sticks, are needed to achieve high investment.

An adjudicator that cannot observe realized values usually can observe a party's decision whether to trade. The term "trade" can refer to three actions: (i) The seller's decision to deliver; (ii) The buyer's decision to accept delivery and pay; (iii) The buyer's taking of a verifiable action after acceptance that can increase value, such as running advertisements. We focus on the first two of these. On the assumptions in this modified version of the model, a contract will contain two prices: p_0, which the buyer pays if the buyer rejects trade; p_1, which the buyer pays if the buyer accepts trade. At time 4 (recall the timing above), the parties can write a new two price contract, and at time 6 a court will enforce the then current agreement. We will analyze this version of the model with the same backward induction technique used above.

Beginning with time 5, a buyer that trades receives $v - p_1$ and a buyer that refuses trade pays $-p_0$.[19] The buyer thus will trade when $v - p_1 > -p_0$; that is, when condition (#) is satisfied.

$$v \geq p_1 - p_0 \qquad (\#)$$

As above, it always is efficient to trade because all costs have been sunk by time 5 and the low value is positive. Turning to time 4, if condition (#) is satisfied, the parties cannot gain from recontracting: under the original contract, the seller receives a satisfactory price and the buyer

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[18]This option is distorted in models where parties can trade at any time and cannot recontract until after a court issues an order. It is more realistic to assume that parties will have a chance to redo the deal before suing. The option feature of the contracts discussed here is particularly important because we assume that the trading opportunity vanishes before a decisionmaker can act. Noldeke and Schmidt (1995) explore the properties of option contracts in a self investment context.

[19]If trade refers both to the buyer's acceptance and the buyer's later taking of a verifiable action that can increase value, then there will be a price if the buyer merely accepts the good and a higher price if the buyer accepts and takes the action. Letting the action cost x, such a buyer's trading value then will be $v(x) - p(x) - x$. If the seller anticipates the action, he will believe that q is higher than it was in the basic model. No further insight is gained by analyzing this case, but we note it here to indicate that our model is a little more general than the analysis in text may suggest.

makes a positive gain. When the condition fails, the buyer will not trade under the original contract, but because there is a trading gain, the parties will recontract. The trading gain is sv. Hence, from time 4, the parties' payoffs from renegotiation would be $p_0 + \pi_S sv$ for the seller and $-p_0 + \pi_B sv$ for the buyer.

Three contracting schemes can be optimal in this version of the model, depending on the parameters. The schemes are classified by which of the trade values satisfy condition (#).

I': $b > p_1 - p_0$ — the parties never recontract;

II': $a \geq p_1 - p_0 \geq b$ — the parties only recontract when value is low;

III': $a < p_1 - p_0$ — the parties always recontract.

The scheme I' contract cannot induce high investment, but the other two sometimes can.

Scheme I': Under a scheme I' contract, renegotiation is avoided because the contract prices ensure that the buyer will trade under the original contract for both $v = a$ and $v = b$. The seller receives the price p_1 regardless of his investment; thus, he has no incentive to choose the high investment level. Anticipating this, the buyer also will choose the low investment level. The Scheme I' contract thus cannot induce high investment. Regarding the intuition, a scheme I' contract prevents recontracting when realized value turns out to be low by setting a trading price beneath the low value. Such a low price cannot induce the seller to choose the high investment level.

Scheme II': Here, condition (#) holds when the trade value is a but not when it is b. If either or both parties choose the low investment level under a scheme II' contract, the low value b is realized, and each party will receive the recontracting gain specified above. If both parties choose investment level h, the seller will receive p_1 with probability q, because high value is realized, and the recontracting gain with probability $(1 - q)$; and the buyer will receive $(a - p_1)$ with probability q, and his share of the recontracting gain with probability $(1 - q)$.

The seller thus will choose the high investment level when

$$qp_1 + (1 - q)[p_0 + \pi_S sb] - g_S - c_S \geq p_0 + \pi_S sb .$$

This incentive condition simplifies to

$$q(p_1 - p_0) \geq q\pi_S sb + g_S + c_S .$$

The buyer will choose the high investment level when

$$q(a - p_1) + (1 - q)[- p_0 + \pi_B sb] - g_B - c_B \geq - p_0 + \pi_B sb \ ,$$

which can be rewritten as

$$- q(p_1 - p_0) \geq q\pi_B sb - qa + g_B + c_B \ .$$

Summing the two incentive conditions yields condition (2), the incentive condition for the scheme II contract in the basic model. Hence, if (2) is satisfied, there exists a number $p_1 - p_0$ such that both parties' incentive conditions for choosing high investment are satisfied.

Condition (2) is necessary but not sufficient for a scheme II' contract to induce high investment, however. The buyer also must be given the incentive to sabotage when the realized value is low (making renegotiation occur), meaning we must impose the constraint that defines this contracting scheme: $a \geq p_1 - p_0 \geq b$. To see why this constraint is not already implied by (2), note that the buyer's incentive condition can be rewritten as

$$qa \ \geq q(p_1 - p_o) + q\pi_B sb + g_B + c_B \ .$$

The first term on the left hand side is the expected value to the buyer of high investment. The first term on the right hand side is the expected difference in price the buyer must pay for a high value good. When $a = p_1 - p_0$ (the highest $p_1 - p_0$ possible in the scheme II approach), the first term on the right hand side also is qa, and then the condition cannot be satisfied because the last three terms are positive. Intuitively, the difference in price between the high and low quality good cannot be too high, because then a buyer who bought the high quality good would not be compensated for the cost of choosing a high investment level and also for foregoing the gain in recontracting surplus the buyer could have costlessly earned by investing low. On the other hand, the difference in price for the two goods cannot be too low because then the parties would always trade and not invest. Therefore, the buyer's incentive condition for the scheme II' contract must hold when $p_1 - p_0 = b$. Using this value, the condition becomes

$$q(a - b) \geq q\pi_B sb + g_B + c_B \ . \tag{2'}$$

High investment under scheme II' thus can be supported when the incentive conditions (2) and (2') both hold. As above, the value of the parties' relationship is then $qa + (1 - q)sb - c$.

Scheme III': Under this scheme, the buyer would refuse delivery regardless of the trade values, so the parties always recontract. Using an analysis similar to that above, we see that high investment can be supported if and only if condition (##) holds, where

$$\pi_S sq(a-b) \geq g_S + c_S \text{ and } \pi_B sq(a-b) \geq g_B + c_B. \quad (\#\#)$$

The value of the parties' relationship under a scheme III' contract is $s[qa + (1-q)b] - c$. A necessary condition for (##) to hold is $qs(a-b) \geq c + g$. This was sufficient for investment with scheme III in the basic model but is only necessary here.

We can summarize this discussion with

Proposition 4: When the good's realized value to the buyer is unverifiable, the parties can avoid recontracting only under a contract — the scheme I' contract — that yields the low value with certainty. The parties may induce high investment under contracts that require recontracting either when the good's realized value turns out to be low or always.

Remark 4: When realized value is unverifiable, the sabotage value of recontracting also sometimes is necessary to induce high investment. For the reasons given above, when a scheme II' contract is used, recontracting cost should be high but not too high. When a scheme III' contract is used, however, the parties prefer low recontracting costs. As condition (##) shows, because the parties always renegotiate under this contract, they want the net trading gain to be large, and this implies that s also should be large.

We turn next to the question of when parties will use these possible contracts, and first establish

Lemma: (i) If $\pi_B s \geq (a-b)/b$, then scheme II' cannot support high investment; (ii) If $\pi_B s \leq (a-b)/a$, then scheme III' is not optimal.

The incentive condition for a scheme II' contract fails when (i) holds.[20] Regarding the intuition, the seller's incentive condition for this contract always holds when $\pi_B = 1$, so we can focus on the buyer. Because $\pi_B s \leq 1$, the restriction inherent in (i) cannot bind when $a \geq 2b$. If the high

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[20] The incentive condition (2') can be rewritten as $\dfrac{a-b}{b} - \dfrac{g_B + c_B}{q} \geq \pi_B s$. This cannot be satisfied if $\pi_B s \geq (a-b)/b$.

value good is worth having (*a* is much larger than *b*), the buyer has a strong incentive to choose the high investment level. This incentive increases when the buyer does not have too much bargaining power or transaction costs are high (i.e., $\pi_B s$ is low); in these circumstances, the buyer would do relatively poorly in a renegotiation to share the low good's value. Regarding (ii),[21] $(a - b)/a$ is increasing in *a*: when the high trade value is very large, the parties have an incentive to choose high investment levels, thereby minimizing the likelihood of incurring ex post transaction costs. This incentive is strengthened when the buyer has relatively little bargaining power or transaction costs are high.

When $\pi_B s \geq (a - b)/b$ and condition (##) holds, a scheme III' contract can be optimal. The former condition requires the parties' investment costs to be aligned with their bargaining weights; each party must anticipate sufficient surplus to make choosing the efficient investment level worthwhile. The second condition requires a party's expected gain from efficient investment to exceed its costs. This yields

Proposition 5: When $\pi_B s \geq (a - b)/b$ and condition (##) holds, a scheme III' contract may support high investment. Scheme III' is optimal if $s[qa + (1 - q)b] - c \geq b$.

The parties may choose a scheme I' or a scheme II' contract when the conditions summarized in Proposition 4 are not satisfied. Either contract (but not III') could be optimal when condition (*) holds.[22] Recalling the discussion in Part 4.2 above, under (*) a scheme I' contract again would generate *b* with certainty but save recontracting costs. As above, when recontracting costs are not too high, a scheme II' contract would yield a higher expected value: that is, $s \geq K$.[23] On the other hand, renegotiation costs must be high enough to encourage high

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[21]The restriction inherent in (ii) is derived by comparing the scheme values and incentive conditions of the scheme II' and scheme III' contracts.

[22]Condition (*) requires $q(a - b) < c + g < qa$.

[23]Recall that *K* is derived from an inequality that has the expected value under a scheme II contract exceeding *b*: $K = \dfrac{[b + c - qa]}{(1 - q)b}$.

investment. Before, this required only that $s \leq L$.[24] When realized value is unverifiable, however, a scheme II' contract must also satisfy the incentive condition (2'). This condition implies the necessity of $s \leq L'/\pi_B$, where

$$L' = \frac{[q(a - b) - c_B - g_B]}{qb} .$$

This yields

Proposition 2': When condition (*) holds and value is unverifiable, the parties will adopt a scheme II' contract if and only if $K \leq s \leq \min\{L, L'/\pi_B\}$. Otherwise, they will choose scheme I'. Further, $\pi_B \leq L'/L$ and condition (**) are sufficient for such an s to exist.[25]

Remark 5: When value is unverifiable, the parties' bargaining weights together with transaction costs influence which contracting scheme is optimal and whether high investment can be supported. The incentive condition for the scheme I contract, when value is verifiable, is $q(a - b) \geq c + g$. That is, the expected marginal value of high investment is such that costly recontracting is unnecessary to induce efficient investment. When value is unverifiable but this incentive condition is satisfied, it would be best to have $s = 1$ (transaction costs are zero) and then, either by the parties or the state, choose bargaining weights (π_S, π_B) that would make either a scheme II' or a scheme III' contract viable. That bargaining weights could be this fine tuned is unlikely, however. Therefore, positive recontracting costs are necessary for investment in some cases of unverifiable trade value, even when the marginal gain of investment is so large that $q(a - b) \geq c + g$.

When condition (*) holds, so that either a scheme I' or a scheme II' contract is used, an analysis similar to that in Part 4.2 permits us to solve for the optimal s.

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[24]L was derived from (2), the incentive condition for the scheme II contract to induce high investment: $L = \frac{[qa - c - g]}{qb}$.

[25]Recall from Part 4.2 that (**) requires $q(a - b) \geq c + g(1 - q)$.

Proposition 6: Let condition (*) hold. Then if $K \leq \min\{L, L'/\pi_B\}$ the optimal value of s equals $\min\{L, L'/\pi_B\}$ and the parties adopt a scheme II' contract. If $K > \min\{L, L'/\pi_B\}$, the parties choose a scheme I' contract and the value of their relationship is independent of s.

Remark 6: Contracts exist that can induce efficient investment when courts are able to observe only the contract and whether trade has occurred. Given the very large size of advanced economies, the conditions these contracts must satisfy likely will be met in practice in a nontrivial set of cases. They also are unlikely to be met in many cases. Thus, the analysis here adds to the literature showing that contract failure helps support vertical integration.

Remark 7: Parties will commonly prefer recontracting costs to be either infinite or intermediate (as required in Propositions 2 and 2'). As noted above, the state thus should enforce contracts that ban renegotiation and otherwise should erect surmountable barriers to it. These conclusions follow from the realization that parties will most frequently use contracting schemes I, I', II and II', and seldom use scheme III'. When value is verifiable, Proposition 1 shows that only schemes I and II would be used; these either do not require recontracting or require intermediate values for recontracting costs. Scheme I' and II' contracts are similar to scheme I and II contracts in terms of recontracting cost. Under a scheme III' contract, the parties always recontract and thus prefer that recontracting cost be small. A scheme III' contract is difficult to implement, however. To see why, realize that the contract must satisfy condition (##), which requires that high value be nontrivially above low value; but must also satisfy the condition $\pi_B s \geq (a - b)/b$. The latter condition requires a and b to be "close": because $\pi_B s \leq 1$, $a \leq 2b$ is necessary to satisfy the condition.

5.2 Costly recontracting when investment is not strictly cooperative

Investment would not be strictly cooperative if the buyer's high investment could on its own increase the probability that high value is realized. To indicate how this possibility affects the basic analysis, suppose that the buyer's trade value is verifiable and that when the buyer chooses high investment and the seller low investment, high value is realized with probability q', where $q' \in (0, q)$. If the buyer chooses low investment, then $v = b$ with certainty; and if both

parties choose high investment, then $v = a$ with probability q, as in the analysis above.

It is straightforward to extend the model to this setting so we omit details. As before, the parties would use only scheme I or scheme II contracts. The buyer's incentive conditions would be unchanged, but the seller's incentive condition would be more difficult to satisfy. A seller that deviates to low investment would reduce the probability of realizing high value from q to q' rather than to zero. Thus, when q' > 0 (so the buyer's high investment alone could yield high value), it is more difficult to sustain high investment with either contract scheme.

When value is verifiable, however, the parties sometimes could sustain high investment by the buyer alone. When $q'(a - b) > f_B + g_S$, such a contract would be preferred to contracts inducing low investment by both parties. The left hand side of this inequality is the marginal gain from high investment. The right hand side is the buyer's cost of investing high when the seller invests low and the seller's gain when only the buyer invests. A scheme I contract, that never requires recontracting, would be best for inducing efficient investment by the buyer. The buyer's incentive condition is

$$q'\{(a - b) - [p(a) - p(b)]\ \} \geq f_B \, .$$

The left hand side is the buyer's net expected marginal gain from high investment — the value difference less the price difference — and the right hand side is the buyer's cost of alone choosing the high investment level. This incentive condition could always be satisfied by an appropriate choice of prices (which in this case could be made conditional on realized values). The value of a scheme I contract that would induce investment (l, h) is $q'a + (1 - q')b + g_S - f_B$. This implies a greater lower bound when comparing the scheme I and II contracts than in the model above, so that scheme I would be optimal in more cases. To summarize, the analysis here generalizes to the case when investment has a partly "self" element.

5.3 Costly recontracting when the seller's production cost is random

In the basic model, trade always is efficient because the good's realized value always is positive and the seller's production cost is assumed to be zero. If the seller's cost is stochastic, however, trade may be ex post inefficient with positive probability. This raises the issue of whether a contract can avoid inefficient trade while encouraging high investment. To pursue this

question, we now extend the basic model to add a random component to the seller's cost of production and delivery: at time 3, in addition to the v realization, the seller learns what it will cost to produce and deliver the good. The parties can observe the seller's cost but cannot verify it to the court. With probability $1 - w$, the production/delivery cost (above the sunk investment cost incurred at time 2) will be zero, as in the basic model. With probability w, this cost will be d, where we assume $b < d < a$. Thus, trade would be efficient if $v = a$ (yielding a surplus of $a - d$ or a, depending on the cost draw) and trade would be inefficient if $v = b$ and the seller's cost equals d. We also assume that $q(a - b) - qw(d - b) > c$, which is the analogue of assumption $q(a - b) > c$ from the basic model.[26]

This setting of verifiable trade value, but unverifiable seller delivery cost, is much like the situation modeled in Part 5.1, but here it is important to consider the seller's option not to trade. We assume a seller who wants to breach must pay expectation damages of $v - p(v)$, which the court can enforce since v is verifiable These damages will induce the seller to forego trade when (and only when) $v = b$ and the seller's cost would be d. With this added feature, analysis of the contracting problem proceeds as in the basic model. The parties here also can use a scheme I contract, and it will induce high investment if and only if

$$q[(a - b) - w(d - b)] \geq c + g.$$

The second term in brackets appears because with probability w the seller would incur a cost of d, which decreases the surplus of trade in the case of $v = a$ and cancels trade (through seller's breach) when $v = b$. The addition of a random cost component makes it more difficult than in the basic model to induce high investment with a scheme I contract (the left hand side of the condition here is smaller than the left hand side of (1), the original incentive condition for a scheme I contract, while the right hand sides of these conditions are the same). High investment is more difficult to implement with a contract that does not rely on renegotiation because now there not only is a chance that low value will result; there also is a possibility that the low value itself will not be realized in consequence of the seller facing a high production cost.

On the other hand, it is easier to implement a scheme II contract when the seller's cost is

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[26]This extension of the model will apply to short term contracts where the seller faces volatile input costs and to some longer term contracts.

random. The incentive condition for a scheme II contract now is

$$q[a - (1 - w)sb] \geq c + g.$$

The left hand side of this inequality is greater than the left hand side of (2) (the original incentive condition for a scheme II contract), while the right hand sides are the same. The random delivery cost thus loosens the scheme II incentive constraint. Intuitively, an increase in w reduces the probability that parties will be in a contingency where they desire renegotiation in order to trade; this reduces the expected surplus in the low value case (when $v = b$). The reduction in turn increases the marginal expected gain from high investment above the expected gain in the basic model.

Under our assumptions, contracting scheme I dominates schemes III and IV (as in the basic model). Also, the value of the relationship under a scheme I contract is at least as large as the value under a scheme II contract. Thus, the analysis of contracting schemes parallels that of Part 4.2. Finally, because it is harder to implement a scheme I contract and easier to implement a scheme II contract when the seller's production cost is random, this extension of the model justifies a heightened focus on recontracting costs. We summarize by stating

Proposition 7: A random and unverifiable delivery cost makes the scheme II contract more favorable relative to the scheme I contract (compared with the relationship in the basic model). Further, when a scheme II contract is adopted, the optimal s always is intermediate.

6. Conclusion

Contract theory models commonly assume that parties are symmetrically informed ex post and that renegotiation is costless.   On these assumptions, the ex post efficient outcome is always reached, but because parties can conveniently change the initial contract, it becomes difficult for that contract to create efficient incentives to invest. Contract theorists have recognized this problem for some time and search for ways to avoid it. Thus, Che and Hausch note that "A commitment to make payments to a third party may enable the buyer and seller to avoid renegotiation, which undermines our result on the irrelevance of contracting [for inducing

efficient investment]."[27] As they recognize, such commitments are difficult to make. Maskin and Tirole (1999) suggest that a contract could be registered with a court, with instructions that the court not enforce modifications to it, a solution that, at least in common law countries, could not be implemented. Jolls (1997) simply suggests that courts should enforce no-modification clauses in contracts.

This paper makes the more realistic assumptions that renegotiation is costly and that parties sometimes can affect this cost. Costly recontracting plays the role that payments to a third party would play in Che and Hausch's analysis, and at least part of the role that Maskin and Tirole and Jolls recognize is needed. In particular, costly recontracting reduces the value of the relationship in those contingencies where the parties would want to renegotiate: recontracting would absorb part of the ex post surplus. The sabotage value of costly recontracting is not needed when ex post values are verifiable and the marginal return from efficient investment is high; in this circumstance, parties can induce efficient investment through the price term, and thus have no preference over renegotiation cost. When the marginal return is not so high, the sabotage value of recontracting becomes necessary: parties will choose a contract that permits recontracting only when realized value is low. Then the transaction cost penalty widens the difference between the high and low value outcomes, thereby strengthening the parties' incentive to invest efficiently.

In contrast to earlier analyses, we show that parties can prefer contracts that anticipate costly renegotiation. A complete ban on renegotiation (or infinite recontracting cost) is inefficient in our model because parties can produce a low value good despite having chosen high investment levels. Banning renegotiation in the low value case throws away surplus. As a consequence, parties often will prefer intermediate recontracting costs — high enough to encourage investment but low enough to permit some later trading gain when the investment outcome is poor. When realized values are unverifiable, a similar contract can sometimes induce efficient investment, but here what we call the power value of recontracting also becomes relevant. Parties must be able to capture sufficient surplus in a renegotiation to induce them to

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[27]Che and Hausch, note 10 at 130.

invest efficiently, but cannot have too much ex post bargaining power; for then a party may do well enough in a renegotiation over the low value trading gain, despite the cost, to make choosing the efficient investment level unprofitable.

As a positive matter, these results imply that parties sometimes will attempt to endogenize recontracting costs, by creating governance structures or formalities that a recontract must satisfy. It usually is more difficult to renegotiate a governance structure than a particular contract, so endogenously created recontracting costs likely are "sticky." As a legal matter, the law should enforce party efforts to limit recontracting, and also should raise the transaction costs of renegotiation. However, because parties often prefer intermediate recontracting costs and because what is intermediate is context dependent, much of the work of inducing efficient investment must be done by the parties themselves. The legal role should be facilitative. A particularly important facilitative role would be played by courts that specifically enforced the verifiable transfers and prices that the parties' contracts designate.

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