

**Should Courts Ignore Ex-post Information
When Determining Contract Damages?
A Re-evaluation of Contract Remedies**

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ABSTRACT

Scholars have been debating for years the comparative advantage of various damage remedies and specific performance. Yet, most work has compared a single remedy contract to another single remedy contract. But contract law provides the non-breaching party with a variety of *optional* remedies to choose from in case of a breach, and parties themselves regularly write contracts which provide such options. In this paper we extend our previous work which studied multi-remedy contracts. Specifically, we compare a contract that grants the non-breaching party an option to choose between various types of damages and specific performance with an exclusive remedy contract, which restricts the non-breaching party's remedy to damages or specific performance only.

Specifically, we re-evaluate four types of contract remedies: a) specific performance, b) fixed ex-ante expectation damages, c) ex-post actual damages, and d) optimal damages (damages which maximize parties' ex-ante welfare). Each measure is considered in the context of a seller-buyer contract with two-sided incomplete information and necessarily costly litigation. We rank the efficiency of the various remedies (in exclusive and in optional contracts) and are thus able to answer the question in the title: should courts ignore ex-post information when determining contract damages?

1. Introduction

In *Eastern S.S Lines, Inc. v. United States*, the U.S. government chartered a vessel for use during the Second World War and promised to return the vessel in the same condition it had been in at the time the contract was signed. After the war, the government returned the ship unrestored and in significantly worse condition.¹ Due to a decline in the market for old ships, and a rise in the cost of labor and materials, the restoration of the ship did not make economic sense: the cost of restoring it was \$4,000,000, whereas a comparable ship in good condition could be purchased for \$2,000,000. At trial, the ship-owner sought \$4,000,000 in damages based on cost of performance, whereas the government argued for limiting recovery to \$2,000,000.

This case challenges us to consider the optimal choice of remedies for breach of contract when neither of the contracting parties has superior information at the contracting stage. As the court in *Eastern* explicitly mentioned, during contract negotiations neither of the parties anticipated the circumstances that arose when it was time to return the ship. No one anticipated that the cost of performance would be so high or that the ships' value would be so low.² What, then, should a court do when confronted with similar disputes? More specifically, should a court ignore the ex-post circumstances and simply enforce parties' contracts as written, or should the court craft a remedy that considers these circumstances?

In this paper, we address this question and advance the ball in two ways. First, we re-evaluate four types of contract remedies: a) specific performance, b) fixed ex-ante expectation damages, c) ex-post actual damages, and d) optimal damages (damages which maximize parties' ex-ante welfare) in circumstances similar to those in *Eastern*. Each measure is considered in the context of a seller-buyer contract with two-sided incomplete information and necessarily costly litigation. We expand work done by legal economists focusing on the effects of various legal rules on a seller's incentive to breach a contract (Ulen (1984); Goetz & Scott (1977); Shavell (2004)). The previous literature always assumes that some particular remedy will actually be applied once breach occurs. It does not account for the possibility that a privately informed non-breaching party may choose not to file a lawsuit

¹ *Eastern S.S. Lines, Inc. v. United States*, 112 F. Supp. 167 (Ct. Cl. 1953).

² *Id.*, at 175.

seeking damages if the expected compensation under the remedy regime is insufficient to put him in a better position than he would be not filing a lawsuit. One important contribution of our paper is to explicitly identify the (privately informed) non-breaching party's embedded option to not seek remedies under various damage measures when comparing their efficiencies. Also, while the previous literature on contract remedies implicitly assumes a passive court that simply enforces parties' agreements; we apply a more modern approach that explicitly accounts for an active court and its possible welfare-enhancing proclivities (Anderlini, Felli & Postlewaite (2006a); Anderlini, Felli & Postlewaite (2006b); Shavell (2006)).³ We rank the efficiency of the various remedies and are thus able to answer the question in the title: should courts ignore ex-post information when determining contract damages?

Second, we expand our previous work (Avarahm & Liu, 2006) and analyze these damages measures in the context of both exclusive and optional contracts. By *exclusive* contracts we mean contracts where the buyer (non-breaching party) is entitled to damages only as determined by default rules or explicitly provided for in the contract. By *optional* contracts we mean contracts where the buyer can choose ex-post whether she prefers specific performance or monetary damages. Optional contracts have not been widely explored, though the law and parties' agreements at times provide a variety of remedies to non-breaching parties to choose from in the event of a breach.⁴

We present a model where a buyer and a seller contract at the ex-ante stage (T1) in which they are symmetrically informed about the distributions of costs and valuations. In the interim stage, T2, the seller privately learns its costs and the buyer privately learns its actual value. At this point the seller decides whether to breach the contract. In the ex-post stage (T3) the buyer either pays the price, if the seller delivered, or decides whether to file a lawsuit if the seller breached. The buyer in an optional contract would then choose its desired remedy in court. Throughout this analysis we assume that the seller's cost and buyer's valuations are unobservable to the other party, and therefore renegotiating the

³ As explained by Anderlini, Felli & Postlewaite (2006): "the work on incomplete contracts is 'partial equilibrium,'" analyzing a subset of agents' behavior taking as fixed the behavior of agents outside the model (the courts), without investigating whether the assumed fixed behavior of the outside agents is in fact optimal."

⁴ Chapter 7, Article 2 of the UCC provides a list of optional remedies, but parties can agree on any other remedy, provided they conform with some basic principles of contract law. See generally Article 1-102(3) to the UCC; and more particularly see Article 2-719(1). The entire of chapter 66 in Corbin is dedicated to "election of remedies".

contract is prohibitively expensive. We also assume that seller's costs are unverifiable to the court at all times.⁵ We vary, however, the extent to which the buyer's valuation is verifiable to the court. In Part I we first assume that the buyer's valuation can be verified ex-post by the court at no cost. Next, we assume that the buyer's valuation can be verified to the court ex-post but only with costs (we compare the English rule of loser pays with the American rule). In Part II we assume that verification costs are prohibitively high so courts cannot verify the buyer's valuation, but can *infer* it from signals observed during litigation, such as buyer's choice of remedies and the evidence that the seller and the buyer present in court in their respective attempts to deflate or inflate the damages. Following Bernardo, Talley and Welch (2000), and Wickelgren (200?) we then describe and compare the contracts which parties will sign anticipating the signaling game they would play in front of a Bayesian court.

Our investigation yielded several discoveries. First, when parties write an *exclusive* contract and buyer's valuation is verifiable to the court ex-post through *costless* litigation, the fixed ex ante expectation damages remedy is always better than the actual damages remedy and is optimal. This holds even when there are no costs to verify buyer's actual damages. This result is surprising because one would think that *from the ex-ante perspective* the seller's incentives to breach would not be affected by whether the court awards actual damages or expectation damages. A risk neutral seller should be indifferent (from the ex-ante perspective) between having to pay the mean of the buyer's distribution of valuations and having to pay the actual ex-post manifestation of it. What this intuition overlooks, however, is that if a court awards actual damages the buyer would file a lawsuit only when her ex-post actual valuation is larger than the contract price; otherwise the buyer might end up *paying* damages. Thus, the seller does not in fact face the entire distribution of buyer's valuations under actual damages remedy. Instead, he faces a truncated distribution which has a higher mean than the ex-ante expectation damages he would pay under the fixed ex-ante expectation damages regime. As a result, the seller breaches too little. Therefore, joint welfare in an actual damages regime is reduced relative to a fixed ex ante expectation damages regime.

In such circumstances courts are better "tying their own hands" and committing to not hear evidence in T3 regarding the buyer's actual damages. A black-letter rule of simply

⁵ Otherwise the court would have been able to determine the first-best allocation by verifying the two parties' private values.

awarding fixed expectation damages would provide the seller with better incentives for efficient breach. As far as we know, this result was missed by the literature which implicitly assumed that the non-breaching party always seeks damages upon contract breach. Interestingly, this result does not change when we assume that verifying buyer's valuation is costly, whether these costs are born by the buyer or by the seller. We thus answer the question in the title in the affirmative: courts should ignore ex-post information when deciding contract remedies.

Moreover, while this result, (that fixed expectation damages are superior to actual damages) echoes analyses of the *Hadley v Baxendale* rule, it has nothing to do with the incentives to reveal private information that expectation damages may provide ((Bebchuk & Shavell (1991); Ayres and Gertner (1989); Adler (1999)).⁶

Second, we show that specific performance can be more (or less) efficient than any of the other damage remedies, depending on the distributions of values and costs. Recent conventional wisdom ranks specific performance below damages remedies because specific performance strips the seller of the flexibility to breach the contract when his costs are high, whereas damage remedies allow him flexibility to not perform, which is efficiency-enhancing. But this argument overlooks the embedded option to breach which exists even under the specific performance remedy. Specifically, what the conventional wisdom misses is, as was explained above with respect to actual damages, that the non-breaching party will not file a lawsuit when his ex-post value from performance is lower than the price he needs to pay. Thus, specific performance actually does allow the seller some flexibility to breach as well, and does not lead to 100% performance ex-post, even when litigation is costless. We show that when parties' distributions of costs and value are such that a relatively higher value exists for performance than costs (from the ex-ante perspective), specific performance could be very efficient compared to other damages remedy.

Our next results are more nuanced and have to deal with our comparison of exclusive vs. optional contracts. For example, we show that parties will never write an optional actual-damages contract (a contract which allows the non-breaching party to choose ex-post whether to receive actual damages or specific performance). Next we show that parties' joint

⁶ In our model parties contract at the ex-ante stage (and not at the interim stage) and are assumed to be symmetrically ignorant of each other's cost and valuation.

ex-ante welfare, when the remedy the court awards in an optional contract is fixed ex-ante expectation damages, can be greater or lower than parties' joint ex-ante welfare in the optimal *exclusive* contract (which has the same type of damages as its remedy). We thus describe the conditions under which parties subject to a fixed ex-ante expectation damages regime will write an optional contract instead of an exclusive contract.⁷ In addition, we derive the optimal damages courts should award when faced with an optional contract. We do all this assuming that verifying the buyer's valuation is costless, and then assuming it is costly (and compare the English rule with the American rule).

In the last section of the paper, we go deeper. We assume that verifying seller's exact costs and buyer's exact valuation is prohibitively costly, and that therefore a Bayesian court can only make inferences about costs and valuations from a) the mere existence of a breach, b) from buyer's choice to file a lawsuit, c) from buyer's choice (in an optional contract) between damages and specific performance, and d) from the evidence both parties present to the court during litigation in case the buyer chose damages, we find that ...[TBC]

The rest of the paper is organized as follows. In section 2, we survey the relevant Anglo-American law. Section 3 presents our model. Section 4 presents the results. In section 4(1) we compare the various contract remedies for exclusive and optional contracts, under various assumptions regarding costs of verifying buyer's valuation ex-post. In Section 4(2), we compare these remedies under the assumption that the courts cannot directly verify buyer's valuations but instead can only make inferences about it. Furthermore, we assume that parties strategically present evidence to the court in order to achieve their desired outcome. In section 5, we conclude.

⁷ These will also be the conditions at which parties writing an optional contract would prefer to be subject to expectation damages instead of actual damages.

2. The Law of Exclusiveness of Remedies.

The default damages rule in Anglo-American contract law provides money damages based upon that party's subjective "expectation interest,"⁸ so as to "put the injured party in as good a position as that party would have been in if performance had been rendered as promised."⁹ In contrast, where goods contracted for are unique and money damages are otherwise inadequate, the default remedy may be specific performance.¹⁰ The two primary limitations on the default rule of expectation damages are that damages must be reasonably foreseeable by the breaching party,¹¹ and reliably proven by the party seeking a remedy.¹² Since these limitations may make recovery difficult in certain situations,¹³ American law provides parties with two alternative ways of establishing their expectations. First it provides parties with alternatives ways to establish the loss in value,¹⁴ and second, it allows them to stipulate the remedies that will be awarded in the event of a breach.¹⁵

We start with the alternative ways to establish loss of value, assuming this is the relevant remedy. The Restatement (Second) of Contracts Section 348(2) provides that when the non-breaching party cannot reliably prove it subjective loss of value she may "recover damages based on a) the diminution in the market price of the property caused by the breach, or b) the reasonable cost of completing performance or of remedying the defects if that cost is not clearly disproportionate to the probable loss in value to him."¹⁶ Many courts have

⁸ See, e.g., Restatement (Second) of Contracts, §347 (1981) [Hereinafter, Restatement (Second)]; 11 S. WILLISTON, A TREATISE ON THE LAW OF CONTRACTS, §1338, at 198 (3d. ed. 1968); 5 CORBIN ON CONTRACTS § 992 (1964).

⁹ 5 CORBIN ON CONTRACTS § 55.3 (citing cases).

¹⁰ However, before ordering specific performance, a court will consider whether enforcement of such a remedy is within its institutional capacity and ensure other conditions are met. See article 2-716 to the UCC and Restatement (Second) of Contracts articles 359 and 366.

¹¹ See, e.g., *Hadley v. Baxendale*, 156 Eng. Rep. 145 (Court of Exchequer 1854; Restatement (Second) §351.

¹² See Restatement (Second), § 352.

¹³ See Restatement (Second), § 348, comment a ("Although in principle the injured party is entitled to recover based on the loss in value to him caused by the breach, in practice he may be precluded from recovery on this basis because he cannot show the loss in value to him with sufficient certainty.")

¹⁴ See Restatement (Second), § 348 (discussing alternatives to loss in value of performance).

¹⁵ See Restatement (Second), §356 (discussing the availability of liquidate damages).

¹⁶ These principles which apply to a construction contract were extended by courts to a variety of actions including those brought under the Uniform Commercial Code (UCC) and service contracts. See, e.g., *International Adhesive Coating Company, Inc. v. Bolton Emerson International*, 851 F.2d 540, 546 n. 7 (1988) (where buyer paid for repairs to defective boiler, the court found that, "buyer is entitled to cost of repair or replacement."); *Stelco Industries v. Cohen*, 182 Conn. 561 (1980) (noting that while diminution of value is primary measure of damages, where construction supplies were accepted with notice of non-conformity, cost of

found that where a party has substantially performed the terms of a contract in good faith, diminution of value will be the only remedy, but where a party has willfully breached a contract or failed to substantially perform, the remedy will be cost of completion.¹⁷ Other courts have laid down general rules that where performance leaves an uninhabitable structure, or unusable land, the remedy will be the cost of repair,¹⁸ or that where a breach results in goods which are otherwise acceptable to a merchant, the remedy will be diminution in value.¹⁹

The analysis so far assumed that damages for the expectation interest were the relevant remedy. However, as noted, parties can also contractually expand or restrict the set of available remedies in case of a breach. Section 2-719 of the Uniform Commercial Code states that parties “may provide for remedies in addition to or in substitution for those provided in this Article” but that “resort to remedy as provided is optional unless the remedy is expressly agreed to be exclusive, in which case it is the sole remedy.”²⁰ Following the principles articulated in the UCC, courts typically require that a contract expressly and conspicuously declare a specified remedy to be exclusive,²¹ or that the intent of the parties clearly indicated it to be so.²² The Restatement and UCC also allow parties to liquidate the damages by agreement, but only to the extent that this amount is reasonable in light of either the anticipated loss or the difficulty of proving it,²³ and the clause involved must not be unconscionable, or contrary to public policy.²⁴ Generally, the greater the degree of uncertainty, the greater the degree of latitude allowed in an award’s size.²⁵ While Parties can also agree to rule out specific performance as a remedy, they may find it more difficult to

repair is an appropriate measure of damages). *See generally*, WILLISTON ON CONTRACTS, § 66:17 (2008). *See, e.g.*, Bay Aviation Services Co. v. Southland Aviation 211 F. Supp. 125, 141 (D.C. Ark., 1962) (finding that damages for defective work on aircraft could be based on diminution of value or cost of replacement for parts). *See, generally*, WILLISTON ON CONTRACTS, §§ 66:14 & 66:17 (2008).

¹⁷ *See* WILLISTON ON CONTRACTS, § 66:17 (2008); *see, e.g.*, 230 N.Y., at 245.

¹⁸ *See, e.g.*, Groves v. John Wunder Co., 205 Minn. 163 (Minn., 1939) (“To diminish damages recoverable against [the breaching party] in proportion as there is presently small value in the land would favor the faithless contractor.”); *see generally*, WILLISTON ON CONTRACTS, § 66:17.

¹⁹ *See*, Uniform Commercial Code § 2-714 (2004); WILLISTON ON CONTRACTS § 40:38 (2008).

²⁰ UCC § 2-719 (2004).

²¹ *See*, WILLISTON ON CONTRACTS, § 40:40 (2008).

²² *See, e.g.*, AMJR CONTRACTS § 710 (Feb. 2008) (citing cases).

²³ Restatement (Contracts) Second § 356 (discussing liquidated damages and penalties). *See also*, UCC § 2-718 (2004) (discussing same).

²⁴ *See* WILLISTON ON CONTRACTS, § 65:1 (2008)

²⁵ *Id.*

contractually insist on specific performance.²⁶ This is because courts are reluctant to enforce specific performance when the default legal rule is damages.²⁷ With such knowledge, however, parties can include a mandatory arbitration clause, thus probably guaranteeing that their favored remedy will be enforced.

While the default rule is that the remedies are not optional unless explicitly specified as exclusive, parties can protect themselves from a wrong interpretation by the court by stipulating in the contract that damages will *not* be the exclusive remedy. They can agree, for example, that the non-breaching party will be allowed, upon breach, to elect between receiving damages or seeking specific performance. Courts will most likely honor such clauses if the conditions for enforcing specific performance are met.²⁸ Parties can also stipulate how to evaluate expectation damages rather than leaving it to the court. Specifically, they can stipulate whether a party may receive cost of completion or diminution of value. Courts have commonly subjected such clauses to the usual scrutiny given limitations on remedy or liquidate damages.²⁹ Finding that a party must have at least minimally adequate remedies in the event of a breach, courts have invalidated, on public policy grounds, clauses limiting a purchaser to replacement only when a warrantor refuses to replace the defective item.³⁰ Finally, such clauses may be invalidated on the ground that they are unconscionable³¹.

In sum, for our purposes there are four types of contract. First, a *silent* contract where parties do not stipulate any remedy. In such a case the default remedy is damages for the expectation interest, calculated in the way explained above. Second, an *ambiguous* contract where parties stipulate a remedy but do not explicitly stipulate whether the remedy is exclusive or optional. Courts in such cases must interpret parties' intentions to decide whether the remedy is exclusive or optional. Unless stipulated as exclusive the default rule is that any remedy in the contract is *optional*. Third, an *exclusive* contract where parties

²⁶ See EDWARD YORIO, CONTRACT ENFORCEMENT: SPECIFIC PERFORMANCE AND INJUNCTIONS (1989) at § 20.2 (discussing various ways in which parties can prevent the non-breaching party from getting specific performance).

²⁷ See *id.* § 19.2

²⁸ Restatement (Second) of Contracts § 359, comment a (1981); see generally, EDWARD YORIO, CONTRACT ENFORCEMENT: SPECIFIC PERFORMANCE AND INJUNCTIONS, 439 (1989).

²⁹ See, e.g., Uniform Commercial Code, § 2A-503 (2004).

³⁰ See WILLISTON ON CONTRACTS, § 40:40 (2008).

³¹ See, Uniform Commercial Code, § 2A-503 (2004).

explicitly agree that a remedy be the exclusive remedy, and fourth, an optional contract where parties explicitly agree that the remedies are optional.

Unfortunately, it is not clear exactly what circumstances motivate different parties to choose differently among the remedy schemes available. For instance, it is not clear why and when a party prefers an exclusive remedy over an optional one, and vice versa. This demonstrates the need for a model to show when parties would contract for exclusive damages, and when, in contrast, they would agree to allow the non-breaching party seek specific performance, and when they give the non-breaching party a choice between the two. The model we present does exactly that.

3. Related Literature

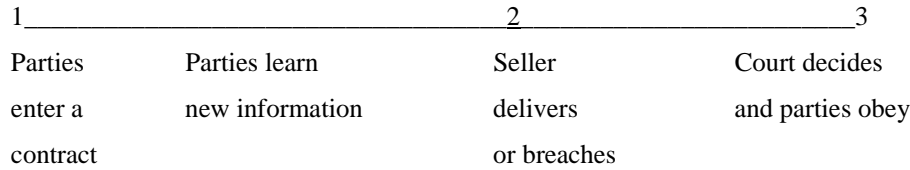
[TBC]

4.1 Setting the Model

At Time 1 a risk-neutral seller-supplier and a risk-neutral buyer-manufacturer enter a contract for the sale of a single widget needed for the buyer's production. The seller receives the money upon performance at Time 2. Uncertainties exist at Time 1 for both the seller and the buyer. For example, there is uncertainty about the seller's cost of performance due to future fluctuations in the market prices for the inputs to the widget the seller promised to deliver. We assume that the seller's cost, c , is drawn from a density function $f(c)$ with cumulative distribution function denoted $F(c)$ in the interval $[0, \bar{c}]$. There is also uncertainty about the buyer's future valuation of the widget due to future fluctuations in the market prices of the products the buyer ultimately manufactures and sells using the widget. We assume the buyer's valuation, v , is drawn from a density function $g(v)$ with cumulative distribution function denoted $G(v)$ in the interval $[0, \bar{v}]$, where $G(\cdot)$ and $F(\cdot)$ are independent and commonly known. Between Time 1 and Time 2 (which is when the seller must decide to either breach or perform) both parties learn their own valuations. However, each party's respective valuation is unobservable to the other party. Therefore, we assume this asymmetry of information prevents the parties from renegotiating the contract. If the seller

breaches at Time 2, then at Time 3 parties litigate the contract remedy. The following chart presents the timeline.

Chart 1- Time line for the model



Without loss of generality, and for simplicity, we assume that the buyer has all bargaining power. Therefore, we can assume the seller's surplus from the contract is zero. However, our results do not depend on this assumption.

We recognize that the price agreed to in the contract at Time 1 and the incentives to breach at T2 (and of course the joint welfare) are influenced by several factors. First, they take into account the default legal damages regime a court will apply at Time 3 if the seller does not deliver at Time 2. Thus, the price of the contract and the incentives to breach will be different if the remedy a court will award is expectation damages, ex-post actual damages, or optimal damages. Second, the prices and incentives to breach reflect the anticipated ex-post costs of verifying a buyer's valuation, as well as whether the English rule of loser pays or the American rule applies. Thus, the price of the contract and the incentives to breach will be different if verifying buyer's valuation is costless ($\beta=0$), costly ($\beta>0$), or prohibitive costly ($\beta\gg 0$). In the case of unverifiable values, at Time 3 parties will engage in a signaling game (we explain the signaling game in more detail below) which provides the court with some inferences regarding their valuations. Third, the price of the contract and the incentives to breach will be different if parties write an exclusive or an optional contract. While parties cannot decide the court's default damages remedy, we allow the parties to decide in Time 1 whether the damages are exclusive or whether the buyer can insist on specific performance at Time 3.

Table 1 presents the various regimes we compare. β represents the cost of verifying buyer's damages.

Table 1- Notations: Comparing various remedy regimes
(price, incentive to breach, and joint ex-ante payoff)

	Specific Performance	Expectation Damages	Actual Damages			Optimal Damages		
			$\beta=0$	$\beta>0$	$\beta>>0$	$\beta=0$	$\beta>0$	$\beta>>0$
Exclusive Contract	SP	EED	EAD	EAD	EAD	EOD	EOD	EOD
Optional Contract	----	OED	OAD	OAD	OAD	OOD	OOD	OOD

* SP means specific performance regime. EED means exclusive expectation damages regime. EAD means exclusive actual damages regime. EOD means exclusive optimal damages regime. OED means optional expectation damages regime. OAD means optional actual damages regime. OOD means optional optimal damages regime. $\beta=0$ means buyer's ex-post valuation is verifiable to the court at no cost. $\beta>0$ means that buyer's ex-post valuation is verifiable to the court at cost. $\beta>>0$ means that buyer's valuation is not verifiable to the court and parties engage in a signaling game.

We then compare the contract price, seller's incentives to breach, and parties' joint expected payoffs under exclusive and optional contracts considering various types of damages and various costs of verification.

4.2 Analysis when $\beta \geq 0$.

In this section, we analyze both exclusive and optional regimes assuming first that $\beta=0$ and then that $\beta>0$. In section 4.3 we analyze the more complicated case where $\beta>>0$ so parties need to engage in a signaling game vis-à-vis a Bayesian court.

4.2.1 Exclusive Regime

We first assume that all remedies are exclusive. Thus, the court's only choice is to enforce the single remedy the parties contracted for.

4.2.1.1 Non-observable but verifiable damages : $\beta=0$

We assume that seller's costs and buyer's valuation are private information and *non-observable* to the other party throughout the entire game, but that the buyer's damages are *verifiable* ex-post in court through discovery. We assume at this point that there are no costs associated with this ex-post verification ($\beta=0$)

Exclusive Specific Performance: The court is assumed to always grant specific performance if the buyer files a lawsuit. We call this regime SP.

We solve this game by backward induction. At Time 3, upon breach the buyer will file a lawsuit only if $v > p$; the seller's expected payoff from breach is $\int_p^{\bar{v}} (p - c)dG(v)$. Therefore, the seller will breach if $c > p$. Since the buyer has all the bargaining power, he will offer a minimum price to extract all seller's expected surplus (*Notation: π denotes expected payoff; P denotes price; subscripts B or S denote buyer or seller.*)

$$\pi_S^{SP^v} = \int_0^p (p - c)dF(c) + \int_p^{\bar{c}} \int_p^{\bar{v}} (p - c)dG(v)dF(c) = 0 \Rightarrow \quad (1)$$

$$p^{SP^v} = [E(c) - G(p^{SP^v}) \int_p^{\bar{c}} c dF(c)] / [1 - G(p^{SP^v}) (1 - F(p^{SP^v}))] \quad (2)$$

$$\pi_B^{SP^v} = j\pi^{SP^v} = \int_0^{p^{SP^v}} (E(v) - c)dF(c) + \int_{p^{SP^v}}^{\bar{c}} \int_{p^{SP^v}}^{\bar{v}} (v - c)dG(v)dF(c). \quad (3)$$

The first term in (1) represents the seller's payoff if he voluntarily delivers whereas the second term represents his payoff when he is forced to deliver by court.

The Independent Court Case (Exclusive Optimal Damages, $\beta=0$):

We first assume that the court is independent in that it is not bound by any damages measure. Rather, the court will choose, ex-post, damages that maximize parties' ex-ante welfare. We first assume that there is no verification cost ($\beta=0$). We call this regime EOD.

Assume that at Time 2, when making the breach-or-deliver decision, the seller's expectation of the court's awarded damages is $\mu_a - p$.³² Then the seller will breach if $c > \mu_a$. And the joint payoff is:

$$j\pi^{EOD^*} = \int_0^{\mu_a} (E(v) - c)dF(c)$$

The court chooses μ_a to maximize $j\pi^{EOD^*}$. The court's objective function (and hence the optimal damages) is of course rationally anticipated by the parties. First order condition yield that $\mu_a^* = E(v)$. Hence,

$$j\pi^{EOD^*} = \int_0^{E(v)} (E(v) - c)dF(c). \quad (4)$$

Remark: The court's welfare-maximizing damages award in this case is the ex ante expectation damages, $E(v)-p$. We provide more details about this solution below.

The Commitment Case (Exclusive Expectation Damages, $\beta=0$): Here the court is assumed to commit itself to awarding ex ante expectation damages. Thus, even if new information about buyer's valuation is presented, the court will not revise the damages award. We call this regime EED.

Under this regime, at time 2, the seller will breach if $c > E(v)$.³³ We have the following equilibrium results:

$$\begin{aligned} \pi_s^{EED^*} &= \int_0^{E(v)} (p - c)dF(c) - \int_{E(v)}^{\bar{c}} (E(v) - p)dF(c) = 0 \Rightarrow \\ p^{EED^*} &= E(v)[1 - F(E(v))] + \int_0^{E(v)} cdF(c) \quad \left\langle = \int_0^{E(v)} [1 - F(c)]dc \right\rangle \end{aligned} \quad (5)$$

$$\pi_B^{EED^*} = j\pi^{EED^*} = E(v) - p^{EED^*} = \int_0^{E(v)} (E(v) - c)dF(c) \quad (6)$$

³² Presumably this damages award shall be non-negative (and will be confirmed in the equilibrium outcome), and thus the buyer will always sue for damages upon breach.

³³ We assume that $\bar{c} > E(v)$. Otherwise, under expectation damages, the seller would never breach.

Remarks: (a) Since seller's expected payoff is zero, buyer's expected payoff is also the joint payoff, $j\pi^{EED^v}$. Recall from the previous subsection that this joint payoff is the best parties can achieve under any monetary damages remedy.

(b) The equilibrium price is always smaller than buyer's expected value:

$p^{EED^v} - E(v) = \int_0^{E(v)} (c - E(v))dF(c) < 0$. Thus, the buyer will always file a lawsuit because his expected recovery is larger than the price he would then have to pay.

(c) Comparing the joint payoff under EED with the joint payoff under specific performance (SP) yields:

$$\begin{aligned}
 j\pi^{EED^v} - j\pi^{SP^v} &= \int_0^{E(v)} (E(v) - c)dF(c) - \int_0^{p^{SP^v}} (E(v) - c)dF(c) - \int_{p^{SP^v}}^{\bar{c}} \int_{p^{SP^v}}^{\bar{v}} (v - c)dG(v)dF(c) \\
 &= \underbrace{\left[\int_0^{E(v)} (E(v) - c)dF(c) - \int_0^{p^{SP^v}} (E(v) - c)dF(c) \right]}_{\text{Difference in efficiency due to voluntary performance}} - \underbrace{\left[(1 - F(p^{SP^v}))(1 - G(p^{SP^v}))[E(v|v \geq p^{SP^v}) - E(c|c \geq p^{SP^v})] \right]}_{\text{Potential efficiency gain from involuntary performance under SP}}
 \end{aligned}$$

Denote $\Delta_1 := \int_0^{E(v)} (E(v) - c)dF(c) - \int_0^{p^{SP^v}} (E(v) - c)dF(c)$ as the difference in efficiency between the EED and SP regimes due to the different incentives that the two regimes provide for voluntary performance. Since $E(v)$ is the optimal breach threshold from the ex-ante perspective, Δ_1 is always non-negative.

Denote, $\Delta_2 := (1 - F(p^{SP^v}))(1 - G(p^{SP^v}))[E(v|v \geq p^{SP^v}) - E(c|c \geq p^{SP^v})]$ as the potential efficiency gains emerging from seller's *involuntary* performance under SP. When buyer's conditional expected value is higher than seller's conditional expected cost, this forced performance under specific performance can create efficiency gains (from an ex ante perspective). The expression above stipulates that if $\Delta_1 \geq \Delta_2$, then SP is inferior to the remedy of EED; otherwise, SP is superior.

(d) Observe that if parties' distributions are identical, then $\Delta_2 = 0$ and EED becomes the superior remedy. This is because there is no gain from forced performance, so the better incentives to breach that EED provides make it the better remedy. However, if buyer's

expected value is significantly higher than seller's expected cost, SP becomes superior as the gain from forced performance under SP regime more than offsets the inferior breach incentives it provides.

(e) Consider the following example: The buyer's valuation and seller's costs are uniformly distributed between 0 to 1, $v, c \sim U[0,1]$. From (2) and (3) above we get that

$$p^{SP^y} = 0.43; j\pi^{SP^y} = 0.12. \text{ From (5) and (6) above we get that } p^{EED^y} = 3/8; j\pi^{EED^y} = 1/8. \text{ In}$$

this case the joint payoff under EED damages is larger than under SP. However, when we assume that $c \sim U[0,1]; v \sim U[0,3/2]$ then we get that

$$p^{EED^y} = 15/32; j\pi^{EED^y} = 9/32; p^{SP^y} = 0.45; j\pi^{SP^y} = 0.33.$$

In this case the joint payoff under EED is smaller than under SP.

The Non-Commitment Case (Exclusive Actual Damages, $\beta=0$): In this case, the court is assumed to award ex-post actual damages, (sometimes called ex-post expectation damages). In this case, the court is tuned towards accuracy- it incorporates ex-post information attempting to compensate the buyer as accurately as possible. We still assume here that there are no costs associating with verifying the buyer's valuation, $\beta=0$. We call this regime EAD.

At Time 3 the buyer will sue for actual damages only if his ex-post valuation is larger than the price he would need to pay for the widget. Anticipating buyer's litigation decision, the seller's expected payoff if he breaches the contract is: $\int_p^{\bar{v}} (p-v)dG(v)$.

Therefore, the seller will breach when $c > E(v) + \int_0^p (p-v)dG(v) \equiv S(p)$. The joint surplus is:

$$\pi_S^{EAD^y} = \int_0^{S(p)} (p-c)dF(c) + \int_{S(p)}^{\bar{c}} \int_p^{\bar{v}} (p-v)dG(v)dF(c) = 0 \Rightarrow$$

$$p^{EAD^y} = \int_0^{S(p^{EAD^y})} cdF(c) + \int_{S(p^{EAD^y})}^{\bar{c}} \left[\int_0^{p^{EAD^y}} p^{EAD^y} dG(v) + \int_{p^{EAD^y}}^{\bar{v}} vdG(v) \right] dF(c). \quad (7)$$

$$\pi_B^{EAD^y} = j\pi^{EAD^y} = \int_0^{S(p^{EAD^y})} (E(v)-c)dF(c) \quad (8)$$

Remarks:

a) Since the breach threshold in this case is larger than the breach threshold under the EED regime, i.e. $S(p) > E(v)$, in expectation there will be fewer breaches under this regime than under EED.

b) The joint (ex-ante) payoff in this case may be smaller or larger than the joint (ex-ante) payoff under SP regime:

$j\pi^{EAD^y} - j\pi^{SP^y} = \Delta_3 - \Delta_2$, where Δ_2 has the same interpretation it had above (potential efficiency gain from forced performance) and

$\Delta_3 := \int_0^{S(p^{EAD^y})} (E(v) - c)dF(c) - \int_0^{p^{SP^y}} (E(v) - c)dF(c)$. Δ_3 is similar to Δ_1 above; it represents the difference in efficiency emerging from different incentives to voluntarily breach that EAD and SP regimes provide to the seller.

c) The joint (ex-ante) payoff in this case is always smaller than the joint (ex-ante) payoff

under the EED regime. $j\pi^{EAD^y} - j\pi^{EED^y} = \int_{E(v)}^{S(p^{EAD^y})} (E(v) - c)dF(c) < 0$ (Recall that EED is also the optimal regime (EOD)).

d) Consider the following example: $v, c \sim U[0,1]$:

$$S(p) = (1 + p^2) / 2; \quad \pi_s^{EAD^y} = 0 \Rightarrow (p^{EAD^y})^4 - 2(p^{EAD^y})^2 + 8p^{EAD^y} - 3 = 0 \Rightarrow p^{EAD^y} = \sqrt{2} - 1 > 3/8 = p^{EED^y};$$

$$j\pi^{EAD^y} = \int_0^{S(p^{EAD^y})} (E(v) - c)dF(c) = \int_0^{2-\sqrt{2}} ((1/2) - c)dc = (3\sqrt{2} - 4) / 2 < 1/8 = j\pi^{EED^y}.$$

The following Lemma summarizes the results:

Lemma 1 *Under exclusive contracts where verifying damages is costless, the following hold:*

(i) $EAD \prec EED (\approx EOD)$;

(ii) $EAD \prec SP$ iff $\Delta_3 < \Delta_2$;

(ii-a) $EAD \prec SP \prec EED$ iff $\Delta_3 < \Delta_2 < \Delta_1$;

(ii-b) $EAD < EED < SP$ iff $\Delta_3 < \Delta_1 < \Delta_2$.

Remarks: (a) (i) stipulates that seeking ex-post accuracy (EAD) is inferior to fixed ex-ante damages (EED), even when buyer's ex-post damages can be verified without cost. The intuition is that from the ex-ante perspective expectation damages are optimal: the seller will breach if and only if his costs are higher than the buyer's expected valuation, $E[v]$, which is, from the ex-ante perspective, an efficient breach. In contrast, in case of actual damages, the breach threshold, $S(p)$, is higher than buyer's expected valuation, $E[v]$. This means that from the ex-ante perspective, efficient breaches happen less often.

(b) The question then becomes why under actual damages the breach threshold is higher than $E[v]$, which is the breach threshold under fixed expectation damages? The answer is that while under the expectation damages regime the buyer will always file a lawsuit (recall from remark (b) above that $p^{EED} < E(v)$), under actual damages regime the buyer will file a lawsuit only if his ex-post valuation is higher than the price, $v > p$. This means that from the ex-ante perspective the seller faces a left-truncated distribution of possible damages awards with a mean larger than $E(v)$. He will therefore breach less often, and only when his costs are high enough to justify it.

(c) The analysis so far assumed that consideration is paid upon performance. However, the superiority of expectation damages over actual damages remains even if price is assumed to have been paid in advance. In such a case, one would initially think that the buyer will always file a lawsuit in the event of a breach, and therefore that the distribution of possible damages the seller faces is no longer truncated. Yet, since courts observe buyer's ex-post actual damages, courts will not make the buyer pay damages for the seller's breach when the buyer's valuation is lower than the price of the widget (no negative damages in contract law). Rather, they will award the buyer restitution, returning to him the money he paid for the widget. As a result, the seller does face the truncated distribution our analysis above suggested.

(d) The superiority of expectation damages over actual damages is not due to the fact that expectation damages may force buyers to reveal private information ((Bebchuk & Shavell

(1991); Ayres and Gertner (1989); Adler (1999)). In our model, at the contracting stage (Time 1) parties do not have private information. It is only at the breach-or-deliver point (Time 2) that they possess private information.

(e) (ii) stipulates that the efficiency ranking of EED and EAD relative to SP depends on their distributions. To better understand this point one needs to observe that there are two cases under which the seller performs. First, the seller performs voluntarily because his costs are low. Second, the seller performs when a court orders specific performance. When parties' distributions of cost and valuation suggest that buyer's expected valuation (given a breach) is sufficiently higher than the seller's expected cost, then this second type of performance---forced performance---is efficiency-enhancing. In this instance, SP is superior despite the adverse breach incentives it originally provides to the seller. Therefore, depending on the distributions, SP can be ranked anywhere when compared with EED and EAD.

4.2.1.2 Non-observable but costly verifiable damages, $\beta > 0$.

In this circumstance, we continue to assume that seller's costs and buyer's valuation are private information and non-observable to the other party. The analysis so far assumed there were no litigation costs, and no costs to verify buyer's damages. We now assume that verifying buyer's valuation has a cost, that is: $\beta > 0$.³⁴ The question of the cost of verifying damages is relevant to party behavior under an actual damages regime (EAD) and an optimal damages regime (EOD). We analyze both regimes under the American rule and the English rule.

³⁴ An assumption here is $0 < \beta \leq \min(\bar{c}, \bar{v}) - E(v)$. This ensures that $E(v) + \beta$ still falls into the intervals of the values. We also assume that there are no other litigation costs, which implies that there are no litigation costs in the case of expectation damages when buyer's ex-post valuation is ignored. While this assumption is somewhat strong, we believe it is similar to assuming that all litigation costs under the actual damages regime are higher than all litigation costs under the expected damages regime by exactly β .

The Non-Commitment Case (Exclusive Actual Damages, $\beta > 0$):

The American Rule

We first assume that the buyer bears her own verification cost, β . In that case, the buyer will sue for damages only if $v \geq p + \beta$. If the seller performs, his payoff is $p - c$; if he breaches the contract, his expected payoff is $\int_{p+\beta}^{\bar{v}} (p - v)dG(v)$. Therefore, the seller will deliver if $c \leq E(v) + \int_0^{p+\beta} (p - v)dG(v) \equiv \widehat{S}(p, \beta)$; and will otherwise breach.

$$\widehat{\pi}_S^{EAD^y} = \int_0^{\widehat{S}(p, \beta)} (p - c)dF(c) + \int_{\widehat{S}(p, \beta)}^{\bar{c}} \int_{p+\beta}^{\bar{v}} (p - v)dG(v)dF(c) = 0 \Rightarrow.$$

$$\widehat{p}^{EAD^y} = \widehat{\rho}(\widehat{p}^{EAD^y}, \beta)E\{c \leq \widehat{S}(\widehat{p}^{EAD^y}, \beta)\} + [1 - \widehat{\rho}(\widehat{p}^{EAD^y}, \beta)]E\{v \geq \widehat{p}^{EAD^y} + \beta\}, \quad (9)$$

where

$$\widehat{\rho}(p, \beta) \equiv F(\widehat{S}(p, \beta)) / \{F(\widehat{S}(p, \beta)) + [1 - F(\widehat{S}(p, \beta))][1 - G(p + \beta)]\}$$

$$j\widehat{\pi}^{EAD^y} = \int_0^{\widehat{S}(\widehat{p}^{EAD^y}, \beta)} (E(v) - c)dF(c) - \int_{\widehat{S}(\widehat{p}^{EAD^y}, \beta)}^{\bar{c}} \int_{\widehat{p}^{EAD^y} + \beta}^{\bar{v}} \beta dG(v)dF(c). \quad (10)$$

Remark:

The equilibrium price in this case is a weighted average of two expected private values. The first is the seller's cost when it is lower than his breach threshold (and thus he will voluntarily deliver). The other is the buyer's valuation when it is higher than her threshold for filing a lawsuit (in which case he will sue for damages upon breach).

The English Rule

We now assume that the breaching seller bears the buyer's verification cost, β . In that case, at Time 3, when the seller breaches the contract, the buyer will sue for damages when $v > p$.

Anticipating this, the seller's expected payoff from breach is $\int_p^{\bar{v}} (p - v - \beta) dG(v)$. Therefore the seller will deliver if: $c \leq E(v) + \int_0^p (p - v) dG(v) + \int_p^{\bar{v}} \beta dG(v) \equiv \tilde{S}(p, \beta)$.

The joint surplus is:

$$j\tilde{\pi}^{EAD^v} = \int_0^{\tilde{S}(\bar{p}^{EAD^v}, \beta)} (E(v) - c) dF(c) - \int_{\tilde{S}(\bar{p}^{EAD^v}, \beta)}^{\bar{c}} \int_{\bar{p}^{EAD^v}}^{\bar{v}} \beta dG(v) dF(c). \quad (11)$$

The following lemma summarizes our results

Lemma 2 *Under exclusive contracts with costly verifiable buyer's damages, the following hold:*

(i) $EAD \prec EED$, under both the English Rule and the American Rule.

(ii) Under EAD it is better to let the seller (breaching party) bear the verification cost iff

$$\int_{\tilde{S}(\bar{p}^{EAD^v}, \beta)}^{\tilde{S}(\bar{p}^{EAD^v}, \beta)} (E(v) - c) dF(c) + \int_{\tilde{S}(\bar{p}^{EAD^v}, \beta)}^{\bar{c}} \int_{\bar{p}^{EAD^v}}^{\bar{v}} \beta dG(v) dF(c) \leq \int_{\tilde{S}(\bar{p}^{EAD^v}, \beta)}^{\bar{c}} \int_{\bar{p}^{EAD^v} + \beta}^{\bar{v}} \beta dG(v) dF(c).$$

Proof. (i): For the case of buyer bearing the verification cost,

$$j\tilde{\pi}^{EAD^v} - j\tilde{\pi}^{EED^v} = \int_{E(v)}^{\tilde{S}(\bar{p}^{EAD^v}, \beta)} (E(v) - c) dF(c) - \int_{\tilde{S}(\bar{p}^{EAD^v}, \beta)}^{\bar{c}} \int_{\bar{p}^{EAD^v} + \beta}^{\bar{v}} \beta dG(v) dF(c) < 0. \text{ The first}$$

expression is always negative, and the second expression is always positive. And similarly for the case of seller bearing the verification cost.

(ii) follows from comparison of the joint payoffs when the seller or the buyer bears the verification cost.

Remarks: (i) above stipulates the superiority of EED over EAD. This is due not only to the deadweight loss which is created (because $\beta > 0$), but also because seller's incentives to breach are further distorted, relative to regime EED.

The Independent Court Case (Exclusive Optimal Damages, $\beta > 0$):

We return to the optimal regime when the court is tuned to maximizing parties' ex-ante welfare and is not bound by existing legal damages measures. However, we now assume that verifying buyer's valuation costs $\beta > 0$.

The American Rule

If the buyer bears the verification cost, the joint surplus is:

$$j\pi^{EOD^y} = \int_0^{\mu_a} (E(v) - c)dF(c) - \beta(1 - F(\mu_a)) \Rightarrow \mu_a^* = E(v) + \beta.$$

$$j\hat{\pi}^{EOD^y} = \int_0^{E(v)+\beta} (E(v) - c)dF(c) - \beta[1 - F(E(v) + \beta)].$$

The English Rule

If the seller bears the verification cost, the joint surplus is:

$$j\tilde{\pi}^{EOD^y} = \int_0^{E(v)+\beta} (E(v) - c)dF(c) - \beta[1 - F(E(v) + \beta)] = j\hat{\pi}^{EOD^y}.$$

$$j\tilde{\pi}^{EOD^y} - j\pi^{EOD^y} = \int_{E(v)}^{E(v)+\beta} (E(v) - c)dF(c) - \beta[1 - F(E(v) + \beta)] < 0.$$

Remarks: (a) In this case of welfare-maximizing damages, it does not matter who bears the verification cost, they result in the same joint welfare, which is smaller than the joint welfare under fixed expectation damages. Therefore, when a court's objective is maximizing parties' joint welfare, rather than determining accurate damages, the court will commit to not verifying buyer's ex-post valuation. We can therefore denote the joint payoff as:

$$j\pi^{EOD^y} = \int_0^{E(v)} (E(v) - c)dF(c).$$

(b) Consider the following example: $v, c \sim U[0,1]$ implies that $j\pi^{EOD^y} = 1/8$.

Proposition 1 summarizes the results.

Proposition 1 *Under exclusive contracts with verifiable damages the following holds:*

- (i) Awarding ex ante expectation damages is the welfare-maximizing remedy, no matter whether the verification is costly or not;*
- (ii) Even when verification is costless, actual damages are inferior to ex ante expectation damages; the efficiency comparison with specific performance, however, depends on parties' distributions;*
- (iii) Therefore, under an exclusive contract regime, committing to a fixed ex ante damages remedy is better than attempting, ex-post, to determine actual damages by incorporating new information regarding buyer's valuation.*

4.2.2. Optional Regime

We now assume that the non-breaching party can choose, ex-post, whether to ask the court to enforce the single remedy the parties contracted for, or to ask the court to grant specific performance.³⁵

4.2.2.1. Non-observable but verifiable damages, $\beta=0$

As before, seller's costs and buyer's valuations are private information and *non-observable* to the other party, but in this case the buyer's damages are *verifiable* ex-post in court through some costless discovery process ($\beta=0$).

The Independent Court Case (Optional Optimal Damages, $\beta=0$):

We again assume that the court is independent in that it is not bound by any of the standard damages measures. Rather, the court will choose the damages that maximize parties' ex-ante welfare, *unless the buyer insists on specific performance*. We first assume that there is no verification cost ($\beta=0$). We call this regime OOD.

³⁵ Of course, optional contracts make sense only when the stipulated remedy is not already specific performance.

We solve the game by backward induction. At Time 2, when making the breach-or-deliver decision, a seller's expectation of what a court will award in damages is $\mu_a - p$. Therefore the seller will breach if $c > \mu_a$, but the buyer will insist on specific performance if $v > \mu_a$.

The joint payoff is:

$$j\pi^{\text{OOD}^v} = \int_0^{\mu_a} (E(v) - c) dF(c) + \int_{\mu_a}^{\bar{c}} \int_{\mu_a}^{\bar{v}} (v - c) dG(v) dF(c)$$

The court chooses damage μ_a to maximize $j\pi^{\text{OOD}^v}$. The first order condition entails:

$$g(\mu_a^*) \int_{\mu_a^*}^{\bar{c}} (c - \mu_a^*) dF(c) = f(\mu_a^*) \int_0^{\mu_a^*} (\mu_a^* - v) dG(v). \quad (12)$$

If we let $h(x) := f(x)/[1 - F(x)]$; $k(x) := g(x)/G(x)$; $\lambda(x) := h(x)/[h(x) + k(x)]$, we can write

$$\mu_a^* = \lambda(\mu_a^*) E(v | v \leq \mu_a^*) + (1 - \lambda(\mu_a^*)) E(c | c \geq \mu_a^*). \quad (13)$$

Remarks: (a) The FOC reflects the trade-off courts must make when choosing welfare-maximizing damages. Raising the breach threshold μ_a will induce more--but also potentially inefficient--performance. Lowering μ_a has an ambiguous effect. On one hand it will induce the seller to breach more often; on the other hand it will encourage the buyer to insist more often on specific performance. Starting from the left-hand-side of the equation (12)---When $c > \mu_a$ and v slightly below but very close to μ_a (the probability of this situation is approximately $g(\mu_a) \int_{\mu_a}^{\bar{c}} dF(c)$), the seller successfully breaches the contract. The expected gain from the efficient breach under this situation is exactly the left-hand-side of the equation: $g(\mu_a) \int_{\mu_a}^{\bar{c}} (c - \mu_a) dF(c)$. For the right hand-side of the equation, when $v < \mu_a$ and c slightly below but very close to μ_a (the probability of this situation is $f(\mu_a) \int_0^{\mu_a} dG(v)$), the seller would voluntarily deliver the good, The expected loss from the inefficient performance

in this situation is $f(\mu_a) \int_0^{\mu_a} (\mu_a - v) dG(v)$ ---- the right hand-side of the equation. When these two effects become equal, the threshold, μ_a , attains its second-best level, μ_a^* .

Denote the first order condition as a function of μ_a ,

$$\phi(\mu_a) = f(\mu_a) \int_0^{\mu_a} (v - \mu_a) dG(v) + g(\mu_a) \int_{\mu_a}^{\bar{c}} (c - \mu_a) dF(c)$$

Then second-order condition implies that $\phi'(\mu_a) < 0$, and we know $\phi(\mu_a^*) = 0$.

$$\begin{aligned} \phi(E(v)) &= g(E(v)) \int_{E(v)}^{\bar{c}} (c - E(v)) dF(c) - f(E(v)) \int_{E(v)}^{\bar{v}} (v - E(v)) dG(v) \\ &= g(E(v)) [1 - F(E(v))] [E(c|c \geq E(v)) - E(v)] - f(E(v)) [1 - G(E(v))] [E(v|v \geq E(v)) - E(v)] \\ &= [1 - F(E(v))] [1 - G(E(v))] h_f(E(v)) h_g(E(v)) \left\{ \frac{E(c|c \geq E(v)) - E(v)}{h_f(E(v))} - \frac{E(v|v \geq E(v)) - E(v)}{h_g(E(v))} \right\} \end{aligned}$$

where $h_i(x)$ is the hazard rate function for $i=f, g$; i.e.,

$$h_f(x) = f(x) / [1 - F(x)]; h_g(x) = g(x) / [1 - G(x)].$$

Using first and second order conditions, it is routine to prove the following lemma:

Lemma 3

$$\mu_a^* \geq E(v) \quad \text{iff} \quad [(E(c|c \geq E(v)) - E(v)) / h_f(E(v))] \geq [(E(v|v \geq E(v)) - E(v)) / h_g(E(v))].$$

Remarks: (a) Unlike in the exclusive contract case, the breach threshold does *not* equal buyer's expected valuation. In fact, it can be higher or lower.

(b) Comparing the joint payoff under this regime with the joint payoff under exclusive optimal damages (which was expectation damages) yields the following lemma:

Lemma 4 If $E(v|v \geq E(v)) \geq E(c|c \geq E(v))$, $j\pi^{OOD^*} \geq j\pi^{EOD^*} \equiv .j\pi^{EED^*}$

Proof. See Avraham and Liu (2006), proof of Proposition 1.

Remark: The optimal optional regime may be better or worse than the optimal exclusive regime, depending on parties' distributions.

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The Commitment Case (Optional Expectation Damages, $\beta=0$): In this case, the court is assumed to be committed to awarding ex ante expectation damages (thus not hearing evidence about buyer's ex post valuation) *unless the buyer asks for specific performance*. We call this regime OED.

As usual, we solve this game by backward induction. At time 3 the buyer will insist on specific performance when $v > E(v)$. At Time 2, the seller will breach if $c > E(v)$. Since the buyer has all the bargaining power, he will offer a minimum price in order to extract all of the seller's expected surplus:

$$\pi_S^{OED^*} = j\pi^{OED^*} = \int_0^{E(v)} (p-c)dF(c) + \int_{E(v)}^{\bar{c}} \left[\int_0^{E(v)} (p-E(v))dG(v) + \int_{E(v)}^{\bar{v}} (p-c)dG(v) \right] dF(c) = 0 \Rightarrow$$

$$p^{OED^*} = E(c) - G(E(v)) \int_{E(v)}^{\bar{c}} (c - E(v))dF(c) \quad (13)$$

$$\pi_B^{OED^*} = j\pi^{OED^*} = \int_0^{E(v)} (E(v) - p^{OED^*})dF(c) + \int_{E(v)}^{\bar{c}} \left[\int_0^{E(v)} (E(v) - p^{OED^*})dG(v) + \int_{E(v)}^{\bar{v}} (v - p^{OED^*})dG(v) \right] dF(c)$$

$$= \int_0^{E(v)} (E(v) - c)dF(c) + \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c)dG(v)dF(c) \quad (14)$$

Remarks: (a) The equilibrium price is always smaller than seller's expected value:

$$p^{OED^*} < E(c);$$

(b) comparing the joint payoff under OED with the joint payoff under exclusive expectation damages (EED) yields:

$$j\pi^{OED^*} - j\pi^{EED^*} = \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c)dG(v)dF(c) = [1 - F(E(v))][1 - G(E(v))]\{E[v|v \geq E(v)] - E[c|c \geq E(v)]\}$$

Therefore, if $E(v|v \geq E(v)) > E(c|c \geq E(v))$ the optional regime with default ex ante expectation damages is more efficient than a regime where ex ante expectation damages are the exclusive remedy. The intuition is simple. Recall that $E[v]$ is the (optimal) breach threshold under EED. This result implies that if the buyer's conditional expected valuation (given a breach) is larger than the seller's conditional expected costs, then giving the buyer the option to enforce is efficient. Indeed, in these cases, from the ex ante perspective, the buyer is more likely to be the highest valuer of the widget, and therefore performance would be superior.

(c) Comparing the joint payoff under OED with the joint payoff under specific performance (SP) yields:

$$\begin{aligned} j\pi^{OED^y} - j\pi^{SP^y} &= \int_{p^{SP^y}}^{E(v)} (E(v) - c) dF(c) + \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c) dG(v) dF(c) - \int_{p^{SP^y}}^{\bar{c}} \int_{p^{SP^y}}^{\bar{v}} (v - c) dG(v) dF(c) \\ &= \Delta_1 + \Delta_4 - \Delta_2, \end{aligned}$$

where Δ_1, Δ_2 are as above and $\Delta_4 := \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c) dG(v) dF(c)$.

(d) Comparing the joint payoff under OED with the joint payoff under exclusive actual damages (EAD) yields:

$$j\pi^{OED^y} - j\pi^{EAD^y} = \int_{S(p^{EAD^y})}^{E(v)} (E(v) - c) dF(c) + \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c) dG(v) dF(c) = \Delta_5 + \Delta_4,$$

Where Δ_4 is as above and $\Delta_5 := \int_{S(p^{EAD^y})}^{E(v)} (E(v) - c) dF(c)$.

(e) Thus, the efficiency comparison of OED with specific performance, exclusive actual damages and exclusive expectation damages depends on parties' distributions.

The Non-Commitment Case (Optional Actual Damages, $\beta=0$). Here the court is assumed to be seeking, ex post, to determine accurate damages and therefore awards buyers actual damages *unless the buyer asks for specific performance*. We call this regime OAD.

At Time 3, the buyer is indifferent between insisting on performance and seeking actual damages. If the buyer always chooses damages, the result is the same as under regime EAD and the joint payoff is $j\pi^{OAD_{AD}^y} = j\pi^{EAD^y}$. If, in contrast, the buyer always demands specific performance, the result is the same as under regime SP and the joint payoff is

$j\pi^{OAD_{SP}^y} = j\pi^{SP^y}$. While the buyer is indifferent between seeking actual damages and specific performance, the joint ex-ante payoff is not the same in these two cases. Specifically,

$$j\pi^{OAD_{AD}^y} - j\pi^{OAD_{SP}^y} = \Delta_3 - \Delta_2.$$

Thus, parties would stipulate that the buyer has to choose specific performance or actual damages depending on whether Δ_3 or Δ_2 is larger. This implies that parties will never write optional contracts when actual damages and specific

performance are the relevant optional remedies; they will simply write exclusive contracts with the superior remedies between the two as the exclusive contract. The following lemma summarizes the results.

Lemma 5 (i) $j\pi^{OED^y} \geq j\pi^{EED^y}$ iff $E(v|v \geq E(v)) \geq E(c|c \geq E(v))$;

(ii) $j\pi^{OED^y} \geq j\pi^{SP^y}$ iff $\Delta_1 + \Delta_4 - \Delta_2 \geq 0$;

(iii) $j\pi^{OED^y} \geq j\pi^{EAD^y}$ iff $\Delta_5 + \Delta_4 \geq 0$;

(iv) Parties will never agree on actual damages in optional contracts.

Remark: (a) (i) above entails that when a buyer's conditional expected valuation is higher than the seller's conditional expected costs, granting the buyer an option to insist on performance on top of the court's awarded ex ante expectation damages can increase the ex ante joint welfare.

(b) (ii) and (iii) above states that the efficiency comparison of optional ex ante expectation damages with specific performance or exclusive actual damages depends on party value distributions.

(c) The reason why optional actual damages do not offer any efficiency advantage compared to exclusive remedies (as (iv) above entails) is that the buyer's choice of remedies does not depend on his acquired interim information.

Lemma 6 $j\pi^{OOD^y} \geq j\pi^{OED^y}$.

Proof.

$$j\pi^{OOD^y} - j\pi^{OED^y} = \int_0^{\mu_a^*} [E(v) - c]dF(c) + \int_{\mu_a^*}^{\bar{c}} \int_{\mu_a^*}^{\bar{v}} (v - c)dG(v)dF(c) - \int_0^{E(v)} [E(v) - c]dF(c) - \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c)dG(v)dF(c).$$

Let $\Delta(\mu_a) = j\pi^{\text{OOD}^y}(\mu_a) - j\pi^{\text{OED}^y}$, we have $\Delta(E(v)) = 0$.

$\Delta(\mu_a^*) = j\pi^{\text{OOD}^y}(\mu_a^*) - j\pi^{\text{OED}^y} \geq j\pi^{\text{OOD}^y}(\mu_a) - j\pi^{\text{OED}^y} = \Delta(\mu_a), \forall \mu_a$, by the optimality of μ_a^* .

Therefore, $\Delta(\mu_a^*) = j\pi^{\text{OOD}^y} - j\pi^{\text{OED}^y} \geq \Delta(E(v)) = 0$.

The court will not verify the actual damages under a welfare-maximizing remedy.

4.2.2.2 Non-observable but costly verifiable damages, $\beta > 0$.

As before, seller's costs and buyer's valuation are private and *non-observable* to the other party, but that the buyer's damages are *verifiable* ex-post in court through some kind of a *costly* discovery process ($\beta > 0$).

[TBC]

4.3 Analysis when $\beta \gg 0$.

In this section we analyze the complicated case where verifying buyer's exact valuation is too costly to pursue. Instead, the court is assumed to be Bayesian, inferring buyer's valuation from parties' signals during litigation.

Still the question we ask is----*Whether the court should commit itself not to use ex post information to determine damages (refrain from being a Bayesian) in order to provide better ex ante incentives?* But now assume that damages are *non-observable and non-verifiable*.

4.3.1 Exclusive Regime with Court-Imposed Damages

Time I: S, and B, both risk neutral, sign a contract $\{p \text{ (payable upon delivery)}\}$. In case of litigation following a breach, the court will determine damages. The surplus division between parties depends on their bargaining power.

Time 2: c and v realized and privately observed by S and B, respectively.

Time 3: S decides whether to breach.

Time 4: Trial and enforcement.

Analysis:

4.3.1.1 Commitment case: fixed Ex Ante Expectation Damages. The court commits itself to award ex ante expectation damages even if it expects to receive some signals ex post.

Since in the commitment case, there is no need to have a hearing, the outcome completely copies from the verifiable section (Part I, supra). At Time 3, S will breach if $c > E(v)$. If B has all the bargaining power, he will offer a minimum price such that S will accept the contract:

$$\begin{aligned} \pi_S^{\text{EED}^n} &= \int_0^{E(v)} (p - c) dF(c) - \int_{E(v)}^{\bar{c}} (E(v) - p) dF(c) = 0 \Rightarrow \\ p^{\text{EED}^n} &= E(v)[1 - F(E(v))] + \int_0^{E(v)} c dF(c) \quad \left\langle = \int_0^{E(v)} [1 - F(c)] dc \right\rangle \\ \pi_B^{\text{EED}^n} &= j\pi^{\text{EED}^n} = E(v) - p^{\text{EED}^n} = \int_0^{E(v)} [E(v) - c] dF(c) \end{aligned}$$

4.3.1.2 Non-Commitment Case: Court will infer values from breach, and choose damages to motivate efficient ex ante behavior.

Since now values are non-observable and non-verifiable, we must consider the process by which the trial and enforcement occur. First, how does the court determine the damages? It only knows that S wanted to breach, meaning his cost is in an upper region. If we allow no evidence production, then the optimal damages are likely to remain $E(v)$, which provides the most efficient incentive to breach from ex ante perspective. Therefore, non-commitment will result in the same payoff as in commitment if there is no evidence hearing.

Second, how is evidenced produced? Assume that parties will present evidence, $e_i \in [0,1]$,

$i = B, S$. Unit cost for evidence is $m_B(v)$, $m_S(c)$,

$m_B'(v) < 0, m_B''(v) > 0; m_S'(c) < 0, m_S''(c) > 0$ (the higher the buyer's value, the easier for

him to prove high damages, and similarly for S's evidence production). Also, we assume that the court does *not* know the functional form of the evidence cost functions, but only knows the properties of the functions. The functional form of $m_B(v)$ and $m_S(c)$ is the private information of parties.³⁶ Following Bernardo, Talley and Welch (2000), we assume that the court will award damages of $\frac{e_B}{e_S + e_B} D - p$, where D is a constant damages parameter (which is chosen ex ante by the court to maximize social welfare).

Parties' evidence production at Time 4:

$$\text{Buyer: } \text{Max}_{e_B} D \int_{x^E}^{\bar{c}} \frac{e_B}{e_S(c) + e_B} dF(c) - p - m_B(v)e_B;$$

$$\text{Seller: } \text{Min}_{e_S} D \int_{y^E}^{\bar{v}} \frac{e_B(v)}{e_S + e_B(v)} dG(v) - p + m_S(c)e_S$$

$$\Rightarrow D \int_{x^E}^{\bar{c}} \frac{e_S(c)}{(e_S(c) + e_B)^2} dF(c) = m_B(v) \text{ and } D \int_{y^E}^{\bar{v}} \frac{e_B(v)}{(e_S + e_B(v))^2} dG(v) = m_S(c), \quad (15)$$

where x^E is buyer's belief of seller's threshold for breach (i.e., whenever $c > x^E$, seller will breach, in anticipation of the subsequent litigation game in court); similarly, y^E is the seller's belief of buyer's threshold for litigation (i.e., whenever $v > y^E$, buyer will file a lawsuit for damages, in anticipation of the outcome of the subsequent litigation game in court). Assume there exist interior optima, $e_B^*(v)$ and $e_S^*(c)$. It is easy to see that $e_B^{*'}(v) > 0$ and $e_S^{*'}(c) > 0$.

Denote S's litigation stage expected payoff as

$$p - L_S(c) = p - D \int_{y^E}^{\bar{v}} \frac{e_B^*(v)}{e_S^*(c) + e_B^*(v)} dG(v) - m_S(c)e_S^*(c). \quad (16)$$

Similarly, B's expected litigation payoff as

$$L_B(v) - p = D \int_{x^E}^{\bar{c}} \frac{e_B^*(v)}{e_S^*(c) + e_B^*(v)} dF(c) - m_B(v)e_B^*(v) - p. \quad (17)$$

Time 3: For B, he will file the lawsuit for damages if his expected litigation payoff is non-negative, i.e., if $L_B(v) \geq p \Leftrightarrow v \geq v^E$, (18)

³⁶ This is important, otherwise if the court knows the exact functional form, it can perfectly infer the private values from the evidence presented.

where v^E is buyer's litigation threshold obtained from solving $L_B(v) \geq p$. For S, he will obtain $p-c$ if deliver, and will receive $\int_{y^E}^{\bar{v}} (p - L_S(c))dG(v)$ if he breaches. Therefore, S will

$$\text{breach if } c > \int_0^{y^E} pdG(v) + \int_{y^E}^{\bar{v}} L_S(c)dG(v) \Leftrightarrow c > c^E, \quad (19)$$

where c^E is the breach threshold obtained from solving $c > \int_0^{y^E} pdG(v) + \int_{y^E}^{\bar{v}} L_S(c)dG(v)$. In the perfect Bayesian equilibrium, a party's belief of the other party's threshold must be consistent with that party's equilibrium strategy (i.e., $x^E = c^E$ and $y^E = v^E$.) Therefore, the joint payoff is (Notation: ECD^n denotes the case of exclusive court-determined damages with non-verifiable damages):

$$j\pi^{ECD^n} = \int_0^{c^E} (E(v) - c)dF(c) - \int_{c^E}^{\bar{c}} \int_{v^E}^{\bar{v}} [m_B(v)e_B^*(v) + m_S(c)e_S^*(c)]dG(v)dF(c).$$

From the FOC for the litigation game,

$$D \int_{x^E}^{\bar{c}} \frac{e_S(c)}{(e_S(c) + e_B)^2} dF(c) = m_B(v) \text{ and } D \int_{y^E}^{\bar{v}} \frac{e_B(v)}{(e_S + e_B(v))^2} dG(v) = m_S(c),$$

we know that optimal evidence is function of private values, and D . Also from the definitions of c^E , v^E , we know that c^E and v^E are functions of D as well.

Optimal D

Court choosing D^E to maximize

$$j\pi^{ECD^n}(D) = \int_0^{c^E(D)} (E(v) - c)dF(c) - \int_{c^E(D)}^{\bar{c}} \int_{v^E(D)}^{\bar{v}} [m_B(v)e_B^*(v, D) + m_S(c)e_S^*(c, D)]dG(v)dF(c).$$

The first-order condition is:

$$\begin{aligned} & (E(v) - c^E(D))f(c^E(D))(dc^E(D)/dD) - \int_{c^E(D)}^{\bar{c}} \int_{v^E(D)}^{\bar{v}} [m_B(v)(\partial e_B^*(v, D)/\partial D) + m_S(c)(\partial e_S^*(c, D)/\partial D)]dG(v)dF(c) \\ & + g(v^E(D))(dv^E(D)/dD) \int_{c^E(D)}^{\bar{c}} [m_B(v^E(D))e_B^*(v^E(D), D) + m_S(c)e_S^*(c, D)]dF(c) \\ & + f(c^E(D))(dc^E(D)/dD) \int_{v^E(D)}^{\bar{v}} [m_B(v)e_B^*(v, D) + m_S(c^E(D))e_S^*(c^E(D), D)]dG(v) = 0. \end{aligned}$$

(20)

The joint payoff is $j\pi^{ECD^n}(D^E)$.

Definition A perfect Bayesian equilibrium in the exclusive contracting game with non-verifiable values and court-imposed damages is: (i) The court chooses ex ante a constant damages parameter D that satisfies equation (20) and award damages

$D[e_B / (e_S + e_B)] - p$ in the litigation; (ii) Parties sign an ex ante contract with p maximizing the joint expected payoff; (iii) After learning the private information, parties decide on breach and litigation according to equations (18) and (19); and if they proceed to the litigation, they will present evidence according to equation (15); (iv) Beliefs are Bayesian consistent, i.e., $x^E = c^E$ and $y^E = v^E$.

4.3.2 Optional Damages with unverifiable values

Time 1: S, B, both risk neutral, sign a contract,

{ p (payable upon delivery); optional remedies between SP and court - imposed damages for breach }
 , the aggrieved party can decide upon breach whether to file a lawsuit, and if yes whether he desires SP or damages, if he elects SP, the breaching party must deliver with original p as payment; if he elects damages, the court will decide a damage. Parties design the contract to maximize expected joint surplus and divide it between them by adjusting p (the surplus division depends on bargaining power).

Time 2: c and v realized and privately observed by S and B, respectively.

Time 3: S decides whether to breach.

Time 4: B decides whether to insist on SP or to seek damages in the court.

4.3.2.1 Commitment case: fixed ex ante expectation damages. Here, the court commits itself to award ex ante expectation damages and ignores information revealed in the interim stage. Under these circumstances, at Time 4, B will not file a lawsuit if $v < \min(E(v), p)$ and will insist on SP when $v > E(v)$.

At Time 3, S will breach if $c > E(v)$. If B has all the bargaining power, he will offer a minimum price such that S will accept the contract

$$\begin{aligned}
\pi_S^{\text{OED}^n} &= \int_0^{E(v)} (p - c) dF(c) + \int_{E(v)}^{\bar{c}} \left[\int_0^{E(v)} (p - E(v)) dG(v) + \int_{E(v)}^{\bar{v}} (p - c) dG(v) \right] dF(c) = 0 \Rightarrow \\
p^{\text{OED}^n} &= E(c) - G(E(v)) \int_{E(v)}^{\bar{c}} (c - E(v)) dF(c) \\
\pi_B^{\text{OED}^n} &= j\pi^{\text{OED}^n} = \int_0^{E(v)} (E(v) - p^{\text{OED}^n}) dF(c) + \int_{E(v)}^{\bar{c}} \left[\int_0^{E(v)} (E(v) - p^{\text{OED}^n}) dG(v) + \int_{E(v)}^{\bar{v}} (v - p^{\text{OED}^n}) dG(v) \right] dF(c) \\
&= \int_0^{E(v)} (E(v) - c) dF(c) + \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c) dG(v) dF(c)
\end{aligned}$$

We must have $j\pi^{\text{OED}^n} \geq 0$ which means $\int_0^{E(v)} (E(v) - c) dF(c) \geq - \int_{E(v)}^{\bar{c}} \int_{E(v)}^{\bar{v}} (v - c) dG(v) dF(c)$.

Otherwise, parties will not sign the contract at first place.

Remarks:

$$p^{\text{OED}^n} < E(c);$$

$$j\pi^{\text{OED}^n} - [E(v) - E(c)] = \int_{E(v)}^{\bar{c}} \int_0^{E(v)} (c - v) dG(v) dF(c) > 0.$$

We have the same outcome as in the optional regime with fixed damages commitment under the case of verifiable values.

4.3.2.2 Non-Commitment Case: Here, the Court will infer values from breach, and choose damages to motivate efficient ex ante behavior.

Again, since values are now non-observable and non-verifiable, we must consider the process by which the trial and enforcement occur. First, how does the court determine the damages? Assume that parties will present evidence, $e_i \in [0,1]$, $i = B, S$. And, that the *Unit* cost for evidence is $m_B(v)$, $m_S(c)$, $m_B'(v) < 0$, $m_B''(v) > 0$; $m_S'(c) < 0$, $m_S''(c) > 0$ (the higher the buyer's value, the easier for B to prove high damages, and similarly for S's evidence production). Also we assume that the court does *not* know the functional form of the evidence cost functions, but only knows the properties of the functions. The functional form of $m_B(v)$ and $m_S(c)$ is private information of parties. This is important, otherwise if the court knows the exact functional form, it can perfectly infer the private values from the evidence presented. Following Bernardo, Talley and Welch (2000), the court will award damages of

$$\frac{e_B}{e_S + e_B} D - p, \text{ where } D \text{ is a constant damages parameter.}$$

Parties' evidence production at trial if B gives up his SP option and seeks damages through court³⁷: (If after trial B can choose insisting on SP, the expressions below would be wrong, since the damage is not final remedy under optional regime. In the objective function the expected insistence of SP by B must be taken into account. But, if once B chooses trial, he loses the option of SP, then the expressions below are correct. In legal practice, performance is not an option if B elects damages.)

$$\text{Buyer: } \text{Max}_{e_B} D \int_{x^o}^{\bar{c}} \frac{e_B}{e_S(c) + e_B} dF(c) - p - m_B(v)e_B; \quad \text{Seller:}$$

$$\text{Min}_{e_S} D \int_0^{y^o} \frac{e_B(v)}{e_S + e_B(v)} dG(v) - p + m_S(c)e_S$$

$$\Rightarrow D \int_{x^o}^{\bar{c}} \frac{e_S(c)}{(e_S(c) + e_B)^2} dF(c) = m_B(v) \quad \text{and} \quad D \int_0^{y^o} \frac{e_B(v)}{(e_S + e_B(v))^2} dG(v) = m_S(c)$$

Where x is buyer's belief of seller's threshold for breach (i.e., whenever $c > x^o$, seller will breach, in anticipation of the subsequent litigation game in court); y is seller's belief of buyer's threshold for choosing damages (i.e., whenever $v < y^o$, buyer will seek damages though court instead of insisting on SP, in anticipation of the subsequent litigation game in court). Assume there exist interior optimum $e_B^*(v)$ and $e_S^*(c)$. It is easy to see that

$$e_B^*(v) > 0 \quad \text{and} \quad e_S^*(c) > 0.$$

denote S's litigation stage expected payoff

$$\text{as } p - L_S(c) = p - D \int_0^{y^o} \frac{e_B^*(v)}{e_S^*(c) + e_B^*(v)} dG(v) - m_S(c)e_S^*(c). \quad \text{Similarly, B's expected litigation}$$

$$\text{payoff as } L_B(v) - p = D \int_{x^o}^{\bar{c}} \frac{e_B^*(v)}{e_S^*(c) + e_B^*(v)} dF(c) - m_B(v)e_B^*(v) - p.$$

³⁷ Buyer will update his belief of the seller's cost rationally from the signal that S proposes to breach, when deciding whether to exercise his option to insist on performance; and if he chooses not to exercise the option, he will also incorporate the Bayesian updated belief regarding the seller's cost when choosing his optimal evidence production in the litigation game. Similarly, in the litigation game (if it is reached) Seller will have Bayesian updated belief regarding the buyer's value after observing the signal that buyer did not exercise his option to insist on performance. All these Bayesian updating of belief must be consistent with parties' equilibrium strategies along equilibrium path in the perfect Bayesian equilibrium.

Time 4: B will insist on SP if $v > L_B(v)$. Denote $\varphi(v) = v - L_B(v)$, and v^{*O_n} defined by $\varphi(v^{*O_n}) = 0$. Assuming $L_B'(v) < 1$, then B will insist on SP if $v > v^{*O_n}$.

Time 3: for S, he will obtain p-c if deliver, and will receive

$G(v^{*O_n})[p - L_S(c)] + [1 - G(v^{*O_n})](p - c)$ if breach. Therefore, S will breach if $c > L_S(c)$.

Assuming $L_S'(c) < 1$, denote $\phi(c) = L_S(c) - c$, and c^{*O_n} defined by $\phi(c^{*O_n}) = 0$. Then S will breach if $c > c^{*O_n}$. In the perfect Bayesian equilibrium, buyer's belief of the seller's breach threshold must be consistent with seller's equilibrium strategy, i.e., $x^O = c^{*O_n}$; and similarly, $y^O = v^{*O_n}$.

Therefore, the joint payoff is:

$$j\pi^{\text{OCD}^n} = \int_0^{c^{*O_n}} [E(v) - c]dF(c) + \int_{c^{*O_n}}^{\bar{c}} \int_{v^{*O_n}}^{\bar{v}} (v - c)dG(v)dF(c) - \int_{c^{*O_n}}^{\bar{c}} \int_0^{v^{*O_n}} [m_B(v)e_B^*(v) + m_S(c)e_S^*(c)]dG(v)dF(c).$$

From the FOC for the litigation game, $D \int_{x^O}^{\bar{c}} \frac{e_S(c)}{(e_S(c) + e_B)^2} dF(c) = m_B(v)$,

and $D \int_0^{y^O} \frac{e_B(v)}{(e_S + e_B(v))^2} dG(v) = m_S(c)$, we know that optimal evidence is function of private

values, and D . Also from the definitions of c^{*O_n} and v^{*O_n} , we know that c^{*O_n} and v^{*O_n} are functions of D as well.

Then we can solve for optimal damages parameter D^{*O_n} , and get the equilibrium joint payoff $j\pi^{\text{OCD}^n}(D^{*O_n})$.

Example: $v \sim U[0,1]; c \sim U[0,1]$. (as in Spulber (2001, JPE)).

$m_B(v) = 1/(1+v); m_S(c) = 1/(1+c)$. Then from FOC, $D \int_{x^O}^1 \frac{e_S(c)}{(e_S(c) + e_B)^2} \frac{1}{1-x^O} dc = \frac{1}{1+v}$;

$D \int_0^{y^O} \frac{e_B(v)}{(e_S + e_B(v))^2} \frac{1}{y^O} dv = \frac{1}{1+c}$. We have $\frac{1}{y^O} \int_0^{y^O} \frac{e_B(v)}{1+v} dv = \frac{1}{1-x^O} \int_{x^O}^1 \frac{e_S(c)}{1+c} dc$.

$e_S^* =; e_B^*(v) = .$

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