

Completing Contracts in the Shadow of Costly Verification*

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Abstract

Contract theory typically holds that verification costs are obstacles to complete contracting; yet, real world contracts often contain provisions that seem costly to verify. We show how a costly signal can play an important role in contracts. Presence of verification (or litigation) costs implies that the parties will proceed to litigation only when litigation is cost-justified ex post. Furthermore, when they do litigate, the litigation cost works as an extra sanction against the breaching party. So long as the court's judgment is correlated with the realized state of the world, therefore, the parties can design a set of prices (including damages) so as to provide additional incentive to the promisor through an off-the-equilibrium, credible litigation threat. We show that a costly signal might not only improve a contract that relies only on a costless signal, but also, in certain circumstances, eliminate the need for the costless signal. This paper underscores the importance of incorporating the verification, particularly the adjudication, process into contract design and the various choices and incentives that parties have during the contracting stage. Rather than focusing solely on either the problems of adjudication or those of contracting (without sufficient regard to how the disputes will be resolved in the future), we have attempted to take a more comprehensive approach by looking at the design of contracts in anticipation of the path of the adjudication process.

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I. Introduction

In contract theory, verification costs are an important barrier to complete contracts. These costs arise because the legal enforcement of contracts requires the court to engage in costly fact finding: such as whether a contingency materialized or whether the defendant performed as promised. Even if parties could anticipate and agree to distinct obligations in different future states of the world, the benefits of doing so may be outweighed by the verification costs of enforcing the contract in court. Contract theory reduces the process of contract enforcement to a simple binary categorization: either contract terms can be enforced at no cost or they cannot be enforced because they rely on non-verifiable factors.¹ A fundamental premise in the scholarship on contract design is that parties condition their obligations only on measures that are verifiable to a court. This premise is common to two lines of contract theory: agency contracts and sales contracts (e.g. Hart/Moore 1988). An agency contract, for instance, might condition payment on verifiable output but not on unverifiable effort. A sales contract might condition the price on whether verifiable trade occurs and not on the non-verifiable actions of the seller that would increase the likelihood of trade.

This approach is at odds with commercial contracting practice, where parties often include requirements or conditions that seem to invite significant litigation costs. These contract provisions fall in two categories. First, the verification of some provisions calls for evidence that is costly to present (such as expert testimony) or that is easy to fabricate (such as a subjective state of mind). Second, the parties may use standards (such as “best efforts”) instead of rules (such as work hours) in their contract. In these cases, the litigation process must inject content into the standards in order to determine the relevance and weight of various evidentiary proxies presented by the parties at litigation (Scott/Triantis 2006).

Both types of terms are common in commercial contracts and threaten to impose large litigation costs on the parties. Franchise agreements, for example, motivate franchisees by leaving them with the surplus of revenues after they pay royalties and other fees to the franchisor. Although a court may verify revenues relatively easily, franchise contracts contain other provisions that are more costly to enforce. For example, the franchisee covenants to maintain the confidentiality of information obtained from the franchisor confidential. The franchise contract of Church’s Chicken provides a typical clause: “Franchisee shall not, during the term of this Agreement or thereafter, communicate, divulge, or use for the benefit of any other person...any confidential information, knowledge, or know-how concerning the construction and methods of operation of the Franchised Business”.² The subsequent paragraph excepts “information

¹ This highly stylized approach lies in contrast to the more detailed economic analysis of litigation and its effect on the deterrence yielded by tort law and public regulation (which we summarize in Part II, below).

² Sample Church’s Chicken (AFC Enterprises, Inc.) Franchise Agreement at http://library.consusgroup.com/library_sbn/145/145312.asp. section 12.02. For another example in the same industry, see Same Kentucky Fried Chicken contract at http://library.consusgroup.com/library_sbn/146/146134.asp.

which...came to Franchisee's attention prior to disclosure thereof by Franchisor; or which, at the time of disclosure thereof by Franchisor to Franchisee, had become a part of the public domain, through publication or communication by others; or which, after disclosure to Franchisee by Franchisor, becomes a part of the public domain, through publication or communication by others." The franchisor has the right to terminate the franchise for breach of this promise.³ The franchisor has some incentive to terminate opportunistically in order to appropriate the franchisee's investment in the location. Yet, the breach of the confidentiality promise is difficult to prove (or disprove) because the revelation of confidential information, even if demonstrated, must be attributed to the franchisee rather than other sources.

Franchise contracts also contain standards that raise the prospect of costly litigation. For example, the franchisee covenants that it "shall devote full time energy and best efforts to the management and operation of the Franchised Business"⁴ and "shall maintain...the premises...in conformity with Franchisor's high standards and public image"⁵ In addition, the franchisee promises not "to do or perform...any other act injurious or prejudicial to the goodwill associated with the Franchisor's [mark]"⁶ The breach of these covenants may give the franchisor the right to terminate and, as with the confidentiality promise, they therefore raise the prospect of significant litigation expenditures.⁷

Executive employment contracts exhibit a similar pattern.⁸ Executives are motivated by a combination of base salary and incentive compensation, which may be in the form of company stock or options. In addition, compensation tends to be deferred, for example, by the delay in vesting of stock or option rights. Executives make promises similar to franchisees in the form of covenants not to compete, not to solicit employees or customers, and to maintain confidentiality. Breaches of these promises are hard to prove and invite protracted litigation. In addition, like franchisees, executives commit to the standard of best efforts. The breach of these promises triggers the company's right to terminate and may thereby lead to the loss of future compensation, as well as the loss of company shares or options that have been awarded but not vested.⁹

³ Id.,15.02(G).

⁴ Id., 13.01

⁵ Id, 10.01.

⁶ Id, 13.02.

⁷ If franchisee fails to comply with the last of the three covenants, the Franchisor may terminate, without giving franchisee opportunity to cure. (15.02(F)). If franchisee defaults on either of the first two, then the franchisor must provide 30 days to cure to Franchisor's satisfaction (15.03), but if the franchisee commits same default or commits more than one default in a year, then the Franchisor has right to terminate without giving further opportunity to cure. (15.02(K), (L)).

⁸ E.g., contract between Haliburton and C. Christopher Gaut, CFO, March 3, 2003, para 3.2(v)(a) <http://contracts.onecle.com/haliburton/gaut.emp.2003.03.03.shtml>; contract between Home Depot and Joseph DeAngelo, Exec VP & COO, Jan 23, 2007, <http://contracts.onecle.com/home-depot/deangelo-emp-2007-01-23.shtml>; three year renewable contract between Kmart and Paul Guagliardo, Senior VP, Chief Marketing Officer, Feb 27, 2004, <http://contracts.onecle.com/kmart/guagliardo.emp.2004.02.27.shtml>.

⁹ Specifically, contracts typically provide that these rights are lost where the company terminates for cause, which includes the material breach of a term such as confidentiality. It also includes "gross negligence or willful misconduct". The Kmart contract qualifies this further, by adding: "unless the Executive believed

Contract theory does not explain the combination of low- and high-verification cost measures. One reason relates to the multitasking problem raised by a single and noisy output measure, such as revenues or stock prices. Franchisees and executives may focus excessively on tasks that increase the value of these measures and neglect other dimensions of their roles that are important to the maximization of the contract surplus. Thus, for example, the franchise contract disciplines the franchisor, whose acts undermine the value of the franchise mark or disclose confidential information, by threatening termination. Other provisions, however, are not easily explained in this manner because they appear to cover the same behavior as the output measures. We focus on these types of provisions in this paper.

The problem can be framed as follows. Contracts seek to align behavioral incentives by invoking legal enforcement. Yet, despite the conventional premise of contract theory, the desired behavior is very rarely directly and costlessly verifiable and enforceable. Therefore, contracts rely on proxies or signals that are inaccurate and costly to verify, to varying degrees. If several noisy signals were all costless to verify, then the parties should use all of them, particularly when the agent is risk averse or judgment proof. The use of multiple signals helps to dampen the exogenous risk inherent in a single signal and reduce the share of the surplus captured by a judgment proof agent. The role of verification costs is more complicated, and our paper suggests that, in some cases, these costs may further aid in the structure of efficient incentives.

When a contract induces performance, it does so in the shadow of litigation and judicial enforcement. A promisor performs her obligation because she believes that the plaintiff will be less likely to sue her successfully if she performs than if she does not. Indeed, a contract can be designed to reinforce this incentive by ensuring that the promisee is much more likely to sue—or will only sue—if the promisor breaches than otherwise. In game theoretic terms, verification often lies off the equilibrium path, so that verification costs threaten a sanction but are not incurred in fact. Even if the promisor fails to perform, verification costs may be avoided if the parties settle; it is well known that the vast majority of disputes between contract parties are settled before trial.

The fact that verification costs are usually not incurred does not mean that they are irrelevant. They frame the threat that induces settlement or performance. Thus, they are an important tool in contract design. We demonstrate in this paper that verification costs may be harnessed to improve the efficiency of contract design. Thus, contracts may be more complete than is conventionally represented in contracts scholarship. Indeed, contracting parties may sometimes prefer terms with higher rather than lower verification costs. The key to this analysis is to examine more closely the path of contract enforcement, particularly the incentives of parties to sue, to invest in litigation and to settle their disputes. This paper is a first step in this direction.

in good faith that such act or nonact was in, or was not opposed to, the best interests of the Company” para 1(c).

In Part III, we begin with a contract for the sale of a good, whose quality depends on whether the seller invests and on random factors. The optimal contract induces the seller to make the efficient investment, but whether the seller invests is costly to verify. Therefore, the contract must choose among noisy signals. We stipulate that one is costless to verify—the quality of the good—and the other is costly—the court’s determination as to whether the seller invested. In our example, the buyer designs the contract. She can induce the seller’s investment by contracting only with respect to the quality of the good, but this contract yields two potential sources of inefficiency. First, it imposes risk on the seller that is costly if the seller is risk averse. Second, if the seller is judgment-proof, the contract cannot fine the seller for bad quality. As a result, the seller receives a positive expected profit from the contract and shares in the contract surplus. This may have efficiency as well as distributional consequences. In some cases where the incremental surplus from high investment is small, the buyer may opt against the incentive contract because she would not be able to capture the surplus from doing so.

We then show that adding a costly but informative signal, a court’s finding as to whether the seller invested, would make the contract more complete, less risky for the seller and more attractive to the buyer. Specifically, the contract damages may be set to provide the incentive for the buyer to sue if and only if the seller fails to invest. In equilibrium, if the damages are sufficiently high, the seller invests and the buyer does not sue. Moreover, the litigation costs provide additional sanction against the seller’s breach, without over-stimulating suits by the buyer; they create a wedge between the threatened sanction on the seller and the expected net payoff to the buyer. Indeed, we show in Part III.D that even a contract that relies solely on the costly signal of adjudication can, in some cases, dominate a contract that conditions price only on the costless signal. We conduct a comparative statics analysis to show how the desirability of the costly signal depends on the ratio of the cost of litigation to the cost of the seller’s investment.

In Part III, verification costs lie off-the-equilibrium path because the seller performs in equilibrium and the buyer does not sue. In Part IV, we introduce the second way in which verification costs move off-equilibrium: through pre-trial settlements of disputes. As a first crack, we continue to assume that the parties are symmetrically informed, and will therefore settle with certainty. If the seller has significant bargaining power in settlement negotiations, the prospect of settlement dilutes the sanction imposed by litigation costs. If the contract is designed to try to restore the seller’s investment incentive, it will probably be less efficient, given our assumptions, than if the parties were unable to settle. This result underscores that the deterrence value of litigation costs cannot be replicated contractually through prices or damages. Part V concludes with some thoughts for future research. For example, future research should relax our assumption of symmetric information between the parties.

II. Related Scholarship

This paper is related to several strands of scholarship that relate the litigation process to the objective of optimal deterrence, particularly in the fields of tort law and public regulation (such as tax or environmental regulation). In this respect, among

others, it is striking how contracts scholarship has followed such a strikingly independent path to these fields. One group of scholarship focuses on the problems of judicial error and of litigation costs, and their bearing on deterrence. Deterrence depends on difference between the expected sanction on the defendant if she is guilty as opposed to innocent. Judicial error may be Type I (a guilty defendant is found innocent) or Type II (an innocent defendant is found guilty). Both types of errors attenuate the deterrence from enforcement, at least if we set aside incentive to bring suit (e.g., Polinsky and Shavell 1989).

If enforcement hinges on judicial finding of the materialized value of a continuous (rather than binary) variable, then the risk of error may lead to excessive deterrence (e.g. in the tort of negligence), because the cost of falling even slightly short of the standard may be large (Calfee and Craswell 1984; Craswell and Calfee 1986; Shavell 1987). However, if the court is very poorly informed, then under-deterrence is more likely. Investment in improving accuracy of fact-finding may address this problem, but a better approach might be to adjust the standard of care (Kaplow 1998, at 2). Other work concerns the effect of judicial error on the choice between negligence and strict liability (e.g. Shavell 1987; Calfee and Craswell 1984; Kahan 1989).

In a notable extension into contract design, Gillian Hadfield demonstrates that, where judges make errors, vague standards may be preferable to hard-line rules because they do not attach sharp changes in the probability of liability to small changes in behavior at the turning point for liability. As behavior improves, there is a gradual reduction in the probability of liability and this moderates the over-deterrence effect identified in Craswell and Calfee. (Hadfield 1994)

If enforcement gives rise to costly litigation, these costs may outweigh the deterrence benefit from enforcement. Spending more on accuracy may improve deterrence by deepening the wedge between the expected sanction if the defendant is guilty as opposed to innocent (Kaplow and Shavell 1994). However, both the added accuracy in fact finding and precision in legal rules are not worth their cost if the defendant cannot predict the more precise enforcement at the time of its action (or if it stimulates excessive investment in predicting the likely judicial outcome). (Kaplow and Shavell (1994); Kaplow (1995)).

These findings are relevant to contract design. For example, liquidated damages based on average harm are preferable to expectation damages if the promisor lacks information about the vulnerability of the promisee. (Kaplow and Shavell 1996). In addition, incremental expenditures in fact finding may not be worth their cost if the promisor cannot predict the outcome. Also, the analysis of accuracy bars on the optimal complexity of legal rules in public regulation such as tax or environmental law. Kaplow, for example, writes that “Differentiation tends to be more efficient the lower are information costs (both for individuals, ex ante, and for the enforcement authority, ex

post) and the greater is the difference in the harm of the acts being regulated.” (151) This parallels the concern with verification costs in the incomplete contracts theory.¹⁰

Both litigation costs and judicial error determine whether a civil action is brought against the defendant. The prospect of judicial error may skew the selection of cases. Type I error discourages law suits, even against guilty defendants; Type II error encourages law suits, even against innocent defendants. (Polinsky and Shavell 1989) If litigation costs are too high relative to the expected award in damages, they may deter law suits and thereby undermine deterrence. Conversely, if damages are too high relative to litigation cost, they may over-stimulate law suits, even if the defendant is innocent (Shavell 1987). Thus, the incentive to bring suit may be manipulated by changing the cost of litigation and the damages awarded if the defendant is found guilty. (Polinsky and Shavell 1989). In this paper, we analyze how damages can be manipulated to set the appropriate incentives both to sue and to perform a contract.

Bernardo, Talley and Welch (2000) is similar to our project in that their article traces the effect of litigation costs on contract performance. Specifically, they analyze how legal presumptions mediate between costly litigation and ex ante incentives. They present a principal-agent model in which the agent is liable for damages if the court finds she has shirked. The probability of such finding is a function of the legal presumption (the weight given to each side’s evidence) and the evidence each side presents to the court. The agent can reduce its marginal cost of evidence by not shirking. The principal decides whether to sue, based on the background rule of legal presumption and the principal’s belief as to whether the agent has shirked. And, the agent’s incentive to shirk depends on whether she believes that the principal will sue. The authors derive equilibrium conditions given different legal presumptions.

Our illumination of costs that rest off the equilibrium path also bears some resemblance to the analysis of renegotiation in Schwartz and Watson (2004). They emphasize the potential trade-off between the cost of renegotiation and the cost of contracting. They suggest, for example, that complex contracts, reached after costly negotiations, might not be efficient when renegotiation costs are low, because the prospect of hold-up behavior in renegotiation undermines the incentives established in the initial contract.

The discussion in this paper also draws on the analysis of settlement of disputes. In particular, the prospect of settlement affects the deterrence from prospective enforcement. Parties are likely to settle when their information is symmetric. The terms of their settlement, however, varies with their relative bargaining power because it determines how the parties will divide the surplus from avoiding litigation costs. If the defendant enjoys greater bargaining power, settlement reduces the sanction below the level it would be if the parties litigated. Conversely, if the plaintiff enjoys bargaining

¹⁰ Kaplow himself notes the application to contract law, but focuses on the complexity of default rules provided by law, rather than contract design. (Kaplow 1995, at 158)

power, settlement increases the sanction on the defendant. (Polinsky and Rubinfeld 1988).¹¹

III. Verification costs and the plaintiff’s incentive to sue

Suppose a buyer contracts with a seller for the production and delivery of a good at a future date.¹² The value of the good (V) to the buyer is probabilistic—the good can be worth either \$200 or \$120 to the buyer—and depends on whether the seller makes a reliance investment. The cost of the investment (C) is \$30 and, if the seller makes the investment, the probability of the \$200 value is 75% and the probability of the \$120 value is 25%. If the seller does not, the probability of obtaining the \$200 value is 25% and the probability of obtaining the \$120 value is 75%.¹³ Under the given parameters, the joint surplus, net of the investment cost, is \$140 if the seller does not invest and \$150 if he does.¹⁴ The seller’s investment contributes \$10 to the joint surplus and therefore, it is efficient for the seller to invest. The following table summarizes the environment.

Seller’s Choice	Cost	\$120	\$200	Net Surplus
Invest	\$30	25%	75%	\$150
Not Invest	\$0	75%	25%	\$140

Table 1: Contracting Environment with Verifiable Widget Value

The parties will divide the surplus as follows: the buyer receives the expected difference between the value of the good and contract price ($V - P$), while seller retains the price minus the investment cost ($P - C$). The seller’s best alternative to contracting yields profit of zero from his outside option; this is the seller’s reservation price. We assume that the seller is judgment-proof, so that the contract price may not be negative in any state of the world.¹⁵ In our model, buyer designs the contract and makes a take-it-or-leave-it offer to the seller. In doing so, the buyer is constrained by exogenous limits on

¹¹ We assume symmetric information. Kathy Spier has demonstrated some interesting effects from settlement under asymmetric information, that will be useful in future work on the effect of settlement on contract design. (Spier 1994).

¹² Although the model presents a sales contract between a buyer and a seller, it can be easily extended to describe a franchise or an employment contract. In the latter settings, the value of the good (V) can be thought of as the total profit of the franchise or the employer and the cost of investment (C) to be the cost of input, such as effort.

¹³ This formulation assumes that the seller’s reliance investment has a direct externality on the buyer’s value, i.e., seller’s investment has a cooperative component. When this is true, popular mechanisms, such as options contract, cannot ensure both efficient investment and efficient exchange. See Che and Hausch (1999).

¹⁴ If the seller invests, the joint surplus, net of investment cost, is $(3/4)(\$200) + (1/4)(\$120) - \$30 = \150 . If he does not, the joint surplus is $(1/4)(\$200) + (3/4)(\$120) = \$140$.

¹⁵ We do not mean to assume that the seller has no assets. In the model, the seller does have enough assets to make the reliance investment and also to pay for litigation. What we do assume is that it is sufficiently difficult for the buyer to enforce the court judgment (based on breach of contract) against the seller’s assets because the buyer does not know how much assets the seller has and/or the seller can hide the assets from the buyer and the court. So long as it is sufficiently costly for the buyer and the court to collect from the seller’s “hidden” assets, even if not impossible as we assume, the judgment-proofness will be an important factor.

the court's knowledge. The quality or value of the good is costless to verify. However, the seller's investment is costly to verify and the court may err in its finding as to whether the seller invested.¹⁶ We are more precise about the verification parameters below.

This Part focuses mostly on comparing two types of contracts. The first conditions price only on the quality of the product that is costless to verify. The second contract conditions price also on whether the seller invests. The contract is later enforced by a fallible court, so it is more accurate to say that the contract is conditioned upon the court's finding of fact as to investment. Our focus is whether the parties would want to use the second contract, despite the potential court errors and the cost of litigation. We demonstrate that neither judicial error nor the deadweight cost of litigation is a direct obstacle to conditioning price on seller's investment. Rather, the desirability of this contract hinges on a more complex relationship between litigation incentives and deterrence. Before concluding this Part, we introduce a third contract, which conditions only on the court's fact finding as to investment and not quality (even though quality is costless to verify). We find that there may be circumstances in which the contract that conditions price only on investment is optimal.

A. Contracting Only on Verifiable Quality: the Q-contract

If the buyer designs the contract without attempting to induce the seller to invest, the buyer can capture the full contract surplus of \$140 by setting the contract price equal to the seller's reservation price of \$0 regardless of the value of the good; the buyer offers a *fixed-price* contract. If the buyer wants to induce the seller to invest, on the other hand, she will have to pay a higher price for the high-quality good. Her best strategy in this case is to set the contract price at \$60 if the value of the good is \$200 (P_H) and \$0 if it is \$120 (P_L). We will call a contract that conditions only on quality, *Q-contract*. Under this Q-contract, the seller would choose to invest because he realizes a (weakly) higher expected profit than without.¹⁷

Although the Q-contract yields a larger joint surplus than the fixed price contract, it has offsetting disadvantages. First, it imposes risk on the seller and the buyer will have to bear some of the seller's risk bearing cost. If the seller's risk aversion is sufficiently great, the buyer will prefer the fixed price contract. In this paper, we focus on a second disadvantage. The Q-contract compels the buyer to share the contract surplus with the seller, rather than driving the seller down to his reservation value. The buyer bears two

¹⁶ Readers who object to the characterization of quality as verifiable may think instead of the seller producing a higher or lower *quantity* of the good.

¹⁷ More formally, if the buyer wants to induce the seller to make the reliance investment, she would choose a set of prices to maximize her expected profit, $(3/4)(\$200 - P_H) + (1/4)(\$120 - P_L)$, subject to three constraints: (1) the seller must, in expectation, make at least as high a profit by investing than by not $((3/4)P_H + (1/4)P_L - \$30 \geq (1/4)P_H + (3/4)P_L)$; (2) the seller's profit, in expectation, must be as high as his outside option $((3/4)P_H + (1/4)P_L - \$30 \geq \$0)$; and (3) prices cannot be lower than zero. At optimum, the buyer will set $(P_H, P_L) = (\$60, \$0)$ and the seller, in expectation, will earn $(3/4)(\$60) + (1/4)(\$0) - \$30 = \15 .

distinct costs when she chooses to induce investment by opting for a Q-contract rather than a fixed-price contract: she must, in expectation, reimburse the seller's investment cost and she will allow the seller to capture some of the surplus from the exchange. Although only the former cost directly impacts social welfare, the latter may dissuade the buyer from choosing the incentive Q-contract, even when investment is socially efficient. Surplus sharing has efficiency consequences because the buyer's private cost diverges from the social cost. In the current example, the buyer's expected profit under the fixed price contract exceeds its profit under the Q-contract ($\$140 > \135).¹⁸ Hence, even though reliance investment maximizes the joint surplus, the buyer decides not to induce the seller to make the investment.¹⁹

B. Contracting on Both Quality and Investment: the QI-contract

Now suppose the incentive contract is conditioned not only on the value of the good, but also on a second measure, the seller's investment choice. For convenience, we will call this a *QI-contract*. The contract might obligate the seller to make the \$30 investment and back this obligation with a sanction of damages, which the parties liquidate at an amount D .²⁰ For instance, the contract might provide: (1) the buyer must pay the seller certain price that is conditioned on the realized value of the widget; and (2) in case the court declares that the seller has breached his obligation to invest, the seller must pay the buyer liquidated damages of D .²¹ Given our assumption that the seller is judgment-proof, we assume that D cannot be larger than the contract price that is promised to the seller.²²

We assume that the buyer decides to file suit against the seller after (1) the seller has made his investment decision, (2) the value of the good is realized, and (3) the buyer has paid the seller in accordance with the contract. The evidence before the court is noisy in the sense of leading the court to make errors of both types (I and II), but we assume the court's fact finding is correlated with the truth in the following manner. If the seller has made the investment, the buyer will win and be awarded damages with probability $1/3$; if the seller breached, the probability increases to $2/3$. The parties anticipate the judicial

¹⁸Under the Q-contract, the buyer's profit is $(3/4)(\$200 - \$60) + (1/4)(\$120) = \135 .

¹⁹ This problem might disappear if the seller were the party designing and making the take-it-or-leave-it offer, but the problem may reappear if the buyer can make an efficient investment specific to the contract.

²⁰ In theory, the parties may be able to make the liquidated damages to depend also on the realized widget value: (D_H, D_L) . As we will see shortly, however, because P_L will usually be zero, being able to set positive liquidated damages in that state does not necessarily expand the buyer's contracting choices.

²¹ This formulation implicitly assumes that it will be the buyer who has to sue the seller to collect liquidated damages. An alternate formulation might obligate the buyer to pay a certain price, which depends on the realized widget value, but only if the seller has not breached. Under that formulation, (wrongfully) alleging seller's breach, the buyer may withhold payment, and the seller must sue the buyer to receive the promised payment. That is more likely to give the option to file suit to the seller. Under that assumption, the seller's litigation cost will play an important role in constraining frivolous litigation while the buyer's litigation cost plays the role of imposing additional sanction against the breaching buyer. The substantive results, however, will be the same.

²² Perhaps it is more correct to say that even though the buyer can set liquidated damages that exceed the contract price, because the seller is judgment-proof, the maximum the buyer can collect from the seller, in case of breach, is the contract price.

outcomes probabilistically and symmetrically. Table 2 summarizes how the litigation outcome and the quality of the good are related to the seller’s investment choice.

	Quality		Court Fact Finding	
	\$120 (<i>L</i>)	\$200 (<i>H</i>)	“No Breach” (<i>I</i>)	“Breach” (<i>O</i>)
Invest	25%	75%	66.7%	33.3%
Not Invest	75%	25%	33.3%	66.7%

Table 2: Two Informative Signals

In effect, the QI-contract conditions price on four possible states of the world: high-value output and the court finding that the seller did invest (P_{HI}); high-value output and the court finding that seller did not invest (P_{HO}); low-value output and the court finding that the seller did invest (P_{LI}); and low-value output and the court finding that the seller did not invest (P_{LO}). For convenience, we can express the price and liquidated damages structure of a given contract by a vector, $(P_{HI}, P_{HO}, P_{LI}, P_{LO})$, where $P_{HI} \geq 0$, $P_{LI} \geq 0$, $P_{HO} = \max\{0, P_{HI} - D\}$, and $P_{LO} = \max\{0, P_{LI} - D\}$.

1. When Litigation is Costless

The court’s judgment works as a second informative signal that the buyer can rely on to provide investment incentive.²³ If the court’s judgment is costless to obtain, adding this second signal to the contract clearly improves the contract. The optimal contract, using both signals, would set $P_{HI} = \$72$ and $\$0$ in all other states: $(P_{HI}, P_{HO}, P_{LI}, P_{LO}) = (72, 0, 0, 0)$.²⁴ In other words, the buyer promises to pay the seller \$72 when the good value turns out to be \$200 but this will be offset by the liquidated damages of \$72 when the court finds that the seller did not invest. If the seller invests, he receives a price of \$72 with probability $1/2 = (3/4)(2/3)$, and an expected return equal to $(1/2)(\$72) - \$30 = \$6$.

²³ For the court’s judgment to provide additional information about the seller’s investment, the widget value cannot be a sufficient statistic of the judgment. When the two signals are independent but correlated with the investment, this is always true. In this example, the court judgment is “less informative” than the quality of the widget, since the change in probability is smaller.

²⁴ Similar to the problem the buyer faced in designing the optimal Q-contract, the buyer chooses the set of prices, $(P_{HI}, P_{HO}, P_{LI}, P_{LO})$ to maximize her expected profit, $(3/4)(\$200 - (2/3)P_{HI} - (1/3)P_{HO}) + (1/4)(\$120 - (2/3)P_{LI} - (1/3)P_{LO})$, subject to three constraints: (1) the seller’s profit from investment, $(3/4)((2/3)P_{HI} + (1/3)P_{HO}) + (1/4)((2/3)P_{LI} + (1/3)P_{LO}) - \30 , must be at least as large as his profit from no investment, $(1/4)((1/3)P_{HI} + (2/3)P_{HO}) + (3/4)((1/3)P_{LI} + (2/3)P_{LO})$; (2) the seller’s profit must be at least as large as his outside option, $(3/4)((2/3)P_{HI} + (1/3)P_{HO}) + (1/4)((2/3)P_{LI} + (1/3)P_{LO}) - \$30 \geq 0$; and (3) all the prices cannot be negative.

Compared to the case where the buyer had only one signal to rely on, the seller's expected profit has gone down from \$15 to \$6, and the buyer's profit has risen to \$144 from \$135. Thus, the court's informative judgment allows the buyer to increase contract completeness and provide a more tailored incentive scheme. In the current example, it allows the buyer to reduce the rent captured by the seller and induce the seller to make the investment, which is efficient. If the seller were risk-averse, conditioning payment on four different states of the world will enable the buyer to reduce the amount of risk imposed on the seller and thereby improve efficiency. Similar to the current example, however, because neither signals are fully informative, the seller will have to bear some risk in equilibrium.

2. Costly Litigation

The assumption that litigation is costless is, of course, unrealistic. If litigation is costly, would the buyer still want to include the second signal in the contract? If so, how would the optimal contract be different? The first point of departure from the costless litigation assumption is that when litigation is costly, the parties will proceed to litigation only if their (ex post) expected return from the litigation is positive. In particular, the buyer will sue the seller for (alleged) breach only if she expects a positive net payoff, which is determined by (1) the cost of litigation, (2) the size of the liquidated damages, and (3) probability of obtaining an advantageous verdict from the court.

Suppose, for simplicity, each party must bear a fixed cost equal to \$20 if litigation occurs.²⁵ We assume that the seller always bears this cost if the buyer sues, either directly or as an opportunity cost of time and energy, but the judgment-proof seller is unable to pay a damage award other than out of the contract price he would otherwise be entitled to.²⁶ This is a simplifying assumption that does not impair the generality of our substantive results.²⁷ In par IV, when we consider the issue of settlement, we assume that

²⁵ While we say that the litigation expenses are "fixed," we treat the costs and the probabilities as resulting from a litigation game played by both parties. For instance, if (x, y) denote respective amounts of evidence presented by the parties, the buyer would choose x to maximize $p(x, y)D - c(x) - F$ and the seller would choose y to minimize $p(x, y)D + c(y) + F$ where F and c denote fixed and variable costs, respectively. The \$20 litigation cost will include both the variable and fixed costs.

²⁶ We also note that judgment-proofness is sometimes due to the judgment debtor's difficulty in locating assets, rather than the defendant's inability to pay. Therefore, the seller may have assets, beyond the contract price, to pay for litigation but, in the face of an adverse judgment, may choose to incur the cost of hiding them from the buyer.

²⁷ A more realistic model would incorporate the seller's optimal litigation behavior. Particularly, the seller might choose not to defend against the suit and simply pay liquidated damages if the expected loss from the litigation exceeded the liquidated damages: $(2/3)D + \$20 > D$. Setting aside the issue of settlement for the moment, although we were not very explicit about what constitutes the litigation cost, we would expect it to come from two sources: fixed and variable. Fixed cost is the one the seller will have to incur whenever he proceeds to litigation, while variable cost would be under his control. If some parts of \$20 is fixed, rather than variable, even if the seller decides not to defend the suit in litigation, it is likely that his total litigation loss will be larger than the liquidated damages. If the parties can settle before the suit is filed, of course, the seller may not even need to incur the fixed cost. And, the seller's judgment-proofness may also prevent him from paying more than liquidated damages through a settlement contract. Hence, the

the seller's total loss, including the litigation cost, can never be larger than the contract price and show how the buyer can still use costly litigation as an effective incentive device.

If the seller has not breached, the buyer's expected return from litigation is $(1/3)D - \$20$, and the seller's expected loss is $(1/3)D + \$20$. Conversely, if the seller has breached, the buyer expects to earn $(2/3)D - \$20$ and the seller's expects to lose $(2/3)D + \$20$. After observing the seller's breach, the buyer has the incentive to sue if $(2/3)D - \$20 \geq \0 , or $D \geq \$30$. If the seller performs, the buyer will abstain from suing if $(1/3)D - \$20 \leq \0 , or $D \leq \$60$. Thus, if D is set between \$30 and \$60, the buyer will sue the seller if and only if the seller breaches.

Our analysis of the optimal contract with verification costs has three stages, or goals. First, we define a range of liquidated damages that optimize the buyer's incentive to sue (only when the seller fails to invest), given court error and litigation costs. This translates into a range of breach sanctions that the buyer can impose on the seller, while maintaining the optimal litigation incentive on the buyer. Of course, the seller may also be motivated to invest by the differential pricing of output. Second, given that range, we can identify a subset of liquidated damages and output prices that also induce efficient investment. Third, we pick the combination that satisfies the seller's reservation price but leaves him with none of the contract surplus.

Under a QI-contract with appropriate liquidated damages, the buyer can offer a lower price for a high-quality good than under the Q-contract. The reduction in the discrepancy between the high-quality and low-quality price reduces the risk borne by the seller, and compensated for by the buyer in the contract price. In our model, the QI-contract enables the buyer to reduce the expected rent enjoyed by the seller, while maintaining the desirable investment incentive. Thus, the QI-contract not only induces the seller's efficient investment, like the Q-contract, but it also ensures that the buyer will prefer an incentive contract to a fixed-price deal. Recall our earlier demonstration that the buyer might prefer a fixed price contract to the one that induces investment by paying more for a high-quality good.

For example, if the liquidated damages are \$36, the price for a high quality good may be \$40 rather than the \$60 under the Q-contract. The state contingent prices are therefore $(40, 4, 0, 0)$.²⁸ Let's look first at the buyer's litigation incentive under this

contract might need to work with the constraint that the seller's litigation loss may never be larger than the liquidated damages: $\min\{D, (2/3)D + \$20\}$. This is the issue we consider in depth in section IV. Whether or not we impose this restriction, however, the substantive results will stay the same.

²⁸ The formal maximization problem is similar to the one with costless litigation but with a few changes, the most important one being giving the buyer the right litigation incentive. When the buyer wants to induce the seller to make the reliance investment without having to incur litigation costs in equilibrium, she would choose $(P_{Ht}, P_{H0}, P_{Lt}, P_{L0})$ to maximize $(3/4)(\$200 - P_{Ht}) + (1/4)(\$120 - P_{Lt})$ subject to (1) the seller's expected profit with investment is as large as his expected profit without investment, $(3/4)P_{Ht} + (1/4)P_{Lt} - \$30 \geq (1/4)((1/3)P_{Ht} + (2/3)P_{H0} - \$20) + (3/4)P_{L0}$; (2) the seller does at least as

contract. The buyer will sue only if the seller breached and can expect to earn $(2/3)(\$36) - \$20 = \$4$ from the litigation. Second, we turn to the seller's investment incentive. If the seller invests, he is not sued and realizes an expected payoff of $(3/4)(\$40) + (1/4)(\$0) - \$30 = \0 . If he fails to invest, his chances of producing a high-quality good are lower and he would expect to lose in litigation the amount, $(2/3)(\$36) + \$20 = \$44$.²⁹ Thus, the non-investing seller expects a return of $(1/4)(\$40 - \$44) + (3/4)(\$0) = -\1 . In equilibrium, therefore, the seller makes the reliance investment. Finally, the third stage reveals that the seller captures none of the \$150 contract surplus because the high-quality price has been driven down to the seller's break-even point of merely covering its investment cost of \$30.³⁰

The advantage of this QI-contract over the Q-contract described earlier is that it can provide for different payoffs between the states P_{HI} and P_{H0} , while keeping litigation off the equilibrium path. Our analysis proceeded in three stages. First, the risk of judicial error (of both types) and the cost of litigation set a range for liquidated damages that optimize the buyer's incentive to sue (if and only if the seller breaches). This maximizes the deterrence effect of any given level of liquidated damages. Second, the seller's litigation costs add to the sanction for breach. In the current example, there is a set of (P_{HI}, P_{H0}) pairs (or, equivalently, pairs of high-quality prices and liquidated damages) within the range that optimizes litigation incentive, and also sets the optimal incentives for the seller to invest. This takes litigation off the equilibrium path. Third, the contract would incorporate the pair within this narrow set that also minimizes the price paid for high-quality good to the investing seller. This last move is the advantage that the QI-contract enjoys over the Q-contract. It minimizes the seller's share of the rent and, because the pay-for-performance schedule can be less steep ($P_{HI} - P_{LI}$ is smaller), it also reduces the risk borne by a risk-averse seller.

well as his outside option, $(3/4)P_{HI} + (1/4)P_{LI} \geq \0 ; (3) the buyer sues the seller only when the seller does not invest $(2/3)(P_{HI} - P_{H0}) - \$20 \geq \$0 \geq (1/3)(P_{HI} - P_{H0}) - \20 ; and (4) prices cannot be negative. For convenience, we have assumed that both low-value state prices are zero: $P_{LI} = P_{L0} = \$0$.

²⁹ The seller might therefore decide not to defend the suit and simply pay \$36 but, consistent with other literature cited in Part II, we make the simplifying assumption that the seller must participate in the litigation.

³⁰ In this problem, so long as the liquidated damages is between \$30 and \$40, the seller will have an incentive to make the reliance investment. If the court were to grant expectation damages, the buyer might be able to collect only \$40 from the judgment-proof seller, and that provides enough incentive to make the reliance investment.

	Contracting Variables		
	Q-contract	QI-contract	
		Costless Litigation	Costly Litigation
P_{HI}	\$60	\$72	\$40
P_{HO}	\$60	\$0	\$4
$P_{LI} = P_{LO}$	\$0	\$0	\$0
Seller's Profit	\$15	\$6	\$0
Buyer's Profit	\$135	\$144	\$150

Table 3: Comparison of Different Contracts

The example also demonstrates that the buyer would actually prefer contracting in the shadow of a costly litigation and the threat of a significant deadweight loss. The cost of litigation has two distinct and important effects. First, in the absence of litigation costs, the buyer would always sue if the contract provided for liquidated damages and there was a chance of judicial error. Therefore, the presence of litigation costs constrains the buyer's incentive to sue. As we illustrated above, there is likely to be a range of liquidated damages for any given level of litigation costs that will optimize the buyer's litigation incentives, so that she sues only when the seller fails to invest. Second, when the buyer does sue the seller, litigation costs supplement liquidated damages as a sanction for breach, and thereby enhance the seller's incentive to invest.

We note that it is tempting to suppose that the benefit of litigation costs in our model is that they indirectly by-pass the judgment-proofness constraint on the ability to punish the failure to invest. However, this feature, while present, is not a sufficient explanation because it neglects the first effect noted above concerning selective litigation. To illustrate, suppose that the litigation is costless to the buyer but imposes a cost of \$20 onto the seller. The buyer will always sue and this reduces the seller's expected profit by \$20 in litigation costs across the board. Such an indiscriminate sanction has no deterrence value with respect to the seller's investment. Moreover, it reduces the seller's profit by \$20 in all states of the world, and would compel the buyer to raise the contract price in order to meet the seller's outside option.³¹ In other words, the buyer, as the residual claimant, would bear ex ante the expected deadweight loss imposed by litigation in equilibrium.

C. Choice Between Q-contract and QI-contract: Comparative Statics

The optimal use of the two signals (quality and the court's finding of investment) discussed above is sensitive to various parameters, including the seller's investment cost, litigation costs and judicial error. Suppose we hold constant the risk of judicial error, particularly the probabilities of judgment conditional on investment and non-investment.

³¹ The result is similar in spirit to the main idea proposed in the "decoupling" literature: when litigation imposes a deadweight loss on the society, reducing the plaintiff's recovery while increasing the defendant's damages will decrease the number of suits but maintain the same level of deterrence against the defendant. In our example, we are not necessarily decoupling, in the sense of setting two different liquidated damages, but the selection is done through the change of probability of winning by the buyer.

In this section, we let litigation costs, L , vary relative to the seller's investment cost, C . To induce the buyer to sue only when the seller breaches, liquidated damages, D , must fall within the bounds $[(3/2)L, 3L] \equiv [\underline{D}, \overline{D}]$. Within this range, the sanction on the non-investing seller is $(2/3)D + L$. Thus, the range of litigation sanctions that the contract can impose on the seller for breach while maintaining the buyer's optimal litigation incentive is $[2L, 3L] \equiv [\underline{S}, \overline{S}]$. Finally, because the seller is judgment-proof, for the investment clause to be useful, the (high-value) contract price must at least as large as the lower bound on damages: $P_{HI} \geq \underline{D}$.

Difficulties arise when L is either too small or too large, relative to C . We noted earlier the consequence of zero litigation costs: the buyer's excessive incentive to sue. Where litigation costs are positive but small, the range of liquidated damages is quite low, as is the direct sanction of litigation costs, and this compels the buyer to rely more heavily on the price for high-quality goods to motivate investment. Conversely, if L is too high compared to C , given that the seller is judgment proof and the liquidated damages cannot be higher than the contract price, the buyer must offer a higher price for a high-quality good, and this leaves the seller with a correspondingly larger share of the surplus in equilibrium (recall that the seller invests in equilibrium so that she is not liable for liquidated damages).

For example, suppose the investment cost is \$10, instead of \$30, and the litigation cost remains at \$20. Note that the litigation cost is twice as large as the cost of investment. Liquidated damages under the QI-contract would have to be at least \$30 for the buyer to sue the seller in case of breach: $[\underline{D}, \overline{D}] = [\$30, \$60]$. Given that the seller is judgment-proof, in order to provide a credible litigation threat for breach of the investment clause, the buyer will have to raise the high-quality price to \$30. Since litigation does not occur in equilibrium, paying the seller \$30 when the value of the widget is \$200 implies that the seller will receive a rent under the QI-contract of $(3/4)(\$30) - \$10 = \$12.5$. If the buyer were to rely only on verifiable widget quality, she could have paid the seller only \$20 when the quality is high and \$0 when low. This well-crafted Q-contract induces the seller to invest while lowering the seller's rent to $(3/4)(\$20) - \$10 = \$5$.

What matters in this respect is not the absolute cost of litigation, but rather its ratio to the investment cost. If, in the previous example, litigation costs fell with investment cost, then it would have made it much easier for the buyer to provide a credible litigation threat in case of breach of investment clause. Moreover, the optimal QI-contract would remove the rent enjoyed by (or the risk imposed on) the seller from the higher price. Thus, as the ratio of litigation to investment cost increases, there is a point at which the Q-contract will dominate because it is too costly for the buyer to provide the investment incentive through credible litigation. Conversely, as the ratio of litigation to investment cost decreases, QI-contract is more likely to be superior. Thus, in this particular manner, verification costs may induce the buyer to condition the contract on the costless signal of quality alone. We note that this is different from the conventional

concern with verifiability in contract theory. Our results focus on the ratio of litigation costs to the cost of the seller's specific investment that the contract seeks to induce.

The following example illustrates the superiority of the QI-contract in the case of high investment cost, relative to litigation cost. Suppose the seller's investment cost is \$36, instead of \$30, while the litigation costs remain at \$20. The investment is still efficient, because the marginal increase to the joint surplus is \$40. To induce the seller to invest while not leaving him any rent, the buyer can promise to pay the seller \$48 when the widget value is \$200, \$0 when the widget value is \$120, and include a liquidated damages of \$30, i.e., $P_{HI} = D = \$48$. The buyer will provide enough incentive for the seller to invest without leaving the seller any rent. If the buyer could only use the Q-contract, however, the buyer will have to promise the seller \$72 when the widget value is high, and this leaves the seller with a rent of \$18.

D. Contracting Only on Investment: the I-contract

Notwithstanding the results from the previous section, when the investment cost is moderately high relative to litigation costs, the first best contract could rely only on an investment clause and not differentiate between the price of high-quality and low-quality goods (the I-contract). One might think of the Q-contract and I-contract as defining either end of a spectrum of contracts that rely to varying degrees on signals of quality and on investment, and in inverse relationship. The Q-contract relies the most on quality and the least on investment, while the I-contract relies the most on investment and the least on quality; the QI-contracts we have been describing lie in between.

The following example illustrates the attraction of I-contracts where investment cost is moderately high compared to litigation costs. Suppose the litigation costs are \$10 instead of \$20, while keeping the investment cost at \$30. If the buyer were to attempt to use the QI-contract with a positive monetary incentive for output quality, it would be difficult to provide the investment incentive without over-stimulating litigation. With the low widget value price at zero ($P_{LI} = P_{L0} = 0$), the QI-contract will promise the seller \$45 when the widget value is high and set the liquidated damages at \$30. Although this will induce the seller to invest, it will also leave the seller a rent of \$3.75 in equilibrium: $(3/4)(\$45) - \$30 = \$3.75$. As we saw before, the Q-contract, that conditions only on quality, would perform even worse. The buyer will have to promise to pay the seller \$60 when the widget value is high, and this, while providing efficient investment incentive, will leave the seller a rent of \$15: $(3/4)(\$60) - \$30 = \$15$.

In this setting, an I-contract with a fixed price, but damages for failure to invest, can yield optimal incentives and zero rent for the seller. To induce the seller to invest while not leaving him any rent, the buyer can set a fixed price of \$30 that does not depend on the realized widget value and include an investment clause with a liquidated damages of \$30: $(P_{HI}, P_{H0}, P_{LI}, P_{L0}) = (30, 0, 30, 0)$. In case the seller breaches, the buyer will sue the seller and the seller expects to lose $(2/3)(\$30) + \$10 = \$30$. The seller will have enough incentive not to breach the investment clause and the \$30 will be just

enough to compensate him for the cost of investment. The seller receives no rent in equilibrium.³²

When we hold the court's error constant, the effectiveness of litigation as an incentive tool is largely determined by the cost of litigation. When the litigation cost is \$10, the maximum punishment the buyer can impose on the seller, without triggering inefficient litigation in equilibrium, is \$30. As the investment cost rises, the average compensation the buyer must promise to the seller also rises. But, if the buyer were forced to use a monetary incentive (the QI-contract), the price in the high-value state will rise faster than the average compensation, and will soon out-pace the maximum punishment through litigation. If the buyer had to promise to pay the seller \$45 when the widget value is high, the litigation-based punishment of \$30 still leaves the seller with \$15 of profit. Hence, it will be better, in such cases, to rely only on the investment clause.

Although it is tempting to suggest that the I-contract will always perform better than the other two when the investment cost is very large (compared to the litigation cost), this is not so. Suppose the high value is \$300, instead of \$200, and the cost of investment is \$40, so that investment is efficient. Meanwhile, let us keep the litigation cost at \$10. If the buyer were to attempt to use only the investment clause with a liquidated damages of \$30, the buyer will have to pay the seller \$40 in both value states. The seller will breach, since by breaching the seller earns, even after litigation, \$10: $(3/4)(\$40 - \$30) + (1/4)(\$40 - \$30) = \$10$. By investing, on the other hand, the seller earns zero. In order to induce the seller to invest, the buyer will have to combine the investment clause with a monetary incentive: promising to pay the seller \$65 in the high-value state. Hence, for I-contract to be optimal, the prices must remain within the sanction range: $P_{HI} = P_{LI} \in [\underline{S}, \bar{S}]$.

The relationship among the three types of contracts is complex. When the investment cost is small compared to the litigation cost, it is difficult, if not impossible, for the buyer to provide a credible litigation threat. In that range, therefore, relying only on monetary incentive (Q-contract) will be optimal. As the investment cost rises (compared to the litigation cost), however, using litigation as a disciplining device becomes feasible, and it becomes optimal for the buyer to include an investment clause. When the investment cost is in some medium range, it will be optimal for the buyer to use the I-contract, whereas if the investment cost is large or small, the QI-contract will be optimal. So long as the stakes (as determined by the investment cost) are high enough for the buyer to provide a credible litigation threat, therefore, using the investment clause (with or without the monetary incentive) will be better than relying only on monetary incentive.

IV. Verification costs and settlement

³² By investing, the seller receives $(3/4)(\$30) + (1/4)(\$30) - \$30 = \0 , while by breaching, he receives $(1/4)(\$30 - \$30) + (3/4)(\$30 - \$30) = \$0$. The seller will not breach and earn \$0 in equilibrium.

In Part III, the parties avoided litigation costs by providing the plaintiff with the incentive not to sue in equilibrium, through the appropriate adjustment of liquidated damages. In this analysis, liquidated damages were serving a dual purpose, along with litigation costs: providing the efficient incentives for both the plaintiff's decision to sue and the seller's decision to invest. One might wonder, therefore, whether it would be better to focus liquidated damages on the seller's incentive and use another technique to move litigation off the equilibrium: namely, the possibility of settlement. Under this strategy, the optimal contract is different because settlement alters the effective sanction on the seller. Moreover, we show that QI-contracts may be less efficient if the parties can settle than if the parties rely instead on manipulating the buyer's incentive to sue (as in part III).

When the buyer was relying only on verifiable quality or when litigation did not impose any cost, having a chance to settle is trivial because there is no surplus from settlement, which is determined by the total cost of litigation. Being able to settle has implications only when there is positive surplus from settlement from the saving of litigation costs. While there are many ways of modeling settlement, we take a parsimonious approach.³³ After the seller has made the investment choice and the good value has been realized, but before the suit is filed by the buyer, suppose the nature chooses the party who will make a one-time take-it-or-leave-it settlement offer.³⁴ The chosen party makes the offer, which can be either accepted or rejected by the offeree. If he accepts, the game ends, but if he rejects, the buyer decides whether to file suit against the seller or not. Since the buyer decides whether to file the suit after the acceptance/rejection, if the buyer does not have a credible litigation threat, there will be no settlement. Hence, the parties will settle at a positive amount only when the buyer has a credible threat and the settlement amount will be determined by the respective bargaining powers and the reservation values.

Consider the QI-contract discussed in the previous section: $(P_{HI}, P_{H0}, P_{LI}, P_{LO}) = (40, 4, 0, 0)$. Given the liquidated damages of \$36, the buyer has a credible litigation threat only when the seller breaches the investment clause. In that case, the buyer's expected return from litigation is \$4 while the seller's expected loss from litigation is \$44. If the seller were making the settlement offer, he will offer to settle for \$4. If the buyer were making the offer, however, the buyer would demand \$44. However, in light of the fact that the seller is judgment proof, the buyer will not be able to demand more than \$40.³⁵ The reservation values are, therefore, given by \$4 and \$40.

³³ This formulation is similar to that used in Nalebuff (1987). The difference is that we do not deal with the information asymmetry problem.

³⁴ Even though the buyer has all the bargaining power at the contracting stage, this need not be true at the time of settlement. By the time of settlement, their relationship has changed from being potential contracting partners to being in a "locked-in" relationship. Buyer's initial superior bargaining power, for example, due to her monopoly position in the market, will not necessarily translate to the same at the time of settlement. We, of course, remain agnostic about the relative settlement bargaining power. If the nature always chooses the buyer as the offeror, the buyer will extract the entire surplus conditional on having a credible litigation threat.

³⁵ This is to be consistent with our original assumption that the seller is judgment proof. The assumption here is that even if they were to enter into a settlement agreement with payment above the liquidated

Two assumptions, that the seller has some bargaining power in settlement and the seller cannot, through settlement, pay more than the contract price, threaten to reduce the sanction for breaching and the incentive to invest. Thus, the contract terms should anticipate the path of settlement and adjust the liquidated damages accordingly. We can vary assumptions as to bargaining power in order to illustrate the effect on optimal liquidated damages. Let's first assume equal bargaining power: nature chooses the buyer (or the seller) to make the settlement offer with 50% probability. Given that both outcomes are equally likely, they will expect to settle at \$22. This reduces the seller's expected sanction for not investing from \$44 in a world without settlement to \$22, and it is now insufficient to stimulate investment.³⁶ This yields an effective payoff of (20,9,0,0).

To provide investment incentive to the seller, the parties must increase both the liquidated damages and the price promised to the seller when the widget value is \$200. If the buyer sets both the liquidated damages and the high widget value price at \$46, investment incentive can be restored: (46,0,0,0). The buyer's expected return from litigation if the seller fails to invest is $(2/3)(\$46) - \$20 = \$10.7$, and the seller's expected loss is $(2/3)(\$46) + \$20 = \$50.7$. With 50-50 bargaining power, they will settle at about \$28.30. If we trace the effect of this settlement on the ex ante incentive to invest, we find that the seller earns $(3/4)(\$46) + (1/2)(\$0) - \$30 = \4.50 if he invests and $(1/4)(\$46 - \$28.30) + (3/4)(\$0) = \4.45 if he does not.³⁷

The relative bargaining power of the parties affects the magnitude of the high-quality price and the damages. If the buyer has all the bargaining power in settlement (the nature always chooses the buyer as the offeror), setting both the high value price and the liquidated damages at \$40 will be sufficient to implement the first best contract. Whenever the seller breaches, the buyer, with credible litigation threat, can extract entire \$40 from the seller, and eliminate the seller's profit. Since the seller makes zero profit in case of breach, assuming that the seller's profit is at least as large as his outside option when he invests, it will be better for the seller to invest than not.

If the seller has all the bargaining power, the seller can avoid not only her own litigation costs, but can also extract the buyer's litigation costs savings from avoiding

damages, e.g., \$44, the buyer would have difficult time collecting the amount beyond the stipulated damages in case the seller breaches the settlement agreement. On the other hand, given that the buyer has a credible threat and the seller is to lose \$44 if they were to proceed to trial, it may not be unrealistic to assume that the buyer will demand \$44 from the seller and the seller will voluntarily pay that amount to the buyer. If the buyer can collect a settlement demand that is larger than the liquidated damages, implementing the first best solution will become easier and the rest of the analysis will not be affected.

³⁶ With the monetary incentive of paying the seller \$40 when the widget value is \$200, by investing, the seller's expected return is $(3/4)(\$40) + (1/4)(\$0) - \$30 = \0 . If the seller breaches, because he expects to lose \$22 through settlement, his expected profit is $(1/4)(\$40 - \$22) + (3/4)(\$0) = \4.50 . The seller would be better off not investing and paying, on average, \$22 as settlement.

³⁷ The optimal liquidated damages and high value price is approximately \$45.88. We use \$46 to simplify the numerical example.

trial. This effect is particularly significant when litigation costs are high. Setting a contract price of $(46, 0, 0, 0)$ will not stimulate investment if the seller always makes the take-it-or-leave-it settlement offer.³⁸ Rather, the buyer must increase the wedge between P_{HI} and P_{HO} . The investment incentive can be established by setting both high value price and liquidated damages at \$52.5. The buyer, in case of breach, will expect to recoup \$15 through settlement and this will be just sufficient to provide investment incentive to the seller.³⁹

The QI-contract in anticipation of settlement is (weakly) inferior to the QI-contract when settlement is not in prospect. Recall that the benefit of litigation costs off-the-equilibrium is that they drive a wedge between the expected return from litigation to the buyer and the expected loss from litigation to the non-investing seller. Settlement undermines this wedge. If the seller has bargaining power, the sanction for breach is lowered by the ability of the seller to capture some of the buyer's saving from avoiding litigation. This might be offset by an increase in liquidated damages, but we explained earlier why liquidated damages are poor substitute for decreases in litigation costs. An increase in liquidated damages increases the buyer's incentive to sue, perhaps to the point of inducing litigation even when the seller invests.

Nevertheless, the QI-contract with settlement performs better than the optimal Q-contract, because positive settlement, no matter how small, still imposes additional punishment against the breaching seller, even when the seller has all the settlement bargaining power. Therefore, so long as a credible litigation threat can be provided, using the QI-contract with settlement will be better than contracting only on quality.

While the QI-contract with settlement will generally be worse than the QI-contract without settlement, the problem of encouraging investment when the seller has some settlement bargaining power becomes even less tractable as litigation costs rise. Setting aside the fact that the higher litigation cost makes it more difficult for the buyer to provide a credible litigation threat, compared to the QI-contract without settlement, when the seller has some settlement bargaining power, an increase in litigation cost (particularly the seller's) does not translate to an equal increase in the seller's expected loss from settlement. In other words, a unit increase in litigation cost offers a lower increase in punishment in the case with settlement than in the case without. This is because, when the seller has some bargaining power, an increase in settlement surplus through the rise in litigation cost, does not increase the amount of settlement in one-to-one basis. Hence, as the litigation cost gets bigger, the QI-contract with settlement will become increasingly inferior to the QI-contract without settlement.

³⁸ With liquidated damages and the high value price of \$46, after the breach, the seller would expect to lose \$10.70 from settlement. Promising to pay the seller \$46 when the widget value is \$200 would clearly not be enough to provide investment incentive. By breaching, the seller expects to make $(1/4)(\$46 - \$10.70) = \$8.83$, whereas by investing, he would expect $(3/4)(\$46) - \$30 = \$4.50$.

³⁹ The seller's respective expected profits are $(1/4)(\$52.5 - \$15) = \$9.4$ when he breaches, and $(3/4)(\$52.5) - \$30 = \$9.4$ when he does not.

V. Conclusion

A contract will very rarely be able to include terms that invoke perfect and costless signals of desired performance. The task of contract design is the choice among signals that vary in their information content and in their verification costs. If the parties are faced with two costless signals that vary in information content, they should exploit both if they can. Although the parties would prefer a signal that contains more information than the one that does not, that does not imply that they will discard the less informative signal. But, what if the signals vary in costs of verification? Can we say that, holding the information content the same, the parties will always prefer the costless one to the costly one? Will they ever use the costly one in addition to, or even instead of, a costless signal? What if the costly signal contains even less information than the costless one?

This paper has shown that a costly but noisy signal can play a very important role in incentive provision. Indeed, if such a costly signal is incorporated in the contract, the parties might not incur that cost in equilibrium when the signal is incorporated in the contract. That decision needs to be made *ex post*: verification costs (through appropriate adjustment of prices) allow the parties to tap into the costly signal only selectively. Furthermore, when the parties do decide to incur that cost, it imposes an additional sanction against the breaching party. Hence, so long as the verification is pushed off the equilibrium, the contract designer can provide a very powerful incentive without having to incur the verification cost. Indeed, we have illustrated that the parties often should pick the costly signal, either together with or instead of the costless signal, even if it is less informative than the costless one.

This paper underscores the importance of incorporating the verification, particularly the adjudication, process into contract design and the various choices and incentives that parties have during the contracting stage. Rather than focusing solely on the problems of adjudication or those of contracting (without sufficient regard to how the disputes will be resolved in the future), we have attempted to take a more comprehensive approach by looking at the choices the contracting parties have while paying sufficient attention to the contract dispute resolution process. We hope we have made the case for a more ambitious agenda in this regard that ultimately will account for the effect of other decisions in the enforcement process, beyond the decision to sue and to settle: for example, decisions of the defendant to respond and of both parties to present evidence.

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