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Remedies for Anticipatory Breach of Contract with Two-Sided Asymmetric Information: A Comparison of Legal Regimes

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Abstract

The Law and economics movement has paid a lot of attention to carefully analyzing various doctrines of contract law. Yet, with few exceptions, the doctrine of anticipatory breach seems to have escaped law and economics scholars' scrutiny. Specifically, the question of optimal choice of remedies has escaped scholars' eyes. While traditionally in England the party who files a law suit can get only damages, in the US the party can not only ask for assurances for performance, but also, in appropriate cases, get specific performance. Which regime is better? Can parties opt in and out of those regimes? Is there a legal regime which is superior to both the English and American regimes? In this paper we attempt to start filling in this gap by studying the relationship between various regimes of remedies. Specifically, we start by studying the conditions in which the American legal regime (which grants the non-breaching party an option to choose, in appropriate cases, between specific performance and actual damages) is superior to the English regime (which allows the non-breaching party to seek only actual damages). We then explore a third regime, which as far as we know does not exist, and show that it is unconditionally Pareto Superior to both the English and American legal regimes. Our analysis in this paper informs transactional lawyers of the relevant economic factors they should consider when deciding between remedies in a given anticipatory breach context. We focus on the ex-ante design of the contract in light of new and asymmetric information that the parties anticipate they will gain after they draft the contract. We assume fist, for simplicity, that no renegotiation or investments are involved. We demonstrate the optimal way to design contract clauses which takes advantage of the information that the seller and the buyer receive between the time they enter into the contract and the time

of the breach. We present two models. One is for non-market goods and the other is for market-goods. The law is different with respect to the way damages are calculated for these two classes of goods. We thus model both types of transactions. Section two describes the legal background against which we have designed our models. Section three surveys the literature that evaluates contract remedies in the context of anticipatory breach context from an economic perspective. Section four presents two simple models with incomplete two-sided asymmetric information. In section four, we compare the performance of the American legal regime with that of the English one. Section five discusses some interesting extensions meant to approach the first-best allocative efficiency. The appendix provides a more rigorous mathematical demonstration of the model.

Remedies for Anticipatory Breach of Contract with Two-Sided Asymmetric Information: A Comparison of Legal Regimes.

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* We are grateful for valuable comments from ….All remaining errors are our own responsibility.

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1. Introduction

The Law and economics movement has paid a lot of attention to carefully analyzing various doctrines of contract law. Yet, with few exceptions, the doctrine of anticipatory breach seems to have escaped law and economics scholars' scrutiny.[1] Specifically, the question of optimal choice of remedies has escaped scholars' eyes. While traditionally in England the party who files a law suit can get only damages, in the US the party can not only ask for assurances for performance, but also, in appropriate cases, get specific performance. Which regime is better? Can parties opt in and out of those regimes? Is there a legal regime which is superior to both the English and American regimes?

In this paper we attempt to start filling in this gap by studying the *relationship* between various regimes of remedies. Specifically, we start by studying the conditions in which the American legal regime (which grants the non-breaching party an option to choose, in appropriate cases, between specific performance and actual damages) is superior to the English regime (which allows the non-breaching party to seek only actual damages). We then explore a third regime, which as far as we know does not exist, and show that it is unconditionally Pareto Superior to both the English and American legal regimes.

Our analysis in this paper informs transactional lawyers of the relevant economic factors they should consider when deciding between remedies in a given anticipatory breach context.

We focus on the ex-ante design of the contract in light of new and asymmetric information that the parties anticipate they will gain after they draft the contract. We assume fist, for simplicity, that no renegotiation or investments are involved.[2] We demonstrate the optimal way to design contract clauses which takes advantage of the information that the seller and the buyer receive between the time they enter into the contract and the time of the breach.

We present two models. One is for non-market goods and the other is for market-goods. The law is different with respect to the way damages are calculated for these two

[1] Exceptions are Jackson (1978), Mahoney (1995), Triantis (2003) and Triantis & Triantis (1998).
[2] Indeed, in an environment of asymmetric information renegotiation costs are high. More on renegotiation below in footnote 26.

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classes of goods. We thus model both types of transactions. Section two describes the legal background against which we have designed our models. Section three surveys the literature that evaluates contract remedies in the context of anticipatory breach context from an economic perspective. Section four presents two simple models with incomplete two-sided asymmetric information. In section four, we compare the performance of the American legal regime with that of the English one. Section five discusses some interesting extensions meant to approach the first-best allocative efficiency. The appendix provides a more rigorous mathematical demonstration of the model.

2. The Law of Anticipatory Breach.

Anticipatory breach is a relatively recent development in the Anglo-American law.[3] As Corbin puts it: "An anticipatory breach of contract by a promisor is a repudiation of his contractual duty before the time fixed in the contract for his performance has arrived."[4] While traditionally one could not get a remedy before the actual time of performance, in the mid 19th century courts in England and later in America did start granting some kind of remedy before the time of performance.

Section 2-610 of the UCC provides the aggrieved party with two main options in case of repudiation. First, the aggrieved party can "for a commercially reasonable time await performance" and urge the repudiating party to retract from the repudiation. She may ask for reasonable assurances of performance during this time. Second, the buyer can resort to remedies stipulated in section 2-711 (even if the buyer has notified the repudiating party that he would wait.[5] Under the remedies stipulated in section 2-711, the buyer may cancel the contract (and refrain from paying the price not yet paid). Whether or not the buyer has cancelled the contract she may choose from several courses of conduct. Her options depend on the type of goods in question, as the UCC distinguishes at this stage between cases where the goods are traded in the markets and therefore have readily available market prices, and cases where the goods are unique. If the goods are

[3] The leading case is Hochster v. de la Tour, 118 Eng Rep. 922 (Q.B 1853).
[4] 9-54 Corbin on Contracts § 959
[5] UCC 2-610. The aggrieved party can also suspend her own performance. We ignore this possibility here as we assume, for simplicity, that the only obligation the buyer has is to pay the contract price. For the same reason we ignore the remedies set forth in section 2-703, as they refer to seller's remedies.

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not unique, the buyer may choose to "cover," i.e. to make a reasonable purchase of goods in substitution for those due from the seller. Alternatively, the buyer can recover damages for non-delivery as provided in section 2-713 and 2-723. For goods that have a market price, the damages would be based on the difference between the market price and the contract price.[6]

If the goods are unique, the buyer can, in appropriate cases, get specific performance. Alternatively, she could choose to recover damages for non-delivery. As there is no readily available market price, the UCC allows the parties to use any other reasonable method of measuring damages, provided that they have given the other parties fair notice about it.[7]

In sum, under the UCC, there are two different types of processes. If the goods have a readily available market price, then the buyer can choose to "cover" or "recover." From an economic standpoint, as is made clear below, because the calculation of the damages is straight forward, both options are equivalent.[8] If the goods do not have a readily available price, then the buyer will need to prove her loss in court--not a trivial task. Whether or not it is easy to prove damages, the buyer can ask the seller to provide her with assurances that the seller will perform, and, in appropriate cases, can even get a decree of specific performance from the court.

The doctrine of anticipatory breach in England is very similar.[9] The only difference is that the buyer cannot get specific performance. This difference between the English legal regime and the American legal regime is interesting. Why? We thus develop simple models that compare the efficiency of both legal regimes. We offer two different models to deal with the two types of goods-- those which do, and those which do not-- have readily available market prices.

[6] If there is no evidence of a market price prevailing, then parties can bring evidence of a price reasonable before or after the time of the repudiation, or at any other market place which is a reasonable substitute There is a debate in the literature regarding the exact time the market price should be looked at. Section 2-723 mentions the "time when the aggrieved party learned of the repudiation". Some have argued that the relevant time is the time of the original performance. JJ White and Robert Summers, Uniform Commercial Code. We ignore this debate at this point.

[7] USS 2-723 and official comments.

[8] A buyer's decision whether to "cover" or "recover" will be based on the transaction costs involved in each case. We ignore this aspect in this paper.

[9] See Chitty on Contracts, (Volume 1, General Principles) (London, 2004) at 1383. See also The Law of Contract (Michel Furmston, Ed), 2nd edition, at 435.

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3. Related Literature

In this section we survey previous related work and distinguish our work

[To be Completed]

4. A model of anticipatory breach- goods with no readily available price.

4.1The setting.

At Time 1 a seller-supplier and a buyer-manufacturer (both are risk-neutral) enter a contract for the sale of a single unit of indivisible goods that the buyer-manufacturer needs for its production of the finished goods. The seller receives the money upon performance, that is, when he supplies the good sometime in the future[10]. There is uncertainty about seller's cost of production due to future fluctuations in the market prices of the inputs needed to manufacture the materials the seller promised to deliver. Thus, it is assumed that seller's costs, c, are drawn from a density function f(c) with cumulative density function denoted F(c) in the interval $[\underline{c}, \overline{c}]$. There is also uncertainty about the buyer's valuation of the contract due to future fluctuations in the market prices of the products the buyer ultimately manufactures and sells. Thus, it is assumed that buyer's valuation, v, is drawn from a density function g(v) with cumulative density function denoted G(v) in the interval $[\underline{v}, \overline{v}]$, where G(.) and F(.) are independent functions. What is clear, however, is that by the time the parties' dispute is deliberated in courts, call it Time 4, both parties will have learned the new market prices. The seller will know his costs and the buyer her valuation. The following chart presents the timeline.

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[10] Anytime after time 4.

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1		2	3		4
Parties enter a contract	Seller learns his cost	Seller signals anticipatory breach	Buyer reports her valuation at trial	Buyer learns her valuation	Court decides and parties make decisions

Chart 1- Timeline for the model with expectation damages

At Time 1, the seller and the buyer are symmetrically uninformed about each other's as well as their own valuations. They enter a contract with a price, p . Without loss of generality, and for simplicity, we assume that the buyer has the entire bargaining power so the seller's surplus from the contract is assumed to be zero. This entails that the buyer makes a take-it-or-leave-it offer of the price, p .

We note that the price written in the contract is correlated with and reflects the legal regime employed by the courts that the parties are expected to face at Time 3, if the seller repudiates at Time 2. Importantly, there are two legal regimes, the English Legal Regime (ELR) and the American Legal Regime (ALR). More on this below.

In the interim period between Time 1 and Time 4, both parties learn their true valuations but cannot make any changes to the contract between them (no renegotiation after Time 1). Possible justifications for the parties learning more about their true valuations only after Time 1 is that new information that was unknown before (but which was anticipated to be known later) is now revealed. For example, the seller learned his exact cost of performance after OPEC withdrew its threat to raise oil prices, or, the buyer learned that the product she intends to manufacture was approved by some federal agency for distribution in the US, and so forth.

At Time 2 the seller, after learning his exact cost of performance, decides whether to repudiate; that is, the buyer reasonably suspects that the seller will not perform at Time 4, as was promised. The buyer's suspicions could be based on a message that he received from the seller (such as a letter saying he would not perform in time) or due to some

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exogenous information that has arrived (for example, that the seller has filed for bankruptcy).

Because the goods have no readily available market price, at Time 3 the court hears evidence about the damages that the breach of the promise to deliver caused the buyer and consequently determines the amount of damages the seller needs to pay the buyer.

For simplicity, we assume that only the buyer presents evidence about the loss, and that the seller only tries to refute the evidence. At this stage, there are two extreme cases of court-imposed expectation damages. One is when the court is naïve and completely believes what the buyer reports. That is, the buyer can totally mislead the court about her valuation. Denote $\hat{v}_r$ ($r = A$ or E is the regime in force) as the buyer's report, then in this case $d_r = \hat{v}_r - p_r$.[11] The other case is when the court completely disbelieves the buyer's report (perhaps due to seller's refutations), and therefore determines the buyer's loss based on whatever the court can observe (which is buyer's expected valuation only, i.e., $d_r = E(v) - p_r$.).

Of course, different courts will have different levels of naivety. To capture this point, we assume that courts will determine that the expectation damages lie somewhere in between those two cases. Thus, the court is assumed to hear the buyer's report and, knowing that the buyer has an incentive to misreport the loss, the judge will also use his/her discretion to make some (downward) adjustments. Specifically, we assume that the damages will be a linear combination of the buyer's report $(\hat{v}_r)$ and the buyer's (observed) expected value $E(v)$, i.e., $d_r = a\hat{v}_r + (1-a)E(v) - p_r$, where $a \in [0,1]$ is a parameter representing the court's level of "naivety." We assume that the buyer does not know in advance the level of naivety of the court, and therefore cannot adapt its report to the specific court in which the trial takes place. Instead, we assume that the buyer can observe only $E[a]$, the average level of naivety of the court, when it decides whether and by how much to inflate her loss. For notational ease, we denote the bottom-line valuation

[11] Alternatively, parties agree in Time 1 that in case of an anticipatory breach, the Buyer can submit to the court her valuation, which will be conclusive for the calculation of the expectation damages.

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that the court takes into account (after accounting for buyer's strategic behavior) when determining the damage award $a\hat{v}_r + (1-a)E(v) - p_r$ as $\tilde{v}_r(a, \hat{v}_r)$, and sometimes we will omit its arguments, simply denoting as $\tilde{v}_r$. At Time 3, based on the evidence that the buyer presented to the court, the court decides the amount of expectation damages that the breach caused. Then, after the trial, but before Time 4, the buyer learns her realized valuation.

At Time 4, there are two possible regimes that the court can apply. First, an English Legal Regime (ELR), in which the court awards the buyer damages, d_E, for the anticipatory breach. Second, an American Legal Regime (ALR), in which the buyer can insist on getting (assurance for) specific performance over receiving damages, d_A. At Time 3, when the buyer makes her decisions, the seller's realized cost of performance is not observable to the buyer or verifiable to the court.[12]

We now compare the incentives to breach and parties' expected payoffs under ELR versus under ALR.

4.2 ELR with expectation damages

When the legal regime is ELR, (that is, when the buyer is only entitled to court imposed expectation damages at Time 4), the buyer offers the seller in Time 1 a take-it-or-leave-it contract (p_E), where p_E, the price under ELR, is payable upon performance. The seller will receive $p_E - c$ if he performs, $(-d_E)$ if he breaches, where $d_E = \tilde{v}_E(a, \hat{v}_E) - p_E$ is the expectation damages that the court determines based on the buyer's evidence.

[12] This is a major difference between our model and the models considered in the literature on incomplete contracts. Like other models in the literature, we assume that parties at Time 1 only observe each other's distributions. In addition to that, we also assume that parties do not know their own valuation, but rather have only an estimate of it. Parties in this sense are symmetrically uninformed: they both observe nothing but their own and each other's distributions. No private information exists. In Time 2 asymmetry of information is introduced. Parties learn their own valuation but still cannot observe (and definitely not verify) their opponent's valuation, only its initial distribution. Observe that our model is a sequential game. We believe that a sequential game more realistically captures real life situations. The results do not change though even if we model it as a simultaneous game.

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Therefore, the seller will breach if $c > \tilde{v}_E(a, \hat{v}_E)$. Between Time 2 and Time 3 the buyer chooses her report $\hat{v}_E$ to maximize her expected payoff,

$$p_E^B = F[\tilde{v}_E(a,\hat{v}_E)][E(v) - p_E] + [1 - F[\tilde{v}_E(a,\hat{v}_E)]](\tilde{v}_E(a,\hat{v}_E) - p_E).$$

The first order condition (FOC) gives us the buyer's optimal report (if $a > 0$),[13]

$$\hat{v}_E^* = E(v) + \frac{1}{a} \cdot \frac{1 - F[\tilde{v}_E(a,\hat{v}_E^*)]}{f[\tilde{v}_E(a,\hat{v}_E^*)]}. \tag{4.1}$$

From (4.1), we know that $\hat{v}_E^* > E(v)$.

The seller's expected payoff (if he accepts the contract) is:

$$p_E^S = F(\tilde{v}_E)[p_E - E(c / c \le \tilde{v}_E)] + [1 - F(\tilde{v}_E)][-(\tilde{v}_E - p_E)].$$

And the equilibrium is summarized in Lemma 5:

<u>Lemma 5</u> *Under ELR with court-imposed expectation damages,*

$$\tilde{v}_E^* \equiv a\hat{v}_E^* + (1-a)E(v) = E(v) + [1 - F(\tilde{v}_E^*)] / f(\tilde{v}_E^*);$$

$$p_E^* = \tilde{v}_E^* - \int_{\underline{c}}^{\tilde{v}_E^*} F(c)dc; \qquad d_E^* = \int_{\underline{c}}^{\tilde{v}_E^*} F(c)dc;$$

$$p_E^{B^*} = F(\tilde{v}_E^*)E(v) - \int_{\underline{c}}^{\tilde{v}_E^*} c dF(c); \qquad p_E^{S^*} = 0.$$

Remarks. (a) Observe that the buyer inflates her expected loss by an amount $d(\tilde{v}_E^*) \equiv \frac{1}{a} \cdot \frac{1 - F(\tilde{v}_E^*)}{f(\tilde{v}_E^*)} > 0$. This reflects the intuition that the buyer will try to get more than her expected value, which she is guaranteed even without misleading the court. By Assumption 1, we have $d' < 0$. Equation (4.1) tells us that $\partial \tilde{v}_E^* / \partial [E(v)] = 1/[1 - ad'(\tilde{v}_E^*)]$. $d' < 0$ (and $a > 0$) implies that $\partial \tilde{v}_E^* / \partial [E(v)] \in (0,1)$, i.e., the buyer's value report, will increase in $E(v)$, but since $E(v) \uparrow \Rightarrow \tilde{v}_E^* \uparrow \Rightarrow d(\tilde{v}_E^*) \downarrow$, we know that the exaggeration part, $\hat{v}_E^* - E(v) = d(\tilde{v}_E^*)$, will become smaller when we increase the buyer's mean valuation.

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[13] If $a = 0$, the judge will set $d_R = E(v)$, and he won't require the buyer to report her expected loss.

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(b) Observe that the seller will breach whenever $c > \tilde{v}_E^* > E(v)$. Thus, from the ex-ante perspective, there is under-breach relative to the social optimum. From the ex-post perspective, there is under-breach if $v < \tilde{v}_E^*$ and over-breach if $v > \tilde{v}_E^*$.

4.2 ALR with expectation damages

When the legal regime is the American Legal Regime, (ALR), (that is, when the buyer can insist on specific performance), the buyer offers the seller at Time 1 a take-it-or-leave-it contract (p_A), where p_A, the price under ALR, is payable upon performance. If at Time 4 the buyer insists on delivery, she will obtain $v - p_a$; if she agrees to the breach, she will get paid $d_A = a\hat{v}_A + (1-a)E(v) - p_A \equiv \tilde{v}_A(a, \hat{v}_A) - p_A$, where $\hat{v}_O$ is the buyer's report at Time 3. Therefore, the buyer will insist on delivery if $v \geq \tilde{v}_A$ and agree to breach otherwise. If the seller delivers, he will obtain $p_A - c$. If the seller attempts to breach, his expected payoff will be $G(\tilde{v}_A)(p_A - \tilde{v}_A) + [1 - G(\tilde{v}_A)](p_A - c)$. Hence, the seller would have wanted to breach anytime $c \geq \tilde{v}_A$.

The buyer chooses $\hat{v}_{OA}$ to maximize her expected payoff ,

$$p_A^B = F(\tilde{v}_A(a, \hat{v}_A))[E(v) - p_A]$$
$$+[1 - F(\tilde{v}_A(a, \hat{v}_A))]\{G(\tilde{v}_A(a, \hat{v}_A))(\tilde{v}_A(a, \hat{v}_A) - p_A) + [1 - G(\tilde{v}_A(a, \hat{v}_A))][E(v / v \geq \tilde{v}_A(a, \hat{v}_A)) - p_A]\}.$$

The first order condition is,

$$[\int_{\underline{v}}^{\tilde{v}_A} v dG(v) - G(\tilde{v}_A)\tilde{v}_A] f(\tilde{v}_A) + [1 - F(\tilde{v}_A)]G(\tilde{v}_A) = 0 \qquad (4.2)$$
$$\Rightarrow \tilde{v}_A^* = E(v | v \leq \tilde{v}_A^*) + [1 - F(\tilde{v}_A^*)] / f(\tilde{v}_A^*).$$

Comparing the buyer's reporting strategy under the two regimes, we have the following proposition:

<u>Proposition 4</u> $\hat{v}_A^* < \hat{v}_E^*$.

Proof: Suffices to show that $\hat{v}_A^* < \hat{v}_E^*$ Suppose to the contrary that $\tilde{v}_A^* \geq \tilde{v}_E^*$.

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From the first order conditions, we know that $\tilde{v}_E^* = E(v) + [1 - F(\tilde{v}_E^*)] / f(\tilde{v}_E^*)$, and

$\tilde{v}_A^* = E(v | v \le \tilde{v}_A^*) + [1 - F(\tilde{v}_A^*)] / f(\tilde{v}_A^*)$. Hence we now have

$E(v | v \le \tilde{v}_A^*) + [1 - F(\tilde{v}_A^*)] / f(\tilde{v}_A^*) \ge E(v) + [1 - F(\tilde{v}_E^*)] / f(\tilde{v}_E^*)$. However,

$E(v | v \le \tilde{v}_A^*) < E(v)$ always holds, and by the monotone hazard rate assumption,

$\tilde{v}_E^* \ge \tilde{v}_A^* \Rightarrow [1 - F(\tilde{v}_A^*)] / f(\tilde{v}_A^*) \le [1 - F(\tilde{v}_E^*)] / f(\tilde{v}_E^*)$.

Therefore, $E(v | v \le \tilde{v}_A^*) + [1 - F(\tilde{v}_A^*)] / f(\tilde{v}_A^*) \ge E(v) + [1 - F(\tilde{v}_E^*)] / f(\tilde{v}_E^*)$. cannot hold.

Thus, we have proved that $\tilde{v}_A^* < \tilde{v}_E^*$, or equivalently that $\hat{v}_A^* < \hat{v}_E^*$.

QED.

Remark. The ALR makes the buyer less aggressive in exaggerating her expected loss and misleading the court. Under ELR, the buyer inflates her expected loss trying to obtain more compensation in the case of a breach, because the only tool she has to affect the breach threshold is her report. Under ALR, besides this tool, she has the veto power; she can enforce the trade when her ex post valuation is very high. Therefore, she does not need to inflate her expected loss too much.

If the seller accepts the contract, the buyer will get an expected payoff of,

$$p_A^B = F(\tilde{v}_A)[E(v) - p_A] + [1 - F(\tilde{v}_A)]\{G(\tilde{v}_A)(\tilde{v}_A - p_A) + [1 - G(\tilde{v}_A)][E(v / v \ge \tilde{v}_A) - p_A]\};$$

and the seller's expected payoff is

$$p_A^S = F(\tilde{v}_A)[p_A - E(c / c \le \tilde{v}_A)] + [1 - F(\tilde{v}_A)]\{G(\tilde{v}_A)(p_A - \tilde{v}_A) + [1 - G(\tilde{v}_A)][p_A - E(c / c \ge \tilde{v}_A)]\}.$$

The equilibrium is summarized in the following Lemma 6:

Lemma 6 *In equilibrium,*

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$$\tilde{v}_O^* = E(v | v \le \tilde{v}_A^*) + [1 - F(\tilde{v}_A^*)] / f(\tilde{v}_A^*);$$

$$p_A^* = E(c) + [1 - F(\tilde{v}_A^*)]G(\tilde{v}_A^*)\tilde{v}_A^* - G(\tilde{v}_A^*)\int_{\tilde{v}_A^*}^{\bar{c}} c dF(c);$$

$$d_A^* = \tilde{v}_A^* - p_A^*; \qquad p_A^{S^*} = 0;$$

$$p_A^{B^*} = F(\tilde{v}_A^*)E(v) + [1 - F(\tilde{v}_A^*)]\int_{\tilde{v}_A^*}^{\bar{v}} v dG(v) + G(\tilde{v}_A^*)\int_{\tilde{v}_A^*}^{\bar{c}} c dF(c) - E(c).$$

As for the ELR regime, now we want to compare the equilibrium joint payoffs under different regimes with court-imposed expectation damages. The difference in equilibrium joint payoff is,

$$p_A^{B^*} - p_E^{B^*} = F(\tilde{v}_A^*)E(v) + [1 - F(\tilde{v}_A^*)]\int_{\tilde{v}_A^*}^{\bar{v}} v dG(v) + G(\tilde{v}_A^*)\int_{\tilde{v}_A^*}^{\bar{c}} c dF(c) - E(c) - [F(\tilde{v}_E^*)E(v) - \int_{\underline{c}}^{\tilde{v}_E^*} c dF(c)]$$

$$= [F(\tilde{v}_A^*) - F(\tilde{v}_E^*)]E(v) + [1 - F(\tilde{v}_A^*)]\int_{\tilde{v}_A^*}^{\bar{v}} v dG(v) + G(\tilde{v}_A^*)\int_{\tilde{v}_A^*}^{\bar{c}} c dF(c) - \int_{\tilde{v}_A^*}^{\bar{c}} c dF(c)$$

$$= \int_{\tilde{v}_A^*}^{\bar{v}} ([1 - F(\tilde{v}_A^*)]v) dG(v) - \int_{\tilde{v}_A^*}^{\bar{c}} ([1 - G(\tilde{v}_A^*)]c) dF(c) + \int_{\underline{c}}^{\tilde{v}_A^*} [E(v) - c] dF(c) - \int_{\underline{c}}^{\tilde{v}_A^*} [E(v) - c] dF(c)$$

$$= [1 - F(\tilde{v}_A^*)][1 - G(\tilde{v}_A^*)][E(v / v \ge \tilde{v}_A^*) - E(c / c \ge \tilde{v}_A^*)] + \int_{\tilde{v}_A^*}^{\tilde{v}_E^*} [c - E(v)] dF(c)$$

Lemma 7 *Necessary and sufficient condition for* $p_A^{B^*} > p_E^{B^*}$ *is*

$$[1 - F(\tilde{v}_O^*)][1 - G(\tilde{v}_O^*)][E(v / v \ge \tilde{v}_O^*) - E(c / c \ge \tilde{v}_O^*)] + \int_{\tilde{v}_O^*}^{\tilde{v}_E^*} [c - E(v)] dF(c) \ge 0$$

Remark. Lemma 7 follows directly from Lemma 6. Equivalently, Lemma 7 can be written as: $[1 - F(\tilde{v}_O^*)]\int_{\tilde{v}_O^*}^{\bar{v}} v dG(v) - [1 - G(\tilde{v}_O^*)]\int_{\tilde{v}_O^*}^{\bar{c}} c dF(c) + \int_{\tilde{v}_O^*}^{\tilde{v}_E^*} [c - E(v)] dF(c) \ge 0$

Proposition 5: ALR is unconditionally better than ELR; i.e. $p_A^{B^*} > p_E^{B^*}$.

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Proof:

NOTE: We have not been able to prove Proposition 5 analytically. Below we show numerically that Proposition 5 is suspected to be correct. By the time of ALEA we hope to either prove Proposition 5 or revise it.

4.3 A simple numerical example

As before the seller's cost of production, at Time 1, is normalized to be drawn from the uniform distribution $f(c) =$ uniform [10,70]. The buyer's best estimate of her valuation, at Time 1 is drawn from the uniform distribution $g(v) =$uniform [30,90]. Table 1 compares the two legal regimes.

Table 2- A Comparison of the Legal Regimes – expectation damages

Applicable Rule	d^*	p^*	p^{B^*}	$\hat{v}^*$	p^{S^*}
ELR	20.83	39.79	20.62	$60+(5/a)$	0
ALR	17.82	38.85	22.47	$60-(10/(3a))$	0

Table 2 shows that indeed $\hat{v}$ is smaller under ALR than under ELR, which indicates that the buyer's "lie" to the court at Time 3 is smaller under ALR. Observe that the buyer in Time 1 can bribe the seller to agree to switch from ELR to ALR in return for the seller's surrender of control over the remedy. The bribe is in the amount of the expectation damages clause. (Yet, the buyer pays a lower price). As can be seen, while maintaining the seller's payoff as constant, the buyer's expected payoff is increased, making the switch a Pareto improvement. Observe that the joint payoff is nine percent larger under ALR than under ELR.

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4.3 A complicated numerical example – normal distributions.

When parties' distributions are normally distributed, analytically solving the model for the ELR and ALR contracts becomes much harder. We therefore solved it numerically. First, without loss of generality, we assumed that the buyer's valuations are normally distributed with a mean of 18.5 and a standard deviation of 2.5. Second, we assumed that the seller's costs are normally distributed with a relatively low mean and standard deviation. Without loss of generality, we assumed the seller's mean equals 14.5 and the standard deviation equals 1.2. Third, we calculated the price for both the ELR and ALR contracts only to find the joint payoff for both the ALR and the ELR contracts. Fourth, we plotted the difference between the joint payoffs. Fifth, we increased the uncertainty about the seller's valuation (as represented by the standard deviation) by 0.2 and performed the above routine again. We continued performing these 5 steps and increasing the standard deviation by 0.2 until the standard deviation was equal 4.4. Observe at this point that we solved the model for a seller whose mean valuation is relatively low, while manipulating the uncertainty about his valuation (as represented by the standard deviation) from a standard deviation of 1.2 (which is much lower than the buyer' standard valuation) to a much larger of standard deviation of 4.4.

The sixth and last step was to increase the mean by 0.5 and do all the above steps again. Thus, in effect, we calculated the ratio of the joint payoffs under ALR and ELR for all iterations between the buyer and the seller, where the latter's valuation was assumed to be normally distributed with a mean between 14.5 to 20 and standard variation between 1.2 to 4.4. Observe that we allow for the seller's mean to be higher than the Buyer's mean. Parties may nevertheless contract in such cases due to seller's option to breach. The next graphs present our results for normal distributions (which was derived in the way described above) and for uniform distributions (which was derived in a similar way):

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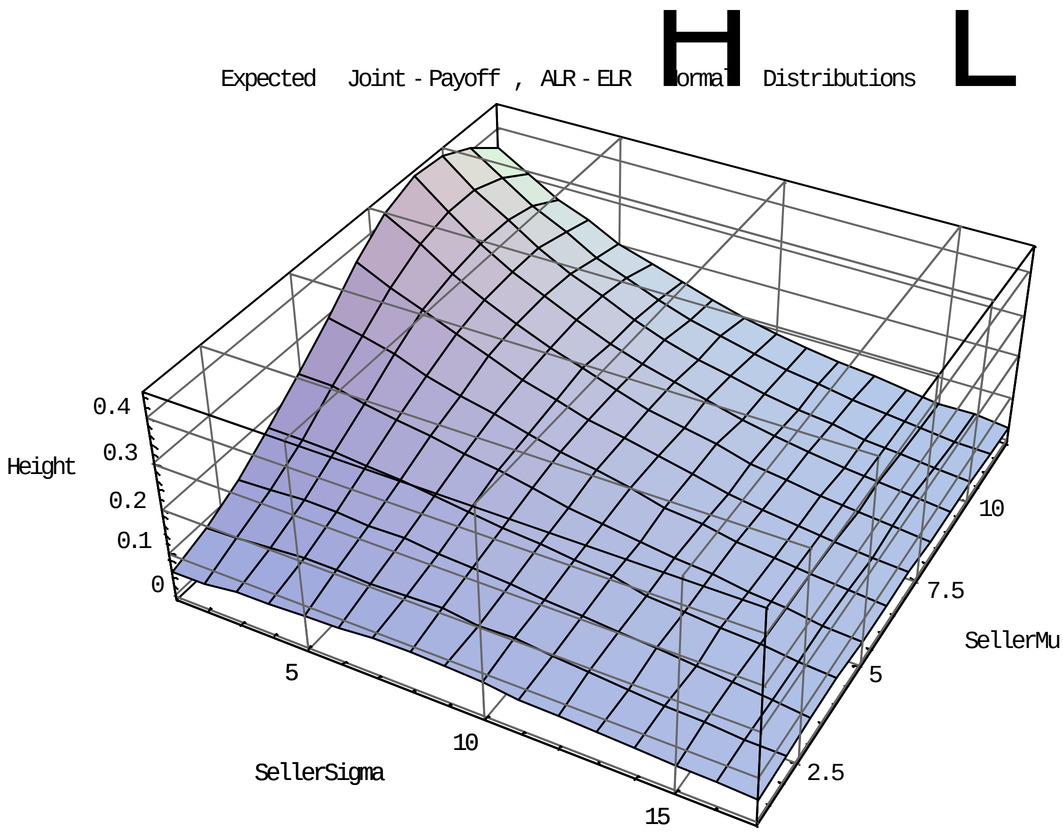
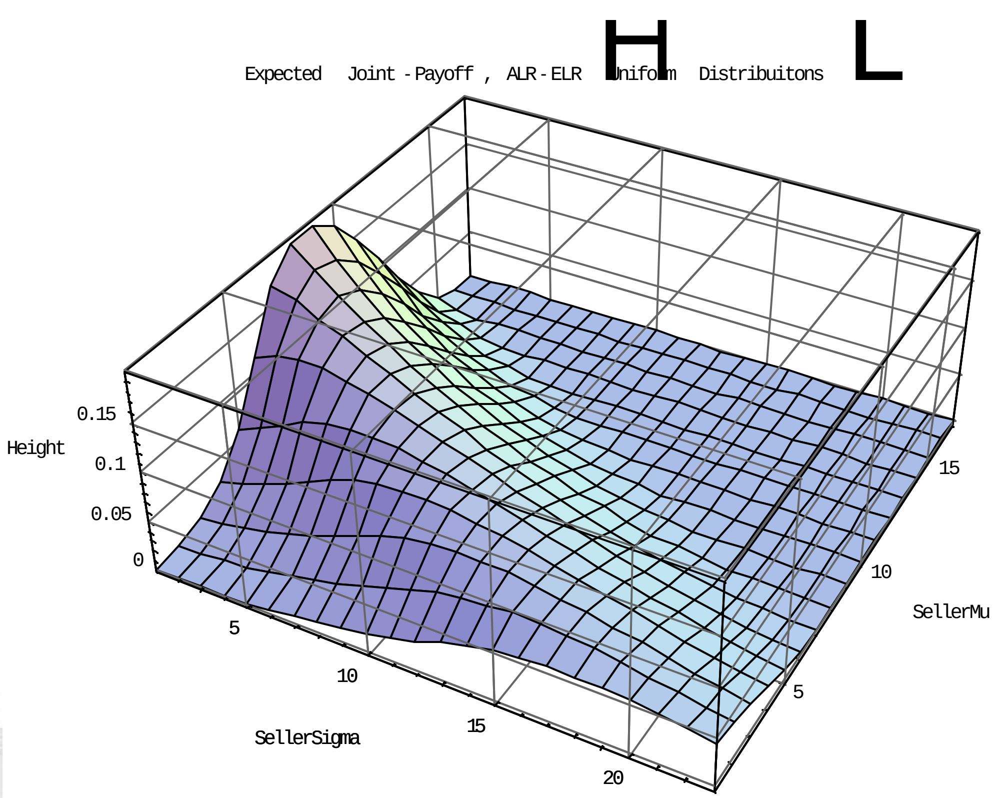


Expected Joint - Payoff , ALR - ELR H ormal Distributions L
Height
0.4
0.3
0.2
0.1
0
5
10
15
SellerSigma
2.5
5
7.5
10
SellerMu



Expected Joint - Payoff , ALR - ELR H nifo m Distribuitons L
Height
0.15
0.1
0.05
0
5
10
15
20
SellerSigma
5
10
15
SellerMu

tory

As the graphs above show, for both normal and uniform distributions, the ALR is *unconditionally* better than the ELR. The intuition is that because under ALR the buyer has fewer incentives to mislead the court about its valuation, the efficiency loss is smaller compared to that in ELR.

5. A model of anticipatory breach- goods *with* readily available price.

The previous section dealt with goods that do not have readily available prices. As was shown, the UCC's arrangements are unconditionally better than the arrangement in English law. In this section, we deal with goods that do have readily available market price. For these types of goods, the court does not need to rely on parties' reports, but instead is assumed to be able to costlessly observe the market price for the good, and determine the damages accordingly.

[To be completed.]

6. Extensions.

In the previous sections, we presented simple models that capture the current legal regimes. We compare the regimes and concluded that the American Legal Regime is unconditionally better than the English Legal Regime. Yet, even the American regime does not achieve first-best allocative efficiency. The reason is simple: the buyer may insist on performance and thus get the goods, while the seller's costs are ex-post higher than the buyer's valuations. The question we want to explore in this section is whether a more sophisticated legal regime can achieve a higher allocative efficiency, perhaps even the first-best.

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6.1 Two-Price Contract with Court-Imposed Expectation Damages (non-market goods)

Consider the American Legal Regime with a twist to it: if the Buyer insists on performance, she must pay the seller the original price plus some extra. This means that there are two different prices in two performance scenarios. First is when the seller simply decides not to breach and deliver the goods. In this case he will receive the agreed upon price. Second is when he is forced to deliver by the buyer.

Observe that in this two-price contract the seller might behave strategically. He might repudiate hoping the buyer will insist on performance and pay him a higher price. It is thus tempting to conclude that such a contract is less efficient. Yet, it is straightforward to show that the ALR two-price contract will always yield a higher joint payoff than the simple ALR contract. We defer this to the appendix. The intuition, however, is that the buyer knows the seller's potential strategic behavior and designs the two prices accordingly. The buyer can always set, if she wants, the two prices to equal each other, which will bring her back to the simple ALR contract. If she chooses not to do it, it must benefit her, and thus the joint payoff.

Proposition 6 *A Two-Price ALR contract is Pareto superior to a simple ALR contract with court-imposed expectation damages.*

6.2. An N-Price Contract with Court-Imposed Expectation Damages (non-market goods)

Inspecting the nature of the two-price ALR contract, we find that it mimics some kind of ascending auction[14], by further partitioning the information space over the ELR contract. In the ELR contract, only the seller's information space is partitioned through his option-exercising behavior. In the two-price ALR contract, the seller signals his information through the breach decision in the first round option, then the buyer in the second round option signals her information through whether or not she insists on performance. Therefore, the two-price ALR contract is more information revealing and

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[14] But here the revenue is not going to some third party as in a standard auction, it goes to the losing bidder in what Ayres and Balkin called "internal" auction.

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can lead to a more nuanced allocation. Following this logic, if we add more rounds of sequential options remedy to the game, the parties' information spaces can be further partitioned to smaller sub-intervals, and we will have more efficient allocation. In this section we will demonstrate this in a uniform distribution example. We will assume that both the seller's cost and the buyer's valuation are uniformly distributed on $[0,1]$.

The basic game is the following: At Time 0, the parties sign a contract to trade some good (or service). At Time 1, the parties learn their private valuations and decide whether to breach or not according to the rule they stipulated in the contract. Specifically, the remedy is characterized by an $n-$round sequential options liabilities. We will assume first that n is an even number, i.e., we will have $n/2$ rounds, where the prices and damages are different in every round. The case of n being an odd number (the seller unilaterally decides whether to breach in the *last* round) can be analyzed in a similar way, which we will show later on. The parties stipulated the original price to be $p_0^{(n)}$. In the first round the seller has an option to breach by paying damages $d_1^{(n)}$; but in the second round the buyer has a subsequent option to insist on performance by paying a higher (than original price $p_0^{(n)}$) price $p_1^{(n)}$; then at third round, the seller has a subsequent option to breach by paying a higher lever of damages $d_2^{(n)}$; at fourth round, the buyer has an option to insist on performance by paying an even higher price $p_2^{(n)}$;……; and so on, until to the final round n, where the buyer can agree to breach by receiving damages $d_{n/2}^{(n)}$, or insist on performance by paying price $p_{n/2}^{(n)}$. Basically, there are a sequence of call options and call-back options, where the subsequent option is actually an option to the option in the preceding round. We assume there is no discounting between rounds.[15]

As before, our result is applicable to the general scenario where the parties share the bargaining power, for instance, the buyer receives a fraction a ($a \in [0,1]$) of the total surplus, and the seller obtains the remainder. For expositional simplicity, however, here we will still keep the assumption that the buyer has all bargaining power. Therefore, the

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[15] Actually, playing the game is not difficult because the game is just a simple message-exchange, which can be accomplished in a short time.

buyer will offer the seller at time 0 a take-it-or-leave-it contract $(p_0^{(n)}, \{p_i^{(n)}\}, \{d_i^{(n)}\})_{i=1,2,...,(n/2)}$. Then at Time 1, after they have learned the private information, they will exchange the breach and insistence requests, with the corresponding liabilities as stipulated in the contract.

As we saw from section 3.4 of two-price ALR contract, the parties will not decide whether to exercise their options simply based on the literal price/damage level. Sometimes even if they will suffer a loss from some specific round by exercising the option in that round, they might still do so in order to gain some profit from the consequent subgame. Because the price/damages are increasing every round and there is some probability that the other party will exercise his/her option in the next round, the loss in the previous round might be over-compensated in the next round. This is the strategic overbidding that the sequential option remedy induces. Knowing this strategic incentive, it will be convenient to first pin down the optimal threshold values in every round; whenever the party's value is beyond the threshold value, he/she will exercise the option in that round. We denote $k_j^{(n)}$ as the threshold value of round i in an nth-order sequential option remedy regime, for $j = 1,2,..., n.$ The buyer seeks to design a sequence of p and the court a sequence of d s to induce the parties' optimal option-exercising behavior that will maximize the joint expected surplus, i.e., designing prices and damages such that they will induce the strategic parties to pick the optimal threshold values in every round maximizing the joint surplus.

Viewed through these lenses, ELR is a first-order option remedy, under which the seller will breach whenever his cost is beyond $k_1^{(1)}$. Then the buyer will induce an optimal $k_1^{(1)}$ to maximize the joint payoff, which is,

$$Jp^{(1)} = F(k_1^{(1)})[E(v) - E(c / c \le k_1^{(1)})] = (1 - k_1^{(1)})k_1^{(1)} / 2.$$

The optimal $k_1^{(1)^*} = 1/2$, i.e., the buyer will set expected expectation damages. $Jp^{(1)^*} = 1/8$.

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Two-price ALR is simply a second-order sequential option remedy, under which the seller will propose breach in the first round whenever his cost is beyond $k_1^{(2)}$; and the buyer will insist on performance in the second round if her valuation is above $k_2^{(2)}$. The expected joint payoff is,

$$Jp^{(2)} = F(k_1^{(2)})[(1/2) - E(c/c \le k_1^{(2)})] + [1 - F(k_1^{(2)})][1 - G(k_2^{(2)})][E(v/v \ge k_2^{(2)}) - E(c/c \ge k_1^{(2)})].$$

The optimal $k_1^{(2)^*} = 1/3, k_2^{(2)^*} = 2/3, Jp^{(2)^*} = 4/27.$

In the third-order sequential option remedy, there is an additional round after the buyer insisted on performance, in which the seller will breach if his cost is beyond $k_3^{(3)}$. The joint expected payoff is,

$$\begin{aligned} Jp^{(3)} &= F(k_1^{(3)})[(1/2) - E(c/c \le k_3^{(3)})] \\ &+ [F(k_3^{(3)}) - F(k_1^{(3)})][1 - G(k_2^{(3)})][E(v/v \ge k_2^{(3)}) - E(c/k_1^{(3)} < c < k_3^{(3)})]. \end{aligned}$$

The optimal $k_1^{(3)^*} = 1/4, k_2^{(3)^*} = 1/2, k_3^{(3)^*} = 3/4, Jp^{(3)^*} = 5/32.$

Similarly, under an nth-order sequential option remedy regime the joint expected payoff (if n is an even number) is,

$$\begin{aligned} Jp^{(n)} &= k_1^{(n)}[(1/2) - E(c/c \le k_1^{(n)})] + (k_3^{(n)} - k_1^{(n)})(1 - k_2^{(n)})[E(v/v \ge k_2^{(n)}) - E(c/k_1^{(n)} < c < k_3^{(n)})] \\ &+ (k_5^{(n)} - k_3^{(n)})(1 - k_4^{(n)})[E(v/v \ge k_4^{(n)}) - E(c/k_3^{(n)} < c < k_5^{(n)})] + \ldots \\ &+ (k_{n-1}^{(n)} - k_{n-3}^{(n)})(1 - k_{n-2}^{(n)})[E(v/v \ge k_{n-2}^{(n)}) - E(c/k_{n-3}^{(n)} < c < k_{n-1}^{(n)})] \\ &+ (1 - k_{n-1}^{(n)})(1 - k_n^{(n)})[E(v/v \ge k_n^{(n)}) - E(c/c > k_{n-1}^{(n)})]. \end{aligned}$$

The first-order conditions for $k_i^{(n)}$ s give us the optimal threshold values,

$$k_j^{(n)^*} = j/(n+1), \qquad for \qquad j = 1,2,\ldots,n; Jp^{(n)^*} = \frac{n(n+2)}{6(n+1)^2}.$$

Notice that the optimal threshold values are an equal-distance series, which is a particular result of the assumed uniform distributions. For other distributions, the series may not be so “well-behaved”.

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If n is an odd number, the expected joint payoff is,

$$Jp^{(n)} = k_1^{(n)}[(1/2) - E(c/c \le k_1^{(n)})] + (k_3^{(n)} - k_1^{(n)})(1 - k_2^{(n)})[E(v/v \ge k_2^{(n)}) - E(c/k_1^{(n)} < c < k_3^{(n)})]$$
$$+ ... + (k_n^{(n)} - k_{n-2}^{(n)})(1 - k_{n-1}^{(n)})[E(v/v \ge k_{n-1}^{(n)}) - E(c/k_{n-2}^{(n)} < c < k_n^{(n)})];$$

and the optimal solution is the same as when n is an even number.

It is obvious that when $n \to \infty, Jp^{(n)^*} \to 1/6$, which is the first best joint payoff ($\int_0^1 \int_0^v (v-c)dcdv = 1/6$).

Now the question is what contract $(p_0^{(n)}, \{p_i^{(n)}\}, \{d_i^{(n)}\})_{i=1,2,...,(n/2)}$ can induce the optimal threshold values that the parties will take. We solve this in a kind of reverse way by asking what threshold values the parties will take given a contract. Given the prices and damages, the seller will choose threshold values $(k_1^{(n)}, k_3^{(n)}, ..., k_{n-1}^{(n)})$ to maximize his expected payoff, and the buyer will choose threshold values $(k_2^{(n)}, k_4^{(n)}, ..., k_n^{(n)})$ to maximize her expected payoff.

By definition, at the margin of the threshold values (if the valuations are above them, parties will exercise the option, and will not exercise the option if values fall below the threshold values), the party should get the same expected payoff by not exercising the option as what he/she would receive by exercising the option. Given prices and damages, the equilibrium conditions for optimal threshold values are as follows (assuming that n is an even number):

$$k_1^{(n)}: \quad p_0^{(n)} - k_1^{(n)} = k_2^{(n)}(-d_1^{(n)}) + (1 - k_2^{(n)})(p_1^{(n)} - k_1^{(n)}),$$
$$k_2^{(n)}: \quad k_1^{(n)}(k_2^{(n)} - p_0^{(n)}) + (1 - k_1^{(n)})d_1^{(n)} = k_1^{(n)}(k_2^{(n)} - p_0^{(n)}) + (k_3^{(n)} - k_1^{(n)})(k_2^{(n)} - p_1^{(n)}) + (1 - k_3^{(n)})d_2^{(n)},$$
$$k_3^{(n)}: \quad k_2^{(n)}(-d_1^{(n)}) + (1 - k_2^{(n)})(p_1^{(n)} - k_3^{(n)}) = k_2^{(n)}(-d_1^{(n)}) + (k_4^{(n)} - k_2^{(n)})(-d_2^{(n)}) + (1 - k_4^{(n)})(p_2^{(n)} - k_3^{(n)}),$$
$$...,$$
$$k_{n-1}^{(n)}: \quad (1 - k_{n-2}^{(n)})(p_{(n/2)-1}^{(n)} - k_{n-1}^{(n)}) = (k_n^{(n)} - k_{n-2}^{(n)})(-d_{n/2}^{(n)}) + (1 - k_n^{(n)})(p_{n/2}^{(n)} - k_{n-1}^{(n)}),$$
$$k_n^{(n)}: \quad (1 - k_{n-1}^{(n)})d_{n/2}^{(n)} = (1 - k_{n-1}^{(n)})(k_n^{(n)} - p_{n/2}^{(n)}).$$

In any of the above equations, the left hand side is the party's expected payoff when

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he/she does not exercise the option; the right hand side is the party's expected payoff when he/she exercises the option.

Substituting the optimal threshold values, $k_j^{(n)^*} = j/(n+1) \quad (for \quad j = 1,2,...,n)$, into the above equations and solving them, we get the optimal prices and damages:

$$p_i^{(n)^*} = 2i/[3(n+1)] + p_0^{(n)}; d_i^{(n)^*} = (n+2i)/[3(n+1)] - p_0^{(n)}, \qquad for \qquad i = 1,2,...,n/2.$$

As explained before, $p_0^{(n)}$ as a parameter can be used to allocate the total surplus to individual parties according to their relative bargaining power. Here with the buyer having all bargaining power, the buyer will set $p_0^{(n)}$ such that the seller's expected payoff is zero. The seller's expected payoff is:

$$\begin{aligned} p^{S(n)} &= k_1^{(n)}[p_0^{(n)} - E(c/c \le k_1^{(n)})] + (k_3^{(n)} - k_1^{(n)})[k_2^{(n)}(-d_1^{(n)}) + (1-k_2^{(n)})(p_1^{(n)} - E(c/k_1^{(n)} < v < k_3^{(n)}))] \\ &+ (k_5^{(n)} - k_3^{(n)})[k_4^{(n)}(-d_2^{(n)}) + (1-k_4^{(n)})(p_2^{(n)} - E(c/k_3^{(n)} < v < k_5^{(n)}))] + ... \\ &+ (k_{n-1}^{(n)} - k_{n-3}^{(n)})[k_{n-2}^{(n)}(-d_{(n/2)-1}^{(n)}) + (1-k_{n-2}^{(n)})(p_{(n/2)-1}^{(n)} - E(c/k_{n-3}^{(n)} < c < k_{n-1}^{(n)}))] \\ &+ (1-k_{n-1}^{(n)})[k_n^{(n)}(-d_{n/2}^{(n)}) + (1-k_n^{(n)})(p_{n/2}^{(n)} - E(c/c \ge k_{n-1}^{(n)}))]. \end{aligned}$$

Substituting the optimal threshold values, prices, and damages into the equation, we have the reduced form of the seller's equilibrium expected payoff,

$$p^{S(n)^*} = p_0^{(n)} - (7n^3 + 18n^2 + 17n + 9)/[18(n+1)^3],$$

therefore, under the assumption that the buyer has all bargaining power,

$$p_0^{(n)^*} = (7n^3 + 18n^2 + 17n + 9)/[18(n+1)^3].$$

Therefore, the parties can sign a simple fixed-term sequential option contract, $(p_0^{(n)^*}, \{p_i^{(n)^*}\}, \{d_i^{(n)^*}\})_{i=1,2,...,(n/2)}$, at time 0, and it can approach first-best when we have sufficiently many rounds.

Proposition 7 *An nth-order sequential option contract and corresponding court-determined damages as described above approaches first best efficiency when n goes to infinity.*

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Remark: (1) It is well known that asymmetric information obstructs efficient trade, a la Myerson and Satterthwaite (1983). The “impossibility theorem” is the result the difficulty of satisfying the ex post IR. As there is a continuum of types, there is a continuum of IR constraints to be satisfied, which is why it is impossible to achieve. However, our contract can attain first best because the parties contract ex ante, meaning the continuum of IR constraints is reduced to a single ex ante IR constraint in expected terms. Actually, as shown by D’ Aspremont, Gerard-Varet (1979), Konakayama, Mitsui and Watanabe (1986), and Rogerson (1992), an ex ante contract can attain first best. But those contracts, being contingent contracts, are not usually seen in the real world. We have shown that a simple *fixed-term* contract can approach first best with a series of sequential options, in the environment of two-sided asymmetric information where bargaining is difficult due to the rent extraction incentives and distortions from signaling.

(2) Aghion, Dewatripont and Rey (1994) and Chung (1991), among others, demonstrated that a simple contract plus a renegotiation design can replicate a complex mechanism in inducing efficient trade and efficient investment. Their models, however, like others such as Hart and Moore (1988), assume that the information is observable, but not verifiable. Here in our model the information is not observable, but as we showed, the spirit that a complex mechanism can be replaced by an efficiency-equivalent simple contract still carries over to the environment without observable information, up to some limitation that the simple contract can only approach the full efficiency asymptotically. We do not need to take this limitation too far, because in some distributions a very limited number of rounds are sufficient to induce almost first best allocation. For instance, in our uniform example, a fourth-order contract brings a joint surplus of 4/25, which is pretty close to 1/6.

(3) This simple fixed-term n-round contract essentially mimics the bargaining process, trying to force some information revelation, and thereby to have a finer identification or partition of the parties’ positions. We know, however, that under asymmetric information bargaining often leads to multiple equilibria and inefficiencies. But our n-round contract is different from bargaining in several ways. Bargaining is unstructured, but our contract is structured ex ante; by stipulating in the contract, the parties have their option-exercising rights at their respective rounds. A party does not need to get an agreement

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from the other party before exercising his option, which is different from the consensual nature of bargaining.

(4) Through the option-exercising behavior, the private information is revealed gradually. It works like an ascending auction, where the parties submit bids (prices and damages in our case) for the right of performance. But unlike a typical auction, here the revenue will not go to some third party; it will go to the losing bidder.

The result can be applied to general distributions. Assuming $c \sim F(c)$ on $[\underline{c}, \bar{c}]$, $v \sim G(v)$ on $[\underline{v}, \bar{v}]$, where F and G are independent and common knowledge. Then as before we first obtain the optimal threshold values $\{k_i^{(n)*}\}_{i=1,2,\dots,n}$ by maximizing the joint surplus,

$$
\begin{aligned}
&Jp^{(n)} = F(k_1^{(n)})[E(v) - E(c / c \le k_1^{(n)})] \\
&+ (F(k_3^{(n)}) - F(k_1^{(n)}))(1 - G(k_2^{(n)}))[E(v / v \ge k_2^{(n)}) - E(c / k_1^{(n)} < c < k_3^{(n)})] \\
&+ \dots + (F(k_{n-1}^{(n)}) - F(k_{n-3}^{(n)}))(1 - G(k_{n-2}^{(n)}))[E(v / v \ge k_{n-2}^{(n)}) - E(c / k_{n-3}^{(n)} < c < k_{n-1}^{(n)})] \\
&+ (1 - F(k_{n-1}^{(n)}))(1 - G(k_n^{(n)}))[E(v / v \ge k_n^{(n)}) - E(c / c > k_{n-1}^{(n)})].
\end{aligned}
$$

In any round whenever a party's valuation is above the threshold value, he/she will exercise the option at that round, otherwise the party will not exercise the option.

Then to obtain the optimal prices and damages, we will suppose prices and damages are given and the parties maximize their individual payoffs by choosing optimal threshold values. These marginal conditions will give us a group of equations linking the threshold values and prices/damages; then by substituting the optimal threshold values in, we have the optimal prices/damages.

6.3 Continuous Case and Implementation

For general distribution we can show that more rounds are better than less rounds, because with more rounds, more information will be revealed through the option exercising decisions. Thus, the allocative inefficiencies can be reduced.

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Though the n-round sequential option remedy effectively allows the contract to approach first-best, some may claim that too many rounds are involved. But, it is actually a simple message-exchange game. Interestingly, recently we found Knysh, Goldbart and Ayres (2004) are extending the higher-order liability rules to the continuous cases in a nuisance setting. As they observed, many intermediate steps are not necessary for this liability to work. In a continuous setting, all n rounds can be reduced to a one-shot auction, where the parties submitted their maximum bids (b_S, b_B) for the entitlement, and the court will allocate the entitlement to the highest bidder, asking him to pay the loser damages which are functions of the submitted bids ($p(b_B), d(b_S)$). They show that for general distributions with arbitrary correlations, a class of mechanisms $(A, p(b_B), d(b_S))$ with A being any constant (A can be used for distributing the total payoff to the individual party, like an up-front transfer) can achieve first-best, and it is incentive compatible, i.e., the parties will submit their true values.

Their result is very interesting for its generality (Hermalin and Katz (1993)'s "fill-in-the-price" mechanism doesn't work for imperfectly correlated distributions) and the ease with which it can be implemented; however, as they admitted, their result is not a challenge to Myerson and Satterthaite (1983), in that they simply dropped the IR constraint from the analysis by assuming that the parties are already in the game. Given that the parties are already in this game, their mechanism (we will call it KGA hereinafter) is first-best. However, the parties may choose not to participate in this game in the first place. But in our ex ante contracting environment, we can use KGA to implement an n-round sequential option contract in a one-shot auction, in which it can attain first-best efficiency, and is incentive compatible and individually rational. The key is that one single parameter A is not sufficient to satisfy a continuum of ex post IR constraints, but it is sufficient to satisfy a single ex ante IR constraint.

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Proposition 8 *Through instantaneous liability rule auction, we can achieve first-best with IR, IC satisfied.*

Proof: The parties sign a KGA contract $(A, p(b_B), d(b_S))$ ex ante, in which each party will submit a bid b to the court after he/she learned his/her valuations. Then by KGA, it will be incentive compatible and first-best efficient. Denoting a buyer of type v's ex post payoff excluding the constant A from the KGA contract as $p^B(v)$; similarly, a seller of type c's ex post payoff excluding the constant A from the KGA contract as $p^S(c)$. Then A such that $A + \int_{\underline{c}}^{\bar{c}} p^S(c)dF(c) = 0$ will make the contract satisfying IR, because ex post the buyer will receive a payoff of $p^B(v) - A$, while the seller will receive a payoff of $p^S(c) + A$. It satisfies ex post collective IR, which is $\sum p = p^B(v) + p^S(c) \geq 0$;

the buyer's ex ante payoff is

$$\int_{\underline{v}}^{\bar{v}} p^B(v)dG(v) - A = \int_{\underline{v}}^{\bar{v}} p^B(v)dG(v) + \int_{\underline{c}}^{\bar{c}} p^S(c)dF(c) = \int_{\underline{v}}^{\bar{v}}\int_{\underline{c}}^{\bar{c}} \sum p\, dG(v)dF(c) \geq 0. \qquad \text{QED.}$$

Remark: D' Aspremont, and Gerard-Varet (1979), Konokayama, Mitsui and Watanabe (1986), and Rogerson (1992) also can implement the continuous solution for uncorrelated distributions. KGA, however, showed that the first best can be achieved for very general correlated distributions with infinitely many rounds (almost continuous) of options. Actually, at the interim stage with parties having asymmetric information before bargaining as in Myerson and Satterthwaite (1983), and McAfee and Reny (1992) have shown that even a very small correlation between the parties' values can eliminate the informational rent, and thus restore the first-best efficiency.

7. Summary and Future Research

[To be completed.]

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7. Appendix

[To be Completed]

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