

Breach Remedies Inducing Hybrid Investments ^{*}

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Abstract

We show that parties in bilateral trade can rely on the default breach remedy of common law, ‘expectation damages’, to simultaneously induce first-best relationship-specific investments of both the selfish and the cooperative kind. Specifically, this can be achieved by writing a so called Cadillac contract, i.e., a contract which sets the quality required under the contract sufficiently high. In contrast, the result by Che and Chung (1999) that ‘reliance damages’ induce the first best in a setting of purely cooperative investments cannot be generalized to the hybrid case. Moreover, the standard result that ‘expectation damages’ induce ex-post efficient breach no longer generally holds in the presence of cooperative investments.

Keywords: breach remedies, incomplete contracts, hybrid investments, cooperative investments, selfish investments.

JEL-Classification: K12, L22, J41, C70.

1 Introduction

A risk neutral buyer and seller contract for the future delivery of a good. Before delivery takes place, the seller makes an investment which has no value to the outside market but serves to decrease the seller’s cost of production *and* to increase the future value of the good to the buyer. That is, the investment is “hybrid” combining “cooperative” invest-

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ments in the sense of Che and Chung (1999) with “selfish” investments as traditionally analyzed in the literature (see e.g. Chung, 1991; Aghion, Dewatripont and Rey, 1994; Edlin and Reichelstein 1996; Shavell, 1980, 1984; Rogerson, 1984).¹

These investments are highly relevant in practice. Consider the famous General Motors - Fisher Body case which deals with Fisher Body’s decision of whether to build a plant adjacent to General Motors. Such an arrangement, by lowering shipping costs *and* improving supply reliability, offered benefits to both parties (see Che and Hausch, 1999). Or consider the example of Marks & Spencer, which routinely organizes joint trips with its suppliers to trade shows and to visit foreign suppliers of raw materials. The trips enhance mutual understanding and help both parties to identify new products that they could develop together. By facilitating bilateral communication, Marks & Spencer is able to add valuable items to its product line while at the same time lowering the risk of costly reengineering of products for the supplier (see Kumar, 1996).

In the absence of contractual protection, the parties negotiate the terms of trade after investments are sunk and the quality of the product is realized. Unless the investing party has all the bargaining power, it will only internalize a fraction of the investment benefit in such negotiations. Anticipating this potential for hold-up, the seller invests less than is socially desirable (Williamson, 1979, 1985; Grout, 1984; Grossman and Hart, 1986; Hart and Moore, 1988).

We develop a model where parties write a contract specifying a *price* for future trade and the *quality* of the good to be traded. If breach occurs, where either the seller (the buyer) fails to deliver (accept) the good, or the seller delivers a good of inadequate quality, the breached-against party can ask for “*expectation damages*” at trial. Under this commonly-applied legal remedy, the victim of breach would receive compensation to make him whole, i.e., he is compensated in the amount of profit that he would have

¹In their seminal paper, Che and Hausch (1999) also allow for hybrid investments and prove for a special informational setting that, if investments are sufficiently cooperative, contracting becomes irrelevant. In contrast, Che and Chung (1999), who deal with legal breach remedies, consider a different informational set-up and only allow for *purely* cooperative investments. “Cooperative investments” were first studied in an incomplete contract setting by Macleod and Malcolmson (1993) and are also referred to as “cross investments” (e.g. Guriev, 2003) or “investments with externalities” (e.g. Nöldeke and Schmidt, 1995). Other articles that consider cooperative investments include e.g. Bernheim and Whinston (1998), Maskin (1999) and Moore, De Fraja (1999), Rosenkranz and Schmitz (1999), Segal and Whinston (2002), and Roider (2004).

received had the contract been duly performed. We show that, under this legal regime, the contract induces first-best investment incentives and the efficient ex-post breach decision if the parties set the quality required under the contract sufficiently high.² This result holds independent of whether parties can renegotiate or not. However, if the quality specification is set at an intermediate level, investment incentives will be inefficient and the standard result (see e.g. Posner, 1977; Shavell, 1980) that ‘expectation damages’ induce the ex-post efficient breach decision can be shown to no longer hold.

The result is a generalization of Stremitzer (2008) who has analyzed this regime in a setting of purely cooperative investments.³ This is a border case of our hybrid setting where, e.g., the seller’s investment only increases the future value of the good to the buyer but does not decrease his own cost of production. What makes the result interesting is that another well known efficiency result for this setting, due to Che and Chung (1999), cannot be generalized to the hybrid case. Che and Chung (1999) assume that parties can write a contract in which they stipulate the *price* of the good to be traded and an *up-front payment*. If breach occurs, under which the buyer refuses to accept the good, the seller can ask for ‘*reliance damages*’ i.e. he is reimbursed his non-recoverable investment expenses. If renegotiation is possible they show that there exists a price for which the contract induces the first best. Yet, the logic of their proof cannot be extended to the hybrid setting. Indeed, it is always possible to construct examples

²Edlin (1996) also analyses “Cadillac contracts” in the context of ‘expectation damages’ but makes a different point: He considers a setting where the seller makes *selfish* investments. In the absence of a contract, there will be underinvestment due to the hold-up problem. If, however, the contract stipulates the highest possible quality/quantity, and it is the buyer who breaches the contract, the seller will overinvest. This is because he is fully insured and fails to take into account the states of the world where it is inefficient to trade (This is a version of the “overreliance” result by Shavell (1984) who implicitly assumes Cadillac contracts by modelling the trade decision as binary). To solve this problem, Edlin (1996) proposes to set the price so low, that it will always be the investing seller who breaches the contract. That makes him the residual claimant and provides him with efficient investment incentives. Yet, in order to make the seller accept a contract with such a low price, the buyer has to pay the seller a lump sum up front. By contrast, in our model, we are concerned with *hybrid* investments and need not rely on any up-front payments.

³Che and Chung (1999) had argued that ‘expectation damages’ perform very badly in such a setting inducing *zero* cooperative investments. Yet, as Stremitzer (2008) has shown this follows from their implicit assumption that the contract stays silent in terms of *required quality* which will rarely be the case. Indeed, even if the parties do not stipulate anything explicit as to quality in their contract (express warranty), the court will do it for them by default, e.g. by requiring the good to serve its ordinary purpose (implied warranty of merchantability, see Section 2-314 and 2-315 of the Uniform Commercial Code (UCC)). Taking this feature of real world contracting into account, Stremitzer (2008) shows that ‘expectation damages’ will always induce *positive* levels of cooperative investments and achieve the first best if parties choose a sufficiently high quality specification.

where ‘reliance damages’ induce overinvestment regardless of price. Although the precise argument is more complicated, this negative result is driven by the well known fact that ‘reliance damages’ induce overinvestment if investments are purely selfish (Shavell, 1980; Rogerson, 1984). Hence, overinvestment results if investments are sufficiently selfish.⁴

Our paper is organized as follows: Section 2 describes our model and Section 3 derives the socially optimal level of investment. We then show in Section 4, that the argument by Che and Chung (1999) on the efficiency of ‘reliance damages’ cannot be extended to the hybrid case. Section 5 contains our main result that first-best investment levels can be achieved under ‘expectation damages’ if the quality required under the contract is set sufficiently high. If not, investment incentives will be inefficient and ‘expectation damages’ may even fail to induce the efficient ex-post trade decision. Section 6 concludes.

2 The model

Consider a buyer-seller relationship where the risk neutral parties potentially trade a good. At date 0, the parties sign a contract (see Figure 1). The contract specifies a fixed price, p , which has to be paid by the buyer if the seller performs in accordance with the contract and, in case of ‘expectation damages’, a quality threshold, \bar{v} . Furthermore we assume that the parties specify a lump sum transfer, t , from the seller to the buyer if and only if it is necessary as a device to divide the ex ante expected gains from trade between the parties.⁵ At date 1, the seller makes a relation-specific investment, $e \in \mathbb{R}_0^+$, which stochastically determines the buyer’s benefit from trade as well as the seller’s cost of production. We assume that the good has no value to the outside market. At date 2, both the buyer’s benefit from trade, v , and the seller’s potential cost of performance, c , are being drawn from the intervals $[v_l, v_h]$ and $[c_l, c_h]$ by the conditional distribution functions $F(\cdot|e)$ and $G(\cdot|e)$ respectively.⁶ At date 3, the parties play a breachgame in which it is decided whether trade occurs or not. When renegotiations are possible, it

⁴That is, if the effect of seller’s investment on the cost of production is sufficiently large relative to the effect on the good’s quality.

⁵This must be the case with ‘reliance damages’ because a single tool, here the price, is generally insufficient to fine-tune two aspects, investment incentives and the parties ex ante expected share from trade.

⁶Note that cost, c , and the buyers benefit from trade, v , only occur if trade is realized.

is assumed that they are costless and can occur anywhere between date 3 and date 4 at which point the trade decision is finalized. It is assumed that the parties split the potential renegotiation surplus at an exogenously given ratio with the seller receiving a share of $\alpha \in [0, 1]$.

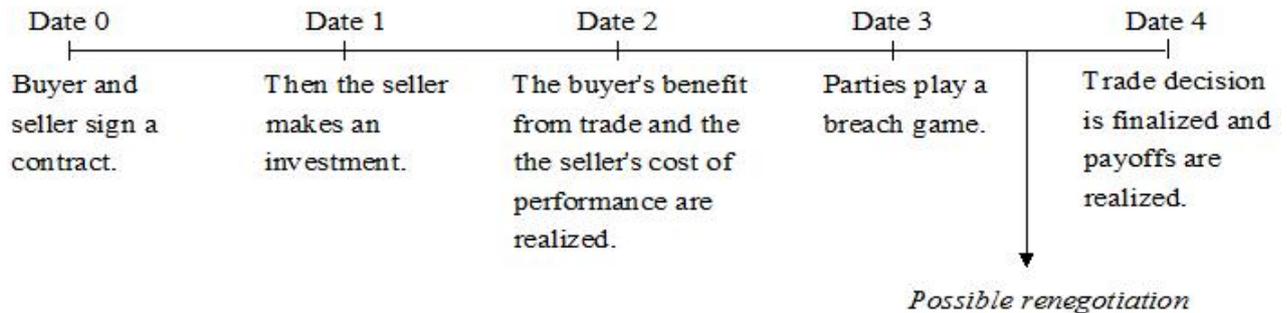


Figure 1: Timeline

As an example, consider the case where an engineering firm develops a new motor for a car manufacturer. In the first stage, the engineering firm invests into know-how and develops a construction plan. The know-how may reduce the costs of production and/or increase the quality of the motor. Once the construction plan is ready, the parties know the costs and benefits which are associated with the motor. Then, they decide whether the motor shall actually be produced or not.

The informational setting of the model depends on the breach remedy under investigation. Under ‘reliance damages’ the court must be able to verify the seller’s investment whereas, under ‘expectation damages’, it must be able to verify the buyer’s valuation and the seller’s variable costs. Note that this information is sufficient to decide whether the quality of the product is below or above threshold level. While the investment may be private information everything else is observable by both parties.

Finally, the following technical assumptions apply throughout:

Assumption 1 $F(\cdot|\cdot)$ and $G(\cdot|\cdot)$ are twice continuously differentiable.

Assumption 2 $F_e(\cdot|e) < 0$ and $F_{ee}(\cdot|e) > 0$ for all $v \in (0, v_h)$ and for all $e \geq 0$.

Assumption 3 $G_e(\cdot|e) > 0$ and $G_{ee}(\cdot|e) < 0$ for all $c \in (c_l, c_h)$ and for all $e \geq 0$.

Assumption 4 $F_e(v|0) = -\infty$ and/or $G_e(c|0) = \infty$

for all v in $(0, v_h)$ and for all c in (c_l, c_h)

Assumption 5 $F_e(v|\infty) = 0$ for all v in $(0, v_h)$ and $G_e(c|\infty) = 0$ for all c in (c_l, c_h)

Assumption 6 $F_{v|c}((v|c)|e) = F_v(v|e)$ and $G_{c|v}((c|v)|e) = G_c(c|e)$ for $c, v \in \mathbb{R}$.

Assumption 2 implies that an increase in e moves the distribution to the right at a decreasing rate in the sense that $F(\cdot|e')$ first-order stochastically dominates $F(\cdot|e)$ for any $e' > e$. In the same way Assumption 3 implies that an increase in e moves the distribution to the left at a decreasing rate in the sense that $G(\cdot|e')$ first-order stochastically dominates $G(\cdot|e)$ for any $e' < e$. Assumptions 4 and 5 ensure an interior solution while Assumption 6 implies that variable costs, c , and the buyer's valuation, v , are stochastically independent. To save notation we assume that the highest possible benefit of the buyer is equal to the highest possible realization of variable cost, $v_h = c_h$.⁷

3 Benchmark

As a benchmark, we consider the socially optimal allocation. A social planner chooses the investment level e^* that maximizes the expected gains from trade conditional on an efficient trade decision, $v \geq c$:

$$e^* \in \arg \max W(e) = \int_{c_l}^{c_h} \int_c^{v_h} (v - c) F_v(v|e) dv G_c(c|e) dc - e. \quad (1)$$

After integrating (1) by parts twice, the efficient investment level, e^* , can be characterized by the following first-order condition:

$$W'(e^*) = \int_{c_l}^{c_h} ([1 - F(c|e^*)] G_e(c|e^*) - F_e(c|e^*) G(c|e^*)) dc - 1 = 0. \quad (2)$$

We assume that $W(e)$ is strictly quasi-concave in e . This ensures that e^* is unique and well defined.

⁷Our main results remain qualitatively the same if this assumption is relaxed.

4 Reliance damages with renegotiations

Che and Chung (1999) show in a setting of purely cooperative investments that there exists a price such that ‘reliance damages’ (henceforth referred to as RD) induce the first best if renegotiation is possible. On the other hand, we know from Shavell (1980) and Rogerson (1984) that ‘reliance damages’ perform rather poorly in an environment of selfish investments, inducing overreliance. This directly leads us to the question how ‘reliance damages’ perform in a hybrid setting which contains aspects of both cooperative and selfish investments. We find that it is not generally possible to extend the result by Che and Chung (1999) to the hybrid case as ‘reliance damages’ may fail to induce the first best regardless of price.⁸ To show this, we analyze the game induced by ‘reliance damages’. Under this remedy, the victim of breach is reimbursed his nonrecoverable reliance expenses. In our context, this implies that the seller is reimbursed his investment if the buyer refuses to accept the good. In the case of reliance damages, a contract specifies a price, p , and potentially some lump sum transfer, t . In order to stay close to the setting studied by Che and Chung (1999), we stick to their assumption that only the buyer can breach the contract. Furthermore, we assume that the parties will always renegotiate towards the ex post efficient trade decision and share the potential renegotiation surplus with the seller receiving a fixed share of $\alpha \in [0, 1]$. When the seller faces his investment decision at date 1, he anticipates both the buyer’s decision at date 3 and the influence of potential renegotiations. If the buyer announces to accept the good, the parties receive their respective trade surpluses, $p - c$ and $v - p$, and share the potential renegotiation surplus with the seller receiving $\alpha[c - v]^+$ where we shall frequently use the notation $[\cdot]^+ = \max[\cdot, 0]$ (see Figure 2).⁹

If the buyer announces to refuse the good, he is obliged to reimburse the seller’s reliance expenditures, e . The parties again share the potential renegotiation surplus with

⁸Since Che and Chung (1999) have already shown that ‘reliance damages’ fail to induce the first best in a setting of purely cooperative investments if renegotiation is not possible, we focus on the case where renegotiations are possible.

⁹ Since the parties renegotiate towards the ex post efficient trade decision, they will thus divide any additional surplus between themselves. We stay in line with Che and Chung (1999) in assuming that they do so at an exogenously given ratio. Our bargaining assumption differs from Rogerson (1984) who implicitly assumes that parties can only renegotiate prior to the buyer’s breach decision. Also Lyon and Rasmusen (2004) and Watson (2007) consider an alternative bargaining set-up.

the seller receiving $\alpha[c - v]^+$.

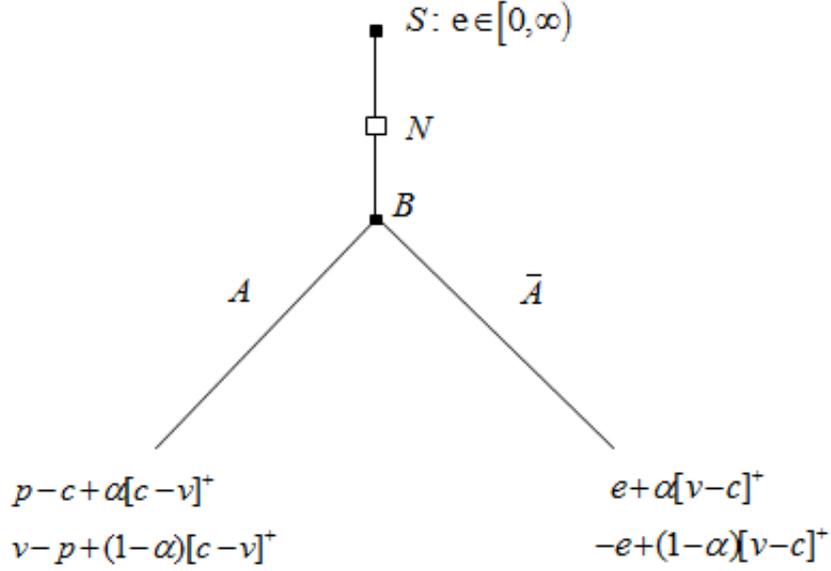


Figure 2: Subgame induced by RD if renegotiations are possible.

Hence, we can conclude that the buyer will announce breach if and only if

$$-e + (1 - \alpha)[v - c]^+ > v - p + (1 - \alpha)[c - v]^+$$

or equivalently

$$v < \hat{v} \equiv \min \left[\frac{p - e - c}{\alpha} + c, v_h \right]. \quad (3)$$

So far the preceding analysis is identical to Che and Chung (1999) with the sole exception that the costs of production are not deterministic in our setting. The intuition behind Che and Chung's (1999) result that there always exists a price which induces first-best investment is fairly straightforward if we consider purely cooperative investments. Clearly a very low price, for example $p = 0$, ensures that the buyer will never announce breach. Anticipating this and that he does not internalize any benefit of his investment, the seller will not invest at all in this case. To be more precise, his payoff decreases in expectation if the seller considers to invest. This is due to the fact that the seller's potential bargaining surplus, $\alpha[c - v]^+$, is decreasing in e and thus his payoff $p - c + \alpha[c - v]^+ - e$ is strictly decreasing in e .

A very high price ensures that the buyer will always announce breach. From an ex ante perspective, the seller is sure to regain his investment and will additionally receive

a renegotiation surplus of $\alpha[v - c]^+$ that is strictly increasing in e . Anticipating this, the seller will invest as much as he can and thus overinvest relative to the efficient level.¹⁰ It is clear that, due to the intermediate value theorem, continuity of the seller's expected payoff function ensures that there must exist an intermediate price that induces first-best investment.

However, this simple intuition fails in a setting of hybrid investments. To see this, first consider the case where the parties specified a very high price. The seller still overinvests because his payoff $\alpha[v - c]^+ + e - e$ is still strictly increasing in e . Yet, if $p = 0$, it does not necessarily remain true that the seller chooses zero investments, as his expected cost of production decreases in e . We can prove the following proposition:

Proposition 1 *Under reliance damages there does not always exist a price inducing first-best hybrid investments.*

Proof: To prove proposition 1, it is sufficient to construct an example where the seller overinvests regardless of price. Here, we consider the simple case where the seller's bargaining power is very small, $\alpha \rightarrow 0$.¹¹ The proof comes in three steps. (i) We derive the investment level that maximizes the seller's expected payoff. (ii) Let $e^{\overline{RD}}$ be the investment level that maximizes the seller's expected payoff for $p = 0$. We can then derive a condition for which $e^{\overline{RD}}$ is higher than the social optimal level, e^* . (iii) We show that the seller never invests less than $e^{\overline{RD}}$ if the contract specifies a positive price. If the condition that is given in the second part of the proof holds, it then directly follows that the seller overinvests regardless of price.

(i) Anticipating the buyer's decision at date 3, the seller, at date 1, expects to receive the following payoff at date 1:

$$\begin{aligned}
 U^{RD}(e) = & \int_{c_l}^{c_h} \int_0^{\hat{v}} (e + \alpha[v - c]^+) F_v(v|e) dv G_c(c|e) dc \\
 & + \int_{c_l}^{c_h} \int_{\hat{v}}^{v_h} (p - c + \alpha[c - v]^+) F_v(v|e) dv G_c(c|e) dc - e.
 \end{aligned} \tag{4}$$

¹⁰Technically speaking, the seller's investment would be arbitrarily close to infinity since Che and Chung (1999) do not impose any wealth constraint but assume $e \in R_0^+$.

¹¹It is not necessary that the seller's bargaining power is marginal, as in our example, to prove that overreliance can occur. However this example allows for a relatively simple intuition compared to cases of larger bargaining powers.

We assume that $U^{RD}(e)$ is strictly quasi-concave in e for all p to ensure that there exists a unique equilibrium investment level. Let $\tilde{v} \equiv \frac{p-e-c_h}{\alpha} + c_h$ and $\hat{c} \equiv \frac{p-e-\alpha v_h}{1-\alpha}$ where \hat{c} is defined such that $c \leq \hat{c}$ implies $\hat{v} = v_h$ and $c \geq \hat{c}$ implies $\hat{v} = \frac{p-e-c}{\alpha} + c$ (see expression 3). Twice integrating by parts and reorganizing we can rewrite (4) as follows:¹²

$$\begin{aligned}
U^{RD}(e) &= p - e - c_h - \alpha \int_{c_h}^{\tilde{v}} F(v|e) + \int_{c_l}^{c_h} G(c|e) dc \\
&\quad - \alpha \int_{c_l}^{c_h} F(c|e)G(c|e) dc - (1 - \alpha) \int_{\hat{c}}^{c_h} F(\hat{v}|e)G(c|e) dc \\
&\quad - (1 - \alpha) \int_{c_l}^{\hat{c}} G(c|e) dc. \tag{5}
\end{aligned}$$

Hence, the investment level e^{RD} that maximizes the seller's expected payoff is given by the following first-order condition:

$$\begin{aligned}
U_e^{RD}(e^{RD}) &= F(\tilde{v}|e^{RD}) - \alpha \int_{c_h}^{\tilde{v}} F_e(v|e^{RD}) dv + \int_{c_l}^{c_h} G_e(c|e^{RD}) dc \\
&\quad - \alpha \int_{c_l}^{c_h} [F_e(c|e^{RD})G(c|e^{RD}) + F(c|e^{RD})G_e(c|e^{RD})] dc \\
&\quad - (1 - \alpha) \int_{\hat{c}}^{c_h} [F_e(\hat{v}|e^{RD}) - \frac{1}{\alpha} F_v(\hat{v}|e^{RD})] G(c|e^{RD}) dc \\
&\quad - (1 - \alpha) \int_{\hat{c}}^{c_h} F(\hat{v}|e^{RD})G_e(c|e^{RD}) dc + [1 - F(\hat{v}|e^{RD})]G(\hat{c}|e^{RD}) \\
&\quad - (1 - \alpha) \int_{c_l}^{\hat{c}} G_e(c|e^{RD}) dc - 1 = 0. \tag{6}
\end{aligned}$$

(ii) To show that overinvestment relative to the socially optimal level can arise for $p = 0$, consider the case where the seller's bargaining power is very small, $\alpha \rightarrow 0$. Inserting $p = 0$ into (6) yields:

$$\begin{aligned}
U_e^{RD}(e^{\overline{RD}}) &= \alpha \int_{\tilde{v}}^{c_h} F_e(v|e^{\overline{RD}}) dv + \int_{c_l}^{c_h} G_e(c|e^{\overline{RD}}) dc \\
&\quad - \alpha \int_{c_l}^{c_h} [F_e(c|e^{\overline{RD}})G(c|e^{\overline{RD}}) + F(c|e^{\overline{RD}})G_e(c|e^{\overline{RD}})] dc - 1 = 0 \tag{7}
\end{aligned}$$

and the limit as α goes to zero is given by:

$$\lim_{\alpha \rightarrow 0} U_e^{RD}(e^{\overline{RD}}) = \int_{c_l}^{c_h} G_e(c|e^{\overline{RD}}) dc - 1 = 0. \tag{8}$$

It is clear that $e^{\overline{RD}} > e^*$ if the first derivative of the expected social welfare function (2)

¹²See Appendix 7.1 for omitted intermediate steps.

evaluated at $e^{\overline{RD}}$ is negative:¹³

$$\begin{aligned} W'(\bar{e}) &= \int_{c_l}^{c_h} ([1 - F(c|e^{\overline{RD}})]G_e(c|e^{\overline{RD}}) - F_e(c|e^{\overline{RD}})G(c|e^{\overline{RD}})) dc - 1 < 0 \\ &\iff - \int_{c_l}^{c_h} [F(c|e^{\overline{RD}})G_e(c|e^{\overline{RD}}) + F_e(c|e^{\overline{RD}})G(c|e^{\overline{RD}})] dc < 0. \end{aligned} \quad (9)$$

This is indeed the case for those parameter constellations where the first negative term in the second line of (9) is larger in absolute value than the second, positive, term or if the selfish effect of investment is strong relative to the cooperative effect, $G_e(c|e^{\overline{RD}}) \gg -F_e(c|e^{\overline{RD}})$.

(iii) In appendix 7.2 we show that the seller will invest at least $e^{\overline{RD}}$ if a positive price has been specified in contract. ■

Even though the proof of proposition 1 is tedious, the intuition behind it is straightforward. To get an intuition about condition (9), consider the case where the seller's investment level only has marginal influence on the realization of the quality of the good. It's then clear that the expected decrease of the cost of production must be the driving factor that determines the optimal investment from a social point of view. Compared to the benchmark, the seller has an incentive to overinvest because he internalizes the cost-decreasing effect of his investment not only for $v \geq c$ but regardless of the quality of the good. The intuition behind our result that a positive price will lead the seller to invest at least as much as $e^{\overline{RD}}$, the investment level induced by $p = 0$, stems from the fact that an increased price yields an increased probability that the buyer will announce breach.¹⁴ If the seller was sure the buyer would announce not to accept the good, he would ex ante expect a payoff of $\alpha[v - c]^+ + e - e$ that would induce an investment level arbitrarily close to infinity. If the seller is with positive probability in a situation where it would be optimal for him to invest arbitrarily close to infinity, it is clear that he has no incentive to invest less than if he was sure to end up on the left side of the tree depicted in figure 2. A non-general explanation that is specific to our example, $\alpha \rightarrow 0$, is that the buyer minimizes the seller's payoff at date 3.¹⁵ Hence from an ex ante perspective

¹³Strict quasi-concavity of $W(e)$ in e ensures that the following argument is valid.

¹⁴If the price is smaller than c_l , the buyer will still always announce breach. Then the seller invests the same amount as if a $p = 0$ had been specified in contract.

¹⁵The buyer announces breach if $p - e - c > 0$, effectively minimizing the seller's payoff apart from the

the seller has an incentive to maximize the minimum of $p - e - c$ and $\alpha(v - c)$.¹⁶ Now it's clear that the seller has no incentive to invest $e < e^{\overline{RD}}$ since he would be worse off regardless of the buyer's decision compared to an investment of $e^{\overline{RD}}$.¹⁷

Our result shows that the efficiency result that Che and Chung (1999) have derived for reliance damages in an purely cooperative environment cannot be generalized to hybrid investments. As we will see in the next section, the efficiency result derived in Stremitzer (2008) for expectation damages with a quality threshold, in a setting of purely cooperative investments, can in contrast be extended to hybrid investments.

5 Expectation damages

5.1 Expectation damages without renegotiations

In contrast to reliance damages, where it is hopeless to achieve the ex-post efficient allocation without the possibility of renegotiation, we will consider the case without renegotiation for 'expectation damages'. This is because the well known standard result that 'expectation damages' induce an ex-post efficient trade decision,¹⁸ yields the prospect that 'expectation damages' can achieve the first best solution even if renegotiation can be ruled out. In this section, we analyze how a simple contract in which the parties stipulate the price and the required quality of the good to be traded, $[p, \bar{v}]$, interacts with 'expectation damages' (henceforth referred to as ED), the default contractual remedy of common law. Under expectation damages, the victim of breach has to be compensated such that he is made whole, i.e. in terms of utility he shall be in the same position as if the breaching party had performed in accordance with the contract. Assuming the buyer will never refuse delivery,¹⁹ the seller faces the following decision:

very small bargaining surplus.

¹⁶Even if α is very small, $\alpha(v - c) + e - e$ is maximized by an e arbitrarily close to infinity, thus we cannot neglect the alpha term on the right side of the tree in figure 2 whereas we can neglect it on the left side.

¹⁷The seller would be worse off since $e^{\overline{RD}}$ maximizes the seller's expected payoff if he was sure to end up on the left side of the tree depicted in figure 2 and thus he must be worse off if he invests $e < e^{\overline{RD}}$. Moreover, since the seller's expected payoff if he was sure to end up on the right side of the tree depicted in figure 2 is strictly increasing in e , he must again be worse off if he invests $e < e^{\overline{RD}}$.

¹⁸see e.g. Shavell, 1980; Posner, 1977

¹⁹We show in Appendix 7.3 that this simplifying assumption does not change the analysis of this and the following subsection.

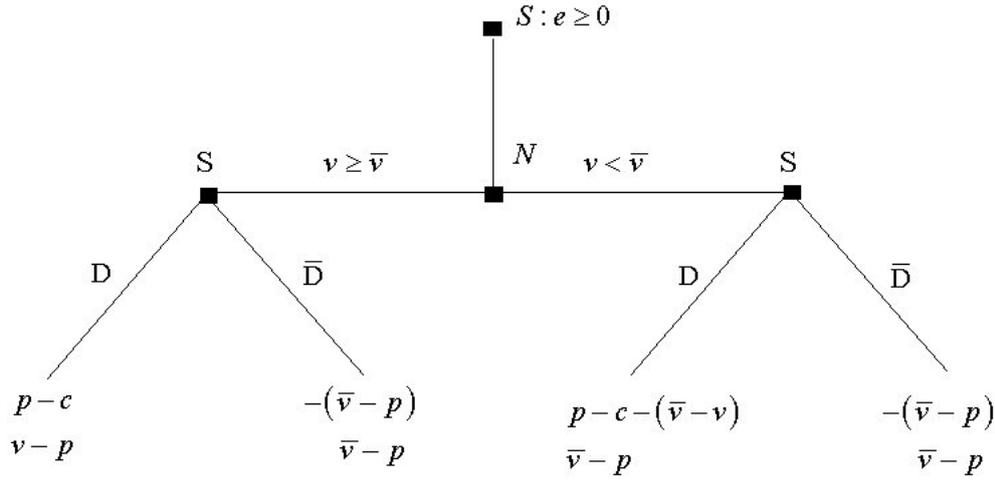


Figure 3: Subgame induced by ED starting with the seller's investment decision.

If he decides to deliver the good, he receives the trade price but has to incur the costs of production. Hence he receives a trade surplus of $p - c$ if he delivers. (Figure 3 depicts the subgame starting with the seller's investment decision induced by the ED remedy.) Moreover, he has to compensate the buyer if the quality of the good turned out to be below the threshold, that has been specified in contract, $v < \bar{v}$. Then, he has to pay damages amounting to $\bar{v} - v$. If he announces not to deliver, and assuming $\bar{v} \geq p$,²⁰ he has to pay damages amounting to $\bar{v} - p$ in any case. The seller's optimal decision at date 3, contingent on the realization of v and c , is described below.

If the buyer's valuation turns out to be above the threshold, $v \geq \bar{v}$, the seller will deliver if and only if $p - c > -(\bar{v} - p)$ or equivalently $c < \bar{v}$. If $v < \bar{v}$, the seller will deliver if and only if $p - c - (\bar{v} - v) > -(\bar{v} - p)$ or equivalently $c < v$. We can prove the following proposition:

Proposition 2 *If the parties specify a threshold below the highest possible realization of the buyer's benefit from trade, $\bar{v} < v_h$, expectation damages fail to induce ex-post efficient trade.*

Proof. Consider the situation where the buyer's valuation turned out to be above the threshold. Then, the seller will not deliver if $c > \bar{v}$. However this is not efficient if $v > c$.

²⁰As a matter of real world contracting, $p < \bar{v}$ seems to be a natural assumption, as courts tend to set \bar{v} higher as the price increases. Note that $\bar{v} < p$ would imply that the seller does not has to pay any damages if he decides not to deliver.

If $\bar{v} \geq c_h = v_h$, this inefficiency cannot occur. ■

This proposition yields a surprising result as it is commonly seen to be one of the main virtues of expectation damages to induce the ex-post efficient breach decision.²¹

Using the analysis of the seller's optimal decision at date 3, we can conclude that the seller expects the following payoff at date 1:

$$\begin{aligned}
U^{ED}(e) &= \int_{c_l}^{\bar{v}} \int_{\bar{v}}^{v_h} (p - c) F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{c_l}^{\bar{v}} \int_c^{\bar{v}} [(p - c) - (\bar{v} - v)] F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{c_l}^{\bar{v}} \int_0^c -(\bar{v} - p) F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{\bar{v}}^{c_h} \int_0^{v_h} -(\bar{v} - p) F_v(v|e) dv G_c(c|e) dc - e. \tag{10}
\end{aligned}$$

Integrating by parts and reorganizing allows us to simplify (10):

$$U^{ED}(e) = p - \bar{v} - e + \int_{c_l}^{\bar{v}} [1 - F(c|e)] G(c|e) dc.$$

The seller's optimal investment level, e^{ED} is characterized by the following FOC:

$$U'^{ED}(e^{ED}) = \int_{c_l}^{\bar{v}} ([1 - F(c|e^{ED})] G_e(c|e^{ED}) - F_e(c|e^{ED}) G(c|e^{ED})) dc - 1 = 0. \tag{11}$$

We can derive the following proposition:

Proposition 3 *If renegotiation is impossible and parties set the quality specification sufficiently high, $\bar{v} \geq c_h$, expectation damages implement the first best.*

Proof. That expectation damages induce the first best if the parties specify a threshold that is at least as high as the highest possible level of variable costs, $\bar{v} \geq c_h = v_h$, directly follows from comparing expression (11) with the benchmark (2). Note that $\bar{v} \geq c_h$ ensures that (11) and (2) are identical and that the seller's delivery decision is efficient. ■

²¹If we relax the assumption $v_h = c_h$ and instead assume $v_h \geq c_h$, the parties could, in a second best solution, specify a threshold between the highest possible realization of costs and the highest possible valuation of the buyer, $\bar{v} \in [c_h, v_h]$. Then, the delivery decision is efficient but the seller will underinvest relative to the efficient level because the valuation of the buyer may turn out to be above threshold.

The straightforward intuition behind proposition 3 is that the seller is made a residual claimant. If $\bar{v} \geq c_h$, he receives the entire trade surplus minus a constant term $-(\bar{v} - p)$. The first best can be achieved since the seller internalizes the full benefit from his investment and because $\bar{v} \geq c_h$ ensures that his delivery decision is efficient. Note that our first-best result holds even if the seller's expected payoff function, $U^{ED}(e)$, is not strictly quasi-concave in e for all \bar{v} . To be able to derive what happens outside the first best, we have to impose stronger assumptions on the curvature of the seller's expected payoff function. We can then prove the following proposition:

Proposition 4 (i) *If the contract specifies a low quality level, $\bar{v} < c_h$, and U^{ED} is strictly quasi-concave in e for all \bar{v} , it can be shown that underinvestment will be the norm.* (ii) *If U^{ED} is strictly concave in e for all \bar{v} investment incentives rise in the level of required quality.*

Proof. (i) To see that underinvestment will be the norm recall that $U^{ED}(e^*) = 0$ if $\bar{v} = c_h$. Fixing $e = e^*$, we consider $U^{ED}(\cdot)$ as a function of \bar{v} . The seller has lower investment incentives relative to the socially optimal level if $U^{ED}(\bar{v}) < 0$ for all $\bar{v} < c_h$ ²² or equivalently

$$\begin{aligned} U^{ED}(\bar{v}) &= \int_{c_l}^{\bar{v}} ([1 - F(c|e^*)] G_e(c|e^*) - F_e(c|e^*) G(c|e^*)) dc - 1 \\ &= \int_{c_l}^{c_h} ([1 - F(c|e^*)] G_e(c|e^*) - F_e(c|e^*) G(c|e^*)) dc - 1 \\ &\quad - \int_{\bar{v}}^{c_h} ([1 - F(c|e^*)] G_e(c|e^*) - F_e(c|e^*) G(c|e^*)) dc < 0 \quad \forall \bar{v} < c_h. \end{aligned} \quad (12)$$

We can conclude that $U^{ED}(\bar{v}) < 0$ for all $\bar{v} < c_h$ because the term in the second line of (12) is equal to zero whereas the term in the third line must be negative due to assumptions 2 and 3.

(ii) If $U^{ED}(e)$ is strictly concave in e for all \bar{v} , investment incentives rise in the level of required quality. To see this note that investment incentives rise in threshold if

$$\frac{dU^{ED}}{d\bar{v}} = - \frac{\{[1 - F(\bar{v}|e^{ED})]G_e(\bar{v}|e^{ED}) - F_e(\bar{v}|e^{ED})G(\bar{v}|e^{ED})\} dc}{\int_{c_l}^{\bar{v}} \{[1 - F(c|e)]G_{ee}(c|e) - F_{ee}(c|e)G(c|e) - 2F_e(c|e)G_e(c|e)\} dc} > 0. \quad (13)$$

²²Strict quasi-concavity of U^{ED} in e for all \bar{v} ensures that U^{ED} is single peaked and hence the following argument is valid. Note that strict quasi-concavity is a common assumption to ensure a unique equilibrium level.

The numerator of (13) must be positive due to assumptions 2 and 3. Strict concavity implies that the denominator of (13) must be negative. This is the case because the denominator of (13) is equal to U''^{ED} . Hence we can conclude that $\frac{de^{ED}}{d\bar{v}} > 0$. ■

The intuition behind the fourth proposition can be explained as follows. First, if the product is conforming to the contract, $v \geq \bar{v}$, and the seller decides to deliver, he will receive a trade surplus of $p - c$. Here, he does not internalize the full benefit of his investment because he only takes the cost-reduction effect of his investment into account but not the value-increasing effect. If $v > c > \bar{v}$, it's optimal for the seller not to deliver even though it would be efficient to do so. In this case, the seller does not internalize any benefit from his investment. Second, if the product is non-conforming to the contract, we have already discussed that the seller is a residual claimant. We can thus conclude that underinvestment must be the norm.

Our result extends Stremitzer (2008), who has shown that expectation damages can lead to the efficient outcome, for purely cooperative investments to the case of hybrid investments. Moreover, the contract that induces first-best investments, in our model, can be interpreted to be a cadillac contract (see Edlin, 1996) because it specifies a quality threshold that cannot be met with positive probability. Cadillac contracts can be seen as a useful device to protect the parties against potential holdup problems as they occur in Che and Chung (1999) who assume that the parties do not specify any quality threshold at all. Our first-best result yields another desirable property. The parties do not need lump sum transfers to divide the ex ante expected gains from trade but can use the price as an instrument to do so. In the next section we will confirm the first-best result in a situation where renegotiations are possible and show that renegotiations can, under certain conditions, even improve investment incentives.

5.2 Expectation damages with renegotiations

As before, we are going to assume throughout that renegotiations are costless and may take place anywhere between date 3 and date 4 and that the parties split a potential renegotiation surplus with the seller receiving a fixed share $\alpha \in [0, 1]$. If renegotiations

are possible, the parties will use the payoffs they would receive without renegotiation as a threat point in renegotiations. Consequently the payoffs in Figure 3 must be adjusted such that the potential effect of renegotiation is taken into account (Figure 4).

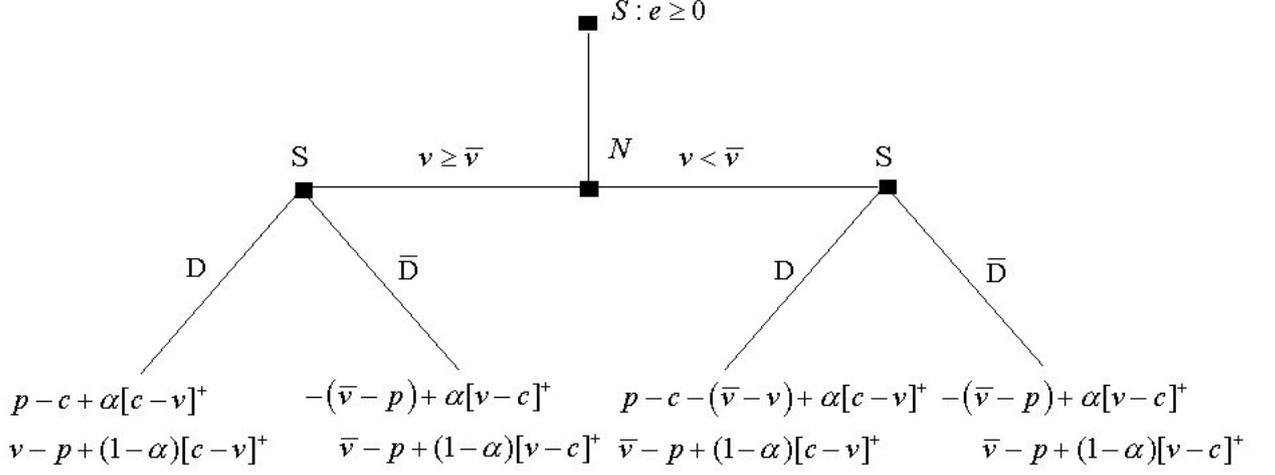


Figure 4: Subgame induced by ED if renegotiations are possible.

The seller's optimal decision at date 3, contingent on the realization of v and c , is being described below.

Case $c \leq \bar{v}$. If $v < \bar{v}$, the seller will announce to deliver if $v > c$. Hence renegotiations have no value and the payoffs are the same as in the case without renegotiations. If $v > \bar{v}$ the seller will announce to deliver if $p - c + \alpha[c - v]^+ \geq -(\bar{v} - p) + \alpha[v - c]^+$ or equivalently $v \in [\bar{v}, \frac{\bar{v} - c}{\alpha} + c \equiv x(\bar{v})]$. He will receive $p - c$ if he announces to deliver and $-(\bar{v} - p) + \alpha(v - c)$ if not.

Case $c > \bar{v}$. If $v < \bar{v}$, we can conclude $c > \bar{v} > v$. Hence the seller will announce not to deliver and receive $-(\bar{v} - p)$. If $v \geq \bar{v}$, the seller will announce to deliver if $p - c + \alpha[c - v]^+ \geq -(\bar{v} - p) + \alpha[v - c]^+$ or equivalently $\bar{v} - c \geq \alpha(v - c)$. Since $c > \bar{v}$ we can conclude that the seller will announce not to deliver. He will receive $-(\bar{v} - p)$ and an additional renegotiation surplus of $\alpha(v - c)$ if $v > c$.

We can conclude that the seller expects the following payoff at date 1:

$$\begin{aligned}
U^{RED}(e) &= \int_{c_l}^{\bar{v}} \int_0^c -(\bar{v} - p) F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{c_l}^{\bar{v}} \int_c^{\bar{v}} [p - c - (\bar{v} - v)] F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{c_l}^{\bar{v}} \int_{\bar{v}}^{x(\bar{v})} [(p - c)] F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{c_l}^{\bar{v}} \int_{x(\bar{v})}^{v_h} -(\bar{v} - p + \alpha(v - c)) F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{\bar{v}}^{c_h} \int_0^c -(\bar{v} - p) F_v(v|e) dv G_c(c|e) dc \\
&+ \int_{\bar{v}}^{c_h} \int_c^{v_h} [-(\bar{v} - p) + \alpha(v - c)] F_v(v|e) dv G_c(c|e) dc - e. \tag{14}
\end{aligned}$$

We assume that $U^{RED}(e)$ is strictly concave in e for all \bar{v} to ensure that there exists a unique equilibrium investment level. After integrating by parts twice and reorganizing (14) simplifies to:

$$\begin{aligned}
U^{RED}(e) &= p - \bar{v} - e + \int_{c_l}^{\bar{v}} [\alpha - F(c|e) + (1 - \alpha)F(x(\bar{v})|e)]G(c|e) dc \\
&+ \alpha \int_{\bar{v}}^{v_h} [(1 - F(c|e))]G(c|e) dc. \tag{15}
\end{aligned}$$

The seller's optimal investment level, e^{RED} , is characterized by the following first order condition:

$$\begin{aligned}
U'^{RED}(e) &= \int_{c_l}^{\bar{v}} [\alpha - F(c|e^{RED}) + (1 - \alpha)F(x(\bar{v})|e^{RED})]G_e(c|e^{RED}) dc \\
&- \int_{c_l}^{\bar{v}} [\alpha F_e(x(\bar{v})|e^{RED}) + F_e(c|e^{RED})]G(c|e^{RED}) dc \\
&+ \alpha \int_{\bar{v}}^{v_h} [1 - F(c|e^{RED})]G_e(c|e^{RED})dc - \alpha \int_{\bar{v}}^{v_h} F_e(c|e^{RED})G(c|e^{RED}) dc - 1 = 0. \tag{16}
\end{aligned}$$

We will derive the following proposition:

Proposition 5 *If renegotiations are possible, Cadillac contracts still achieve the first best.*

Proof. To show that cadillac contracts still achieve the first best, we insert $\bar{v} = c_h$ into (16):

$$U'^{RED}(e^{RED}) = \int_{c_l}^{c_h} ([1 - F(c|e^{RED})] G_e(c|e^{RED}) - F_e(c|e^{RED}) G(c|e^{RED})) dc - 1 = 0. \tag{17}$$

Notice that $F(x(\bar{v} = c_h)|e) = 1$ and $F_e(x(\bar{v} = c_h)|e) = 0$. Hence a Cadillac contract that specifies $\bar{v} = c_h = v_h$ achieves first best. ■

The intuition behind proposition 5 is the following. Cadillac contracts that specify $\bar{v} \geq c_h$ still achieve the first best because the delivery decision is efficient and the seller internalizes the full benefits of his investments. Hence renegotiation has no value if the parties specify a Cadillac contract.

We have shown that in contrast to reliance damages expectation damages with a quality threshold can achieve the first best in a hybrid setting regardless if renegotiation is possible or not. Moreover we have shown that renegotiations are beneficial if the parties specify a sufficiently high threshold.

6 Conclusion

It is reassuring that expectation damages, the default remedy of common law, not only perform well in a setting of purely cooperative investments but also in the hybrid case. Indeed, the *same* Cadillac contract which achieves the first best in the purely cooperative setting will also achieve the first best in the hybrid case. Under reliance damages, on the other hand, parties must fine-tune the contract price, stipulate up-front payments, and rely on renegotiation. Even then, as we have shown, they may not be able to achieve the first best if investments are sufficiently selfish. Our analysis therefore suggests that parties should think twice before opting out of default expectation damages for privately stipulated reliance damages as was recommended by Che and Chung (1999). This could only be justified for informational reasons as it might be easier, in certain situations, to enforce reliance damages which require the verifiability of investments than expectation damages which require the court to be able to form an unbiased estimate of the buyer's valuation for the good.

A more troubling result regarding the performance of expectation damages is that the conventional wisdom that this remedy automatically induces the ex-post efficient trade decision does not generally hold in the presence of cooperative investments. Indeed efficient breach is only ensured if parties set the quality threshold sufficiently high. Otherwise

they would have to rely on renegotiation to achieve the ex-post efficient allocation.

Finally, our analysis illustrates a subtle difference between a mechanism design and the economic analysis of real world institutions. As we have already mentioned, the enforcement of reliance damages requires investment to be verifiable. Then, however, parties should theoretically be able to achieve the first best (e.g. by writing a forcing contract in which they stipulate the efficient investment level). Yet, we show that this does not necessarily imply that reliance damages induce the first best. Indeed, the issue is *not* whether the information required to operate an institution is in theory sufficient to achieve the first best. It is about how institutions make use of that information. Therefore both Che and Chung (1999) and Schweizer (2006) prove interesting results although, by requiring investment to be verifiable, their insights are not surprising from the perspective of contract theory.

7 Appendix

7.1 Proof of Proposition 1, Part (i)

If the buyer announces to accept the good, the parties receive their respective trade surpluses, $p - c$ and $v - p$, and share the potential renegotiation surplus with the seller receiving $\alpha[c - v]^+$. If the buyer announces to refuse the good, the seller's investment serves as a threatpoint in renegotiations. The parties share a potential renegotiation surplus with the seller receiving $\alpha[v - c]^+$. Hence we can conclude that the buyer will announce breach if

$$-e + (1 - \alpha)[v - c]^+ > v - p + (1 - \alpha)[c - v]^+$$

or equivalently

$$v < \hat{v} \equiv \min \left[\frac{p - e - c}{\alpha} + c, v_h \right]. \quad (3)$$

Anticipating this, the seller expects to receive the following payoff at date 1:

$$\begin{aligned} U^{RD}(e) &= \int_{c_l}^{c_h} \int_0^{\hat{v}} (e + \alpha[v - c]^+) F_v(v|e) dv G_c(c|e) dc \\ &\quad + \int_{c_l}^{c_h} \int_{\hat{v}}^{v_h} (p - c + \alpha[c - v]^+) F_v(v|e) dv G_c(c|e) dc - e \end{aligned} \quad (4)$$

or equivalently

$$\begin{aligned} U^{RD}(e) &= \int_{c_l}^{c_h} \{ [p - e - c][1 - F(\hat{v}|e)] + \alpha \int_0^{\hat{v}} [v - c]^+ F_v(v|e) dv \\ &\quad + \alpha \int_{\hat{v}}^{v_h} [c - v]^+ F_v(v|e) dv \} G_c(c|e) dc. \end{aligned} \quad (4.1)$$

The term inside $\{...\}$ can be rewritten as

$$\begin{aligned} &\alpha \int_0^{\hat{v}} [v - c]^+ F_v(v|e) dv + \alpha \int_0^{v_h} [c - v]^+ F_v(v|e) dv \\ &\quad - \alpha \int_0^{\hat{v}} [c - v]^+ F_v(v|e) dv + [p - e - c][1 - F(\hat{v}|e)] \end{aligned}$$

or

$$\alpha \int_0^{\hat{v}} (v - c) F_v(v|e) dv + \alpha \int_0^{v_h} [c - v]^+ F_v(v|e) dv + [p - e - c][1 - F(\hat{v}|e)]$$

or

$$\alpha \int_0^{\hat{v}} \alpha (v - c) F_v(v|e) dv - \alpha \int_0^c (v - c) F_v(v|e) dv + [p - e - c][1 - F(\hat{v}|e)]$$

or

$$\alpha \int_c^{\hat{v}} (v - c) F_v(v|e) dv + [p - e - c][1 - F(\hat{v}|e)]$$

or partially integrating:

$$\alpha(\hat{v} - c)F(\hat{v}|e) - \alpha \int_c^{\hat{v}} F(v|e) dv + [p - e - c][1 - F(\hat{v}|e)]. \quad (4.1.1)$$

Using (4.1.1) we can rewrite (4.1):

$$\begin{aligned} U^{RD}(e) &= \int_{c_l}^{c_h} \{[p - e - c][1 - F(\hat{v}|e)] + \alpha(\hat{v} - c)F(\hat{v}|e) - \alpha \int_c^{\hat{v}} F(v|e) dv\} G_c(c|e) dc \\ &= \int_{c_l}^{c_h} \{p - e - c + F(\hat{v}|e) \alpha[\hat{v} - (\frac{p - e - c}{\alpha} + c)] - \alpha \int_c^{\hat{v}} F(v|e) dv\} G_c(c|e) dc \end{aligned} \quad (4.2)$$

or partially integrating:

$$\begin{aligned} U^{RD}(e) &= [\{p - e - c - \alpha \int_c^{\hat{v}} F(v|e) dv\} G(c|e)]_{c_l}^{c_h} + \int_{c_l}^{c_h} G(c|e) dc \\ &\quad - \alpha \int_{c_l}^{c_h} F(c|e) G(c|e) dc + \alpha \int_{c_l}^{c_h} \frac{d\hat{v}}{dc} F(\hat{v}|e) G(c|e) dc \\ &\quad + \int_{c_l}^{c_h} F(\hat{v}|e) \alpha[\hat{v} - (\frac{p - e - c}{\alpha} + c)] G_c(c|e) dc. \end{aligned} \quad (4.3)$$

In an intermediate step we simplify the term in the last line of (4.3)

$$\int_{c_l}^{c_h} F(\hat{v}|e) \alpha[\hat{v} - (\frac{p - e - c}{\alpha} + c)] G_c(c|e) dc \quad (4.3.1)$$

First we define $\hat{c} \equiv \frac{p - e - \alpha v_h}{1 - \alpha}$. Note that $c < \hat{c}$ implies $\hat{v} = v_h$ whereas $c > \hat{c}$ implies $\hat{v} = \frac{p - e - c}{\alpha} + c$. In the latter case (4.3.1) is equal to zero. Taking this into account we can rewrite (4.3.1) as

$$\begin{aligned} &\int_{c_l}^{\hat{c}} [\alpha v_h - p + e + (1 - \alpha)c] G_c(c|e) dc \\ &= (1 - \alpha) \int_{c_l}^{\hat{c}} [\frac{\alpha v_h - p + e}{1 - \alpha} + c] G_c(c|e) dc \\ &= (1 - \alpha) \int_{c_l}^{\hat{c}} (c - \hat{c}) G_c(c|e) dc \end{aligned} \quad (4.3.2)$$

Using (4.3.2) we can rewrite (4.3):

$$\begin{aligned} U^{RD}(e) &= [\{p - e - c - \alpha \int_c^{\hat{v}} F(v|e) dv\} G(c|e)]_{c_l}^{c_h} + \int_{c_l}^{c_h} G(c|e) dc \\ &\quad - \alpha \int_{c_l}^{c_h} F(c|e) G(c|e) dc + \alpha \int_{c_l}^{c_h} \frac{d\hat{v}}{dc} F(\hat{v}|e) G(c|e) dc \\ &\quad + (1 - \alpha) \int_{c_l}^{\hat{c}} (c - \hat{c}) G_c(c|e) dc \end{aligned} \quad (4.4)$$

Let $\tilde{v} \equiv \frac{p-e-c_h}{\alpha} + c_h$ and note that $\frac{d\hat{v}}{dc} = 0$ if $c < \hat{c}$. Then we can rewrite (4.4):

$$\begin{aligned}
U^{RD}(e) &= p - e - c_h - \alpha \int_{c_h}^{\tilde{v}} F(v|e) + \int_{c_l}^{c_h} G(c|e) dc \\
&\quad - \alpha \int_{c_l}^{c_h} F(c|e)G(c|e) dc - (1 - \alpha) \int_{\hat{c}}^{c_h} F(\hat{v}|e)G(c|e) dc \\
&\quad + (1 - \alpha) \{ [(c - \hat{c})G(c|e)]_{c_l}^{\hat{c}} - \int_{c_l}^{\hat{c}} G(c|e) dc \} \\
&= p - e - c_h - \alpha \int_{c_h}^{\tilde{v}} F(v|e) + \int_{c_l}^{c_h} G(c|e) dc \\
&\quad - \alpha \int_{c_l}^{c_h} F(c|e)G(c|e) dc - (1 - \alpha) \int_{\hat{c}}^{c_h} F(\hat{v}|e)G(c|e) dc \\
&\quad - (1 - \alpha) \int_{c_l}^{\hat{c}} G(c|e) dc \tag{5}
\end{aligned}$$

Then, the seller's optimal investment level, e^{RD} , is represented by the following first-order condition:

$$\begin{aligned}
U_e^{RD}(e^{RD}) &= F(\tilde{v}|e^{RD}) - \alpha \int_{c_h}^{\tilde{v}} F_e(v|e^{RD}) dv + \int_{c_l}^{c_h} G_e(c|e^{RD}) dc \\
&\quad - \alpha \int_{c_l}^{c_h} [F_e(c|e^{RD})G(c|e^{RD}) + F(c|e^{RD})G_e(c|e^{RD})] dc \\
&\quad - (1 - \alpha) \int_{\hat{c}}^{c_h} [F_e(\hat{v}|e^{RD}) - \frac{1}{\alpha} F_v(\hat{v}|e^{RD})] G(c|e^{RD}) dc \\
&\quad - (1 - \alpha) \int_{\hat{c}}^{c_h} F(\hat{v}|e^{RD})G_e(c|e^{RD}) dc + [1 - F(\hat{v}|e^{RD})]G(\hat{c}|e^{RD}) \\
&\quad - (1 - \alpha) \int_{c_l}^{\hat{c}} G_e(c|e^{RD}) dc - 1 = 0. \tag{6}
\end{aligned}$$

7.2 Proof of Proposition 1, Part (iii)

We have already discussed in the main text that, if condition (9) holds, the seller overinvests if $p = 0$ has been specified in contract. What remains to be shown is that the seller will not invest less than $e^{\overline{RD}}$, if a positive price has been specified in contract. To show

this, we consider the limit of (6) as α goes to zero:

$$\begin{aligned}
\lim_{\alpha \rightarrow 0} U'^{RD}(e^{RD}) &= F(\tilde{v}|e^{RD}) + \int_{c_l}^{c_h} G_e(c|e^{RD}) dc \\
&\quad - \int_{\hat{c}}^{c_h} [F_e(\hat{v}|e^{RD}) - \infty F_v(\hat{v}|e^{RD})] G(c|e^{RD}) dc \\
&\quad - \int_{\hat{c}}^{c_h} F(\hat{v}|e^{RD}) G_e(c|e^{RD}) dc + [1 - F(\hat{v}|e^{RD})] G(\hat{c}|e^{RD}) \\
&\quad - \int_{c_l}^{\hat{c}} G_e(c|e^{RD}) dc - 1 = 0.
\end{aligned} \tag{A.1}$$

Fixing $e = e^{\overline{RD}}$, the seller will invest at least $e^{\overline{RD}}$ if $U'^{RD}(p) \geq 0$ for all $p > 0$.²³ After reorganizing, $U'^{RD}(p) \geq 0$ for all $p > 0$ is equivalent to the following condition:

$$\begin{aligned}
\lim_{\alpha \rightarrow 0} U'^{RD}(p) &= F(\tilde{v}|e^{\overline{RD}}) + [1 - F(\hat{v}|e^{\overline{RD}})] G(\hat{c}|e^{\overline{RD}}) \\
&\quad - \int_{\hat{c}}^{c_h} [F_e(\hat{v}|e^{\overline{RD}}) - \infty F_v(\hat{v}|e^{\overline{RD}})] G(c|e^{\overline{RD}}) dc \\
&\quad + \int_{\hat{c}}^{c_h} [1 - F(\hat{v}|e^{\overline{RD}})] G_e(c|e^{\overline{RD}}) dc \geq 1 \quad \forall p > 0.
\end{aligned} \tag{A.2}$$

Recall that $c \geq \hat{c}$ implies $\hat{v} = \frac{p-e-c}{\alpha} + c \leq v_h$. Then, the term in the second line makes sure that condition (A.2) holds unless $\hat{v} \leq 0$ or $\hat{c} \geq c_h$. In the latter two cases, the term in the second line is equal to zero. Hence what is left is to show that condition (A.2) holds if $\hat{v} \leq 0$ or $\hat{c} \geq c_h$. We can conclude that $\hat{v} \leq 0$ implies:

$$\frac{p - e^{\overline{RD}} - c}{\alpha} + c \leq 0 \tag{A.3}$$

Since we consider $\lim_{\alpha \rightarrow 0}$, (A.3) is equivalent to

$$p - e^{\overline{RD}} - c < 0 \Leftrightarrow p - e^{\overline{RD}} \leq c. \tag{A.4}$$

Since (A.4) must hold for all c and $\lim_{\alpha \rightarrow 0} \hat{c} = p - e$, $\hat{c} \leq c_l$ must be true. Then the last term of (A.2) is equal to 1 and because the other terms are all nonnegative, condition (A.2) must hold. The last step is to prove that condition (A.2) holds if $\hat{c} \geq c_h$:

$$\hat{c} \geq c_h \Leftrightarrow p \geq e^{\overline{RD}} + c_h. \tag{A.5}$$

But if (A.5) holds, $F(\tilde{v}|e^{\overline{RD}}) = 1$ must be true. Then again, because all other terms are nonnegative, condition (A.2) must hold. Hence condition (A.2) holds for all $p > 0$ and

²³Strict quasi-concavity of U^{RD} in e for all p ensures that this argument is valid.

we have shown that the seller will invest at least $e^{\overline{RD}}$ if $p > 0$. Since $e^{\overline{RD}} > e^*$, the seller will overinvest relative to the socially efficient level for all prices. ■

7.3 Allowing for Buyer's breach

7.3.1 ED without renegotiation

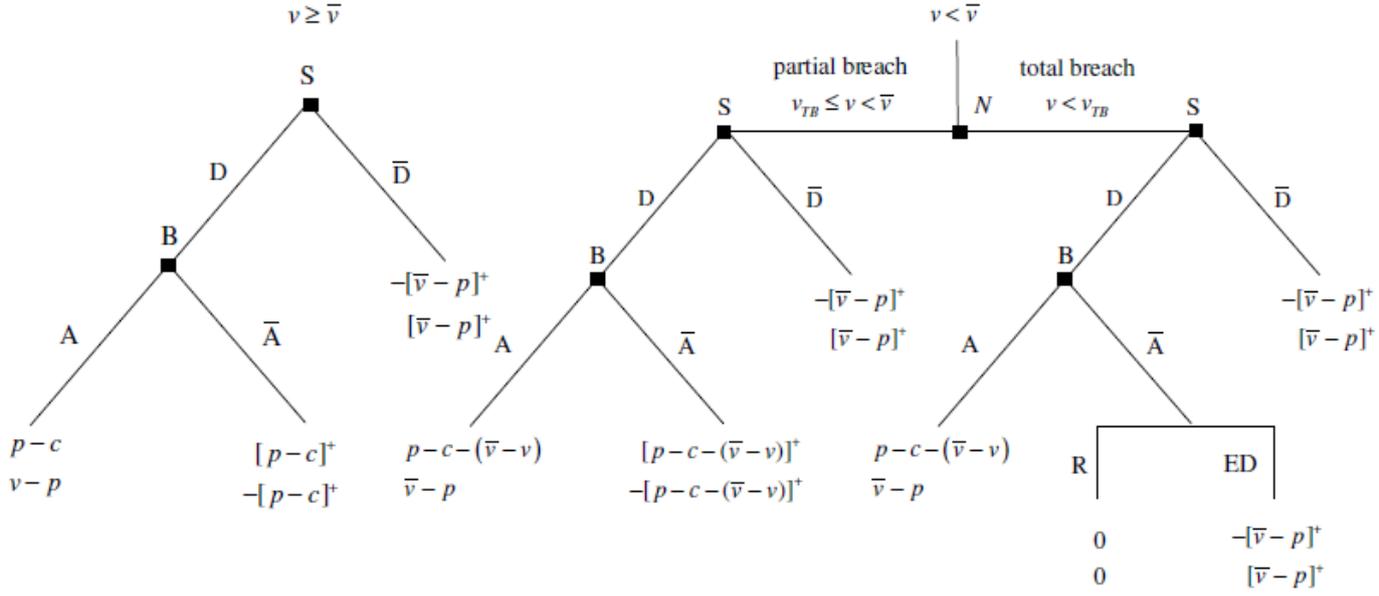


Figure 5: ED without renegotiation if the buyer is allowed to breach.

Rather than assuming ad hoc that the buyer never breaches the contract under expectation damages, we will now show that legal remedies of contract law induce the buyer to accept delivery.

Conforming quality, $v \geq \bar{v}$.

If quality is conforming, non-acceptance (\bar{A}) of the seller's good constitutes breach. Hence, the seller can recover damages of $[p-c]^+$ (Figure 5). The buyer will accept the good if

$$v - p \geq -[p - c]^+ \Leftrightarrow v \geq \begin{cases} p, & \text{if } p \leq c \\ c, & \text{if } p > c \end{cases}. \quad (\text{A6})$$

The natural assumption that $\bar{v} > p$, implies that (A6) must hold. The first case, $p \leq c$, must hold because $v \geq \bar{v} > p$. The second case can only occur if $p > c$. Then, since $v \geq \bar{v} > p$ it must hold that $v > c$. Hence, the buyer will accept delivery in equilibrium. Under the substantial performance doctrine, different remedies will be available depending on whether the non-conformity amounts to total breach or not.

Non-conformity constitutes partial breach, $v_{TB} \leq v < \bar{v}$.

If quality is non-conforming, it is less clear why the buyer should be obliged to accept delivery. Yet, if breach due to non-conforming quality is non-material, $v_{TB} \leq v < \bar{v}$, the buyer is indeed only allowed to demand damages for partial breach. Therefore, if the buyer rejects delivery, the supplier can recover the full price, minus cost saved, minus damages to which the buyer would have been entitled: $[p - c - (\bar{v} - v)]^+$. For $\bar{v} > p$, we see that $\bar{v} - p > 0 \geq -[p - c - (\bar{v} - v)]^+$. Hence the buyer will accept delivery in equilibrium.

Non-conformity constitutes total breach, $v < v_{TB}$.

If, however, the non-conformity is material, $v < v_{TB}$, the buyer can terminate the contract. In this case he can ask for restitution (R) under which he can recover any progress payment that he might have made to the seller. Both parties end up with 0 payoff as the good has no value to the seller. Alternatively, the buyer can recover damages for total breach, $[\bar{v} - p]^+$. Hence the Buyer will receive $\bar{v} - p$ if he accepts the good and since we assume $\bar{v} > p$, he will also receive $\bar{v} - p$ if he rejects to accept the good. Assuming the buyer accepts if he is indifferent, the buyer will accept delivery in equilibrium.

7.3.2 ED with renegotiation

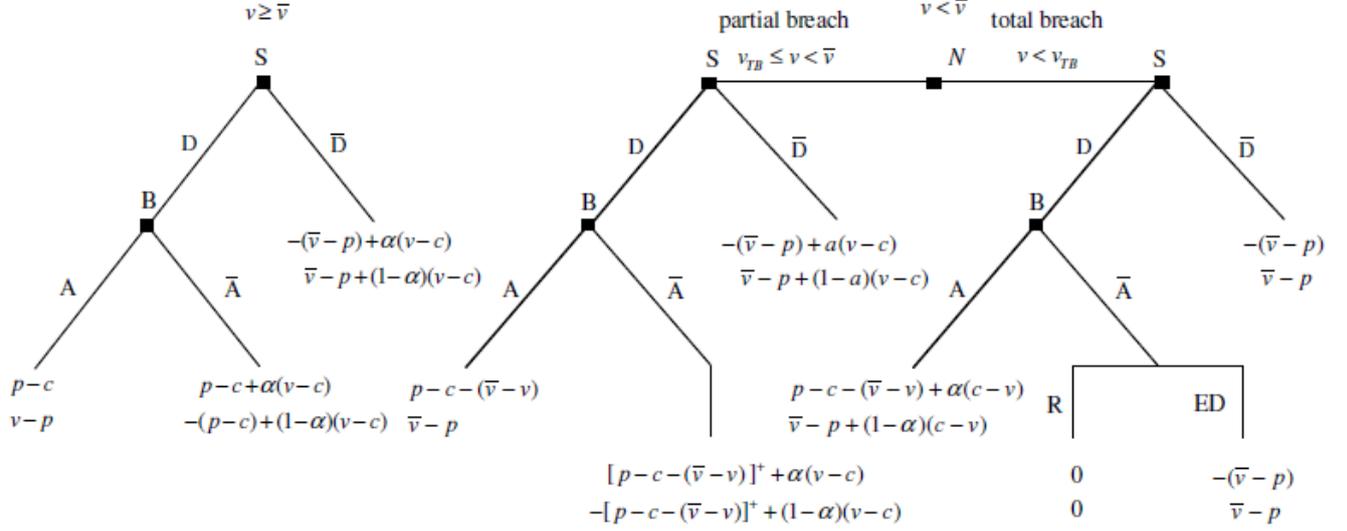


Figure 6: ED with renegotiation if the buyer is allowed to breach.

If we assume that parties renegotiate towards the ex-post efficient trade decision, adjustments to the payoffs in Figure (5) (see Figure 6) need to be made: If e.g. the buyer rejects the seller's good, although trade is efficient, $v > c$, parties will renegotiate splitting the resulting surplus $v - c$ according to their respective bargaining power. Similarly the parties will renegotiate if the buyer accepts the good, although $c \leq v$.

We make one additional assumption which is crucial: Under the substantial performance doctrine of common law the buyer may only treat the non-conformity as total breach if $v < v_{TB} \leq \bar{v}$. In civil law countries a similar provision requires non-conformity to be "fundamental". One test for concluding that non-conformity cannot be treated as total breach is whether the buyer still has an "interest" in the good despite non-conformity. We will assume that the court will conclude that such an interest exists whenever the parties would freely renegotiate to trade: $v > c$. This implies setting $v_{TB} = c$.

Conforming quality, $v \geq \bar{v}$.

The buyer will accept the good if

$$v - p \geq -[p - c]^+ + (1 - \alpha)(v - c) \Leftrightarrow v - p \geq \begin{cases} (1 - \alpha)(v - c), & \text{if } p < c \\ c - p + (1 - \alpha)(v - c), & \text{if } p \geq c \end{cases} . \quad (\text{A7})$$

The first case, $p < c$, holds if $v \geq \frac{p-c}{\alpha} + c$. This must be true because the first case can only occur if $p < c$ and $v \geq c$. The second case holds because $v - c \geq (1 - \alpha)(v - c)$. Hence the buyer will accept in equilibrium.

Non-conformity constitutes partial breach, $v_{TB} = c \leq v < \bar{v}$.

The buyer will accept the good if

$$\begin{aligned} \bar{v} - p &\geq -[p - c - (\bar{v} - v)]^+ + \alpha(v - c) \Leftrightarrow \\ \bar{v} - p + \alpha(c - v) &\geq \begin{cases} 0, & \text{if } c - v \geq -(\bar{v} - p) \\ \bar{v} - p + (c - v), & \text{if } c - v < -(\bar{v} - p) \end{cases} . \end{aligned} \quad (\text{A8})$$

In the first case, the condition must hold since $\bar{v} - p > -(c - v) \geq -\alpha(c - v)$. In the second case, the condition must hold because $c - v \leq 0$ and $\alpha \leq 1$. Hence the buyer will accept in equilibrium.

Non-conformity constitutes total breach, $v < v_{TB} = c$.

As $\bar{v} - p + (1 - \alpha)(c - v) > \bar{v} - p$ for $v < c$, the buyer will always choose acceptance in equilibrium.

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