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Breakup of Repeat Transaction Contracts, Specific Investment, and Efficient Rent-Seeking*

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Abstract

In a repeat trade model with buyer's specific investment, a simple renegotiable contract implements an efficient outcome if premature termination of trade is governed by an appropriate contract breakup rule. In equilibrium, such a rule allows for termination with positive probability and gives the buyer a bargaining leverage over the seller when the contract is renegotiated ex-post. These returns ("breakup rents") from buyer's rent-seeking complement his ex-post bargaining power and restore his ex-ante investment incentives when he would otherwise underinvest due to a standard (ex-ante) hold-up problem. Buyer's opportunism thus creates social value and restores efficiency in case of frictionless renegotiation. When the contract is rigid and not renegotiable until after the first round of trade, however, a first-best breakup rule does not exist. A second-best rule trades off buyer's investment and seller's activity distortions that arise from excessive effort to curb the buyer's bargaining leverage. Conditions on existence of a first or second-best breakup rule as well as implications for the legal discussion on compliance standards for breach of contract are given.

Keywords: Repeat transaction trade, contract breakup, specific investment, hold-up, rent-seeking, installment contracts, compliance standards, breach of contract.

JEL: D86, K12, L14.

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1 Introduction

Suppose that Hart and Moore's (1990) chef and skipper still carry on their "gourmet seafare" service, and the chef has assumed ownership of the yacht. Their business is thriving, as over the years the chef has established a reputation of serving the best clam chowder in the region. Each year he presents an even finer recipe, developed during a harsh and long winter, and each year he approaches the local fishermen to bargain over a contract that ensures him steady, weekly supply of clams throughout the season. Whether or not a clam "harvest" is of high or low quality depends on a number of factors, and fishermen as well as the chef will not learn their exact realization and the quality level until the first day of clam season. They understand that writing a complete contract, accounting for all these factors, is not viable, but rather renegotiate their agreement upon observation of the season's quality type.

The chef and the fishermen engage in repeat trade and enter a contract that is renegotiable after the state of the world is realized. From the standard hold-up literature[1] we know that if the chef (the buyer) does not have exclusive property rights and full bargaining power at the renegotiation stage, he will not be able to capture the full returns of his investment (note the assumption of non-transferability of his recipe) and will thus invest less than is efficient (possibly the level that otherwise earns him a Gault Millau toque). To bypass this inefficiency, vertical integration has been suggested as solution in the context of one-time interaction (Grossman and Hart, 1986; Hart and Moore, 1990). Recall, however, that the chef already owns the yacht (following that advise); what is he supposed to do with yet another cutter?

In this paper, I propose a contractual solution to the hold-up problem arising from buyer's lack of complete property rights as a possible alternative to vertical integration. I argue that by allowing for breakup of a repeat transaction contract, the buyer gains an *ex-post* bargaining leverage over the seller via hold-up when renegotiating the contract. He will exploit these rent-seeking opportunities and extract an additional bargaining surplus—"breakup rents"—to increase his returns on investment and restore his *ex-ante* investment incentives. The buyer's opportunism, in many other contexts associated with inefficient outcomes, therefore creates social value and improves the efficiency property of the underlying repeat trade model.

I consider an incomplete contracts framework where the state of nature and the buyer's specific investment level are nonverifiable by a third party. Attention is limited to *simple contracts*, that means parties are assumed to enter agreements that specify for each trade period the delivery of a good of constant quality in exchange for a constant price.[2] These contracts are assumed to be public action contracts (e.g. Watson, 2007) in the sense that parties rely on

[1]For legal reference, see Corbin (1963; 1A, p. 105); for early work in economics see Goldberg (1976), Klein, Crawford, and Alchian (1978), or Williamson (1985). Comprehensive reviews can be found in reviews by Schmitz (2001), Bolton and Dewatripont (2005; ch. 12), Fares (2006), or Shavell (2007). See also Anderhub, Königstein, and Kübler (2003) for experimental evidence.

[2]Contracts are as simple as specifying x weekly deliveries of y pounds of clams for price of z dollars per pound. The integer 'x' is assumed to be strictly larger than 1 and smaller than the number of deliveries in long-term supply contracts as analyzed by Joskow (1985, 1987, 1990), Masten and Crocker (1985), Goldberg and Erickson (1987), Crocker and Masten (1991), or Goldberg (2002).

a third party "public" enforcer to compel damages in case one of the contract parties does not comply with the terms of trade.[3] For these damage measures, I assume default breach remedies as stipulated for instance in U.S. contract law by the Uniform Commercial Code (American Law Institute, 2000).[4] In particular, referring to Cooter and Eisenberg (1985) or Spier and Whinston (1995), I apply *efficient expectation damages*, i.e. monetary transfers that put an aggrieved party in as good a position as if the other party had fully conformed to the contract *given* the efficient level of specific investment.

The key element of this setup is the contract termination or *breakup rule*.[5] Watson and Wignall (2007) argue that the literature on public action contracts imposes artificial constraints, in particular adhoc restrictions on the physical acceptance of deliveries. In the setup under investigation here, I assume a broad duty to mitigate damages (cf. Edlin, 1996), which implies that a buyer has to accept goods once they are delivered, yet can claim efficient expectation damages if the good is not conforming to the terms of trade. I do, however, allow for *anticipatory rejection* of all goods delivered in future trade rounds. The breakup rule serves as an "artificial legal barrier to cancellation penalties" in the sense of Grossman and Hart (1986; p. 695) who rule out such barriers in their analysis. The shape of such a barrier is with respect to whether or not termination of the contract is rightful and is as such conditional on the conformity of the goods already delivered. Hence, if the seller tenders a quality that is below a certain breakup threshold, the buyer may rightfully terminate but is in breach of contract otherwise. This *conditional* breakup rule is related to the contract cancellation rule for installment contracts under the Uniform Commercial Code. It stipulates that a buyer may cancel[6] a contract if the defect of a delivered good substantially impairs the buyer's (subjective) valuation of the entire contract. I will comment on this specific rule in relation to the results of this paper's model in a later section.

The structure of the paper is as follows: Section 2 introduces the basic framework of a repeat trade technology with two periods. In Section 3, I establish the institutional framework; I first comment on the repeat transaction contract, then define the applied damage remedies for breach of contract, and finally introduce the renegotiation routines. In Section 4, the parties equilibrium strategies for the semi-renegotiated contract are established. Section 5 holds the main results of the paper. I first show that for the setting with contract rigidity (the contract

[3] The efficiency properties of simple contracts have been explicitly looked at by Huberman and Kahn (1988), MacLeod and Malcomson (1993), or Schmitz (2002).

[4] There exists a substantive literature that analyzes the properties of breach remedies with respect to allocative efficiency, investment incentives and risk-sharing. See for instance Shavell (1980), Rogerson (1984), Spier and Whinston (1995), Edlin (1996), Edlin and Reichelstein (1996), Che and Chung (1999), Che and Hausch (1999), or Schweizer (2006) among others.

[5] Comino, Nicolò, and Tedeschi (2006) and Muehlheusser (2007) explicitly account for (contract) termination clauses in their settings. Furthermore, the partnership-dissolution literature (cf., e.g., Cramton, Gibbons, and Klemperer, 1987; Moldovanu, 2002; Li and Wolfstetter, 2007) is somewhat related.

[6] A word on terminology: In this paper I refer to "putting an end to a contract but retaining any remedies for breach of contract" as contract *termination*. The Uniform Commercial Code refers to these facts as *cancellation*. Termination in the Uniform Commercial Code means that "all obligations which are still executory on both sides are discharged [i.e. no damages for nondelivered future installments upon breakup can be recovered] but any rights based on prior breach or performance survives (§2-106)."

is "sticky" and cannot be renegotiated until after the first trade round), a linear breakup rule cannot implement a first-best outcome. For the case of full renegotiation (no such stickiness) a first-best best outcome is indeed possible. I briefly comment on the existence of such an efficiency restoring breakup rule and then discuss some implications for the legal literature on compliance standards. Section 6 concludes. The proofs of the presented results are given in the Appendix.

2 Setup

The basic setup is as follows: Let a seller "S" (*she*) produce and deliver an indivisible commodity of nonnegative quality q_1 at date 1 and of quality q_2 at date 2, $\vec{q} = (q_1, q_2)$. The goods are referred to by their time of deliveries and indexed by $i = 1, 2$. The costs of production (subsuming the costs of delivery) of q_i are given by a convex, twice-differentiable cost function $c(q_i, \theta)$. Technological restrictions prevent advanced production of q_2 at date 1. Upon the start of production of q_1, the seller observes her productivity type θ that prevails over the lifetime of the business relationship. A higher productivity denotes lower production costs, $c_\theta(q_i, \theta) < 0$, in particular, lower marginal costs, $c_{q_i\theta}(q_i, \theta) <$ for all q_i and θ. Type θ is randomly drawn from the unit interval Θ with *pdf* $f(\theta)$ and a strictly increasing *cdf* $F(\theta)$. It is observable to the buyer and seller yet nonverifiable by third parties. The seller does not incur any fixed costs, hence $c(0, \theta) = 0$ for all θ. Moreover, the Inada conditions are satisfied for cost function $c(q_i, \theta)$ with respect to q_i.

The buyer "B" (*he*) can increase his marginal valuation of q_i by investing $r \geq 0$ at convex cost $z(r)$. Such investment may be in the business's physical or human capital and is relationship-specific with zero value outside the respective buyer-seller match. Let the buyer's valuation of q_i for both $i = 1, 2$ be denoted by a concave, twice-differentiable valuation function $v(r, q_i)$ that satisfies the Inada conditions for both arguments. The buyer's valuation is nonnegative for any q_i and r. A higher level of investment r implies a higher valuation for any given q_i, i.e. $v_r(r, q_i) > 0$ and $v_{rr}(r, q_i) \leq 0$, where $v(0, q_i) > 0$ for any positive q_i. Moreover, r has a positive effect on the marginal valuation of q_i, $v_{q_ir}(r, q_i) > 0$. Also note that I assume perfect relationship-specificity, that means investment is without value if performance does not occur, implying $v(r, 0) = v_r(r, 0) = 0$. Moreover, the buyer can decide not to trade commodity 2 with the seller but instead prematurely terminate the business relationship and exit the game. Let this decision $\tau \in \{E, C\}$ be equal to E if the buyer *exits* and no good is exchanged in $t = 2$, or C if he decides to *continue*.

Both parties are assumed to be risk neutral expected utility maximizers and do not face any wealth constraints. The surplus from trade of commodity i with quality q_i is the difference between buyer's valuation $v(r, q_i)$ and the seller's costs of production $c(q_i, \theta)$ and denoted by $w(r, q_i, \theta) = v(r, q_i) - c(q_i, \theta)$. The overall surplus from repeat transactions (net of investment costs $z(r)$) is simply the sum of w over i, given $\tau = C$, hence $W(r, \tau, \vec{q}, \theta) = w(r, q_1, \theta) + 1_{(\tau=C)} w(r, q_2, \theta)$. Moreover, let the social surplus be these gains of trade W minus the costs of investment $z(r)$ and denoted by $\widehat{W}(r,\tau,\vec{q},\theta)$. From the above assumptions it follows that $\widehat{W}(r,\tau,\vec{q},\theta)$ is concave in q_i and r; moreover, let it be nonconvex in type θ.

The sequence of decisions in this basic framework is the following: The buyer invests r before the productivity type θ is realized. The seller then observes state (r,θ) and chooses quality levels q_i for $i=1,2$ where q_2 is conditional on buyer's decision τ. Since termination implies a loss of second period gains of trade, $\tau=E$ is Pareto-inferior to continuation $\tau=C$ for all positive productivity types $\theta>0$. The first-best investment and activity levels are such that the social surplus $\widehat{W}(r,\tau,\vec{q},\theta)$ is maximized. Let the optimal activity level for $i=1,2$ as best response to buyer's investment be a function of θ and r denoted by

$$\sigma^o(r,\theta)\in\arg\max_{q_i\in\mathbb{R}_+}\widehat{W}\big(r,\tau,\vec{q},\theta\;\big|\;\tau=C\big) \tag{1}$$

for $i\neq j$ and the optimal quality strategy $\vec{\sigma}^o(r,\theta)=\big(\sigma^o(r,\theta),\sigma^o(r,\theta)\big)$. By time-separability of w, the quality function $\sigma^o(r,\theta)$ is time-invariant. Similarly, the optimal level of investment is a best response to the quality strategy and maximizes the expected social surplus such that

$$\rho^o(\vec{\sigma}^o)\in\arg\max_{r\in\mathbb{R}_+}\int_\Theta\widehat{W}\big(r,\tau,\vec{\sigma}^o(r,\theta),\theta\;\big|\;\tau=C\big)f(\theta)\,d\theta. \tag{2}$$

The first-best levels are then $\sigma^*(\theta)=\sigma^o(\rho^*,\theta)$ and $\rho^*=\rho^o(\vec{\sigma}^*(\theta))$. The first-best benchmark is defined as follows:

Definition 1 (First-best benchmark)**.** *The first-best benchmark outcome $\{\vec{\rho}^*,\vec{\sigma}^*(\theta)\}$ is such that parties trade in the second period, $\tau=C$, and the* ex-ante *efficient investment level ρ^* and the* ex-post *efficient activity vector $\vec{\sigma}^*(\theta)$ are mutual best responses and characterized by the first-order conditions*

$$\frac{\partial\widehat{W}(\vec{\rho}^*,\vec{q},\theta)}{\partial q_i}\overset{!}{=}0;\;i=1,2,\;i\neq j \tag{3}$$

and

$$\int_\Theta\frac{\partial\widehat{W}\big(r,\tau,\vec{\sigma}^*(\theta),\theta\;\big|\;\tau=C\big)}{\partial r}f(\theta)\,d\theta\overset{!}{=}0. \tag{4}$$

The assumptions for $v(r,q_i)$ and $c(q_i,\theta)$ ensure that there exists a unique $\sigma^*(\theta)>0$ for any $\theta>0$. Recalling that the seller does not incur any fixed costs of production, for any positive productivity type θ there is always a positive value of q_i such that $w(r,q_i,\theta)>0$. Hence, trade is always efficient. Moreover, by the properties of $v(r,q_i)$ and $z(r)$ the first-best investment level is positive, $\rho^*>0$.

3 Institutional framework

The underlying bilateral trade model is complemented by *(3.1)* an incomplete contracts framework. I assume enforceability of contracts and *(3.2)* apply damage function specifications for noncompliance that are proposed by economic and legal scholarship. Moreover, *(3.3)* contracts are assumed to be renegotiable.

3.1 Repeat transaction contracts

Before the buyer invests and the seller sequentially produces and delivers goods $i = 1, 2$, the parties can enter an incomplete, simple supply contract that defines the heart of the trade relationship. Enforceability of such a contract before a court of law is restricted to terms that are verifiable, i.e. are observable to third parties, or can be proven without reasonable doubt or at less then prohibitively high cost. As is standard in the law and economics literature, the seller's productivity type θ and the buyer's investment level r are taken to be nonverifiable, while quality and price levels as well as the parties' communication are observable to third parties and therefore contractible. Similarly, contract clauses that condition on state (r, θ) are assumed to be not enforceable and contracts *incomplete*. The class of contracts under consideration is *simple* with regard to the unconditionality of quality and price provisions: A supply contract specifies a constant quality level $\bar{q} \in \overline{Q}$ to be delivered in exchange for a price $\bar{p} \in \mathbb{R}$, where $\bar{q}$ and $\bar{p}$ are fixed both within and between trade periods.

Definition 2 (Repeat transaction contract)**.** *Let* $\overline{Q} = \{\bar{q} : \sigma^* (\theta), \theta < 1\}$ *and* $i = 1, 2$. *A repeat transaction contract* Z *specifies* $\bar{q} \in \overline{Q}$ *as quality of good* i *to be delivered in* $t = i$ *in exchange for a price* $\bar{p} \in \mathbb{R}$.

The choice set $\overline{Q}$ represents the interval $\left[0, q^{\max}\right)$ where $q^{\max} = \sigma^* (1)$. Note that a contract Z is not the only contract structure governing repeat trade. An even simpler one than repeat transaction contract Z is given by a sequence of one-shot long-term contracts; or parties may renounce the possibilities of foresighted (long-term) contracting and engage in spot-market trading. Both alternatives, however, give rise to a *hold-up* problem as the buyer's investment is assumed to be relationship-specific and in renegotiations the seller can extract part of the buyer's quasi-surplus. A repeat transaction contract on the other hand binds the seller to his promise of delivery in both periods. The buyer's protection from hold-up is thus relatively more pronounced given contract Z than under these alternative contract structures. Such "contract bundles", however, are considered to be not irrevocable. I introduce an explicit linear contract breakup rule that allows for termination of the trade relationship conditional on the verifiable history of the contract. In particular, it is taken to be conditional on the quality q_1 of the seller's first delivery and grants the buyer the right to terminate the trade relationship and exit the contract if and only if $q_1 < \mu \bar{q}$ where μ is between 0 and 1.

Definition 3 (Breakup rule)**.** *Let* $\mu \in [0, 1]$. *The buyer may prematurely terminate the trade relationship and recover damages for* q_1 *and nondelivery in* $t = 2$ *if and only if* $q_1 < \mu \bar{q}$.

Under investigation in this paper is the question of whether or not an appropriate (default) breakup rule μ can substitute for more sophisticated contracts and implement a first-best outcome. That means, not object of interest is the set of all classes of contracts that can implement a first-best outcome under the given multiple trading periods model; sophisticated contracts as analyzed for instance in MacLeod and Malcomson (1993) are not considered in this framework. I assume simple terms of trade such that quality $\bar{q}$ is unconditional (e.g. in "one-size-fits-all" standardized contract) on the the nonverifiable state (r, θ) and the overall payments $2\bar{p}$ such that the expected joint surplus $\widehat{\Pi}$ is equally shared between the buyer and seller[7] and the per-unit price $\bar{p}$ equally apportioned across deliveries.

3.2 Damages for noncompliance

Contract Z binds the parties to trade in periods 1 and 2 and defines their obligations as follows: The buyer has a claim over delivery of goods $i = 1, 2$ of predetermined quality $\bar{q}$ in periods 1 and 2, while the contract grants the seller the right to deliver and see her delivery accepted and paid for by the buyer. Unless these rights are forfeited by action or deliberately waived by proper communication, failure to comply with the respective contractual obligations results in "breach" of contract. In that case, the contractual performance claims (delivery and acceptance) are replaced by claims for monetary compensation compelled by a court of law.[8]

Suppose the seller wrongfully delivers a good with quality $q_i < \bar{q}$, then the buyer can claim monetary compensation that puts him in as good a position as if the seller had fully conformed to her obligations. The seller is thus liable for any losses the buyer incurs from a defect in commodity i. In particular, the buyer can recover his *efficient expectation damages* (Cooter and Eisenberg, 1985; Spier and Whinston, 1995) that restrict compensation to his damages for any q_i under an efficient investment level ρ^*. These damages are denoted by $d(q_i, \bar{q})$ and defined as

$$d(q_i, \bar{q}) = \max\left\{v(\rho^*, \bar{q}) - v(\rho^*, q_i), 0\right\}. \tag{5}$$

The maximum operator hereby induces a no-windfall-gains assumptions; the seller may not recover from the buyer any compensation for a supraconforming quality $q_i > \bar{q}$.[9] Applying efficient expectation damages introduces a "compensation bias" for inefficient investment levels. To see this, note that the buyer's compensated payoffs as function of his investment level and the delivered quality q_i are given as $\bar{b}(r, q_i) = v(r, q_i) - \bar{p} + d(q_i, \bar{q})$; his true expectation interest, given the actual level of investment, is equal to $v(r, \bar{q}) - \bar{p}$. It is straightforward to check (and summarized in Lemma 1) that the buyer is overcompensated for a defective quality level $q_i < \bar{q}$ if $r < \rho^*$. This is due to the value-enhancing nature of the buyer's investment, $v_{q_i r}(r, q_i) > 0$, that induces damages $d(q_i, \bar{q})$ under efficient investment ρ^* to be higher than under the actual level $r < \rho^*$. The reverse case holds true for $r > \rho^*$. Lemma 1 provides a useful characterization of the the degree of over- and undercompensation as function of the buyer's investment decision.

[7] This pricing rule corresponds to a non-cooperative bargaining solution with zero outside options (see, e.g., Rubinstein, 1982; Sutton, 1986) or a cooperative, symmetric Nash-bargaining solution with zero disagreement points (Nash, 1950).

[8] Under codified U.S. contract law, the *Uniform Commercial Code (UCC)* §1-305(a) gives the general notion of "expectation damages", the specifics are found in Sections §2-7XX.

[9] Neither does she have to pay damages for the delivery of a nonconforming $q_i > \bar{q}$.

Lemma 1 (Compensation bias)**.** *Suppose the seller delivers a good i with defective quality $q_i < \bar{q}$. Let $h(r, q_i) = v(\rho^*, q_i) - v(r, q_i)$. Efficient expectation damages in equation (5) yield a compensation bias $h(r, \bar{q}) - h(r, q_i)$. This term is positive ("overcompensation") for $r < \rho^*$ and negative ("undercompensation") for $r > \rho^*$.*

In general, expectation damages induce efficient activity incentives for the seller. She fully internalizes the buyer's losses for a nonconforming q_i and performs efficiently.[10] With nonverifiability of investment r and the propagation of efficient expectation damages, the alignment of seller's incentives ceases to hold. A negative compensation bias, implying buyer's undercompensation, results in less-than-full internalization, a positive bias induces the seller to internalize losses the buyer does in fact not incur. The following restriction on the value-enhancing effect of r will prove to be useful. It states that, given $\bar{q}$, the valuation effect of $r = \rho^*$ relative to $r = 0$ must be strictly smaller than the expected per-period trade surplus given efficient investment. Note that the buyer's overcompensation is maximized for $r = \sigma_i = 0$ such that $h(0, \bar{q}) - h(0, 0)$, where $h(0, 0) = 0$. Let σ_i be the seller's choice of q_i, given θ. The restriction on $v_r(r, q_i)$ thus reads as follows:

Assumption 1. *$h(0, \bar{q}) < \int_\Theta w(\rho^*, \sigma_i, \theta) f(\theta) d\theta$.*

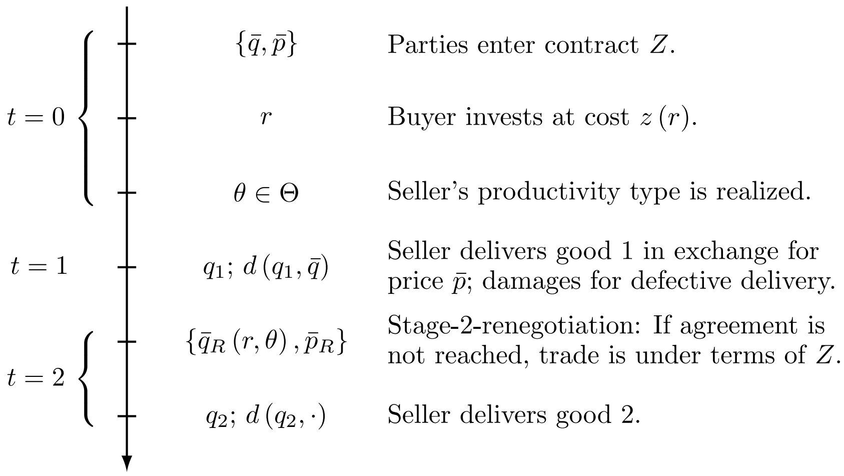
By equation (5), the buyer is able to recover any losses associated with the seller's defective performance. Moreover, the breakup rule in Definition 3 implies that for a delivered quality below the threshold $\mu\bar{q}$, the seller in *total* breach of contract and forfeits her right to deliver in $t = 2$ and see her delivery accepted and paid for. Hence, the buyer may not only collect damages as in equation (5) for a nonconforming quality q_1, but he is granted the right to breakup and recover the losses associated with no delivery, $q_2 = 0$, in $t = 0$. These are denoted by $\bar{b}(\rho^*, \bar{q}) = v(\rho^*, \bar{q}) - \bar{p}$. If, however, $q_1 \geq \mu\bar{q}$, then breaking up the trade relationship constitutes breach of contract on the buyer's side. In that case, he is liable for the seller's expected payoffs $\bar{s}_2^e$. Recall that the seller's true payoffs are deterministic as θ has already been realized, yet due to nonverifiability, damages may not condition on her type. For tractability it is assumed that buyer's payoffs, given efficient investment, and the seller's expected payoffs in $t = 2$ under Z are nonnegative.

Assumption 2. *$\bar{b}(\rho^*, \bar{q}) \geq 0$ and $\bar{s}_i^e \geq 0$ for $i = 1, 2$.*

Legal enforcement of contract Z is through the remedy regime characterized by *efficient expectation damages* in equation (5) and the conditional breakup rule in Definition 3. It is defined as damage function $D : \mathbb{R}_+^2 \times \{E, C\} \to \mathbb{R}$ that maps parties' verifiable actions q_i and

[10] For a discussion of the *efficient breach* paradigm see for instance Hermalin, Katz, and Craswell (2007; ch. 5.2.1).

Figure 1: Timing of the model with contract rigidity



τ into monetary flows from the buyer to the seller,

$$D(\vec{q}; \tau) = \begin{cases} \sum_{i=1}^{2} d(q_i, \bar{q}) & \text{if } \tau = C \\ d(q_1, \bar{q}) + \bar{b}(\rho^*, \bar{q}) & \text{if } \tau = E \text{ and } q_1 < \mu\bar{q} \\ d(q_1, \bar{q}) - \bar{s}_2^e & \text{if } \tau = E \text{ and } q_1 \geq \mu\bar{q}. \end{cases} \tag{6}$$

The regime gives rise to the parties' legal claims which they are assumed to able to collect at the end of the game. Note that the exact timing of the transfers is irrelevant for this paper's analysis.

3.3 Renegotiation

Parties engage in renegotiation of contract Z after state (r, θ) has been realized in order to adapt to the new contract environment and trade on the Pareto-frontier account for and generate possible efficiency gains. Watson (2007) shows in a single-transaction contract framework that the specifics of the renegotiation technology, in particular timing, matter for the model's implications. Similar to his approach, I consider two different degrees of contract renegotiability: In a first step I assume that the contract is "sticky", implying that the specifications of the first round of trade cannot be changed. The timing of this scenario is depicted in Figure 1. Drawing upon the implications from this *semi-renegotiated* contract, I then consider a fully flexible contract where both first and second quality levels can be adjusted upon observation of (r, θ); see Figure 2 for the respective timeline. I briefly discuss the underlying timing and bargaining structure for each of the renegotiation technologies before proceeding to the equilibrium analysis.

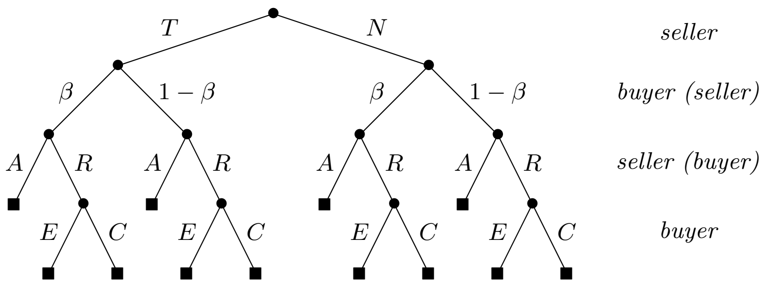
3.3.1 Contract rigidity

For the first scenario under *contract rigidity*, I take the initial contract Z to be inalienable at stage $t = 1$ and allow for renegotiation only after the closing of the first round of trade. A source for such a renegotiation restriction may be an assumption of asymmetric type observability. This means that the seller observes her type in stage $t = 0$ while the buyer observes θ in $t = 1$. Alternatively, one may assume that both parties simultaneously observe θ, yet not until the initialization of the production process of good 1, not allowing for halt of production and renegotiation of specifications until after stage 1.

The timing, depicted in Figure 1, is as follows: After Z is entered, the buyer invests and type θ is realized. The seller then decides over the quality of the first delivery. After this first exchange, the parties may renegotiate quality $\bar{q}$ and price $\bar{p}$ for the second good and agree on contract Z_R. Since the model is one of perfect information, it is straightforward that parties choose a quality level q such that the surplus from trade in $t = 2$ is maximized, $\bar{q}_R \in \overline{Q}_R \subseteq \mathbb{R}_+$, and bargain over their respective shares (reflected by price $\bar{p}_R$) of the trade surplus $\pi(r, \theta)$. If renegotiations shall fail, the parties honor contract Z (or do not trade if the buyer has decided to terminate) for trade of $i = 2$. After the parties have collected their legal claims determined by the remedy regime $D(\vec{q}; \tau)$ the game ends.

For the stage-2 bargaining game under contract rigidity I assume take-it-or-leave-it offers by the buyer with probability β or by the seller with probability $1 - \beta$. If the seller (buyer) accepts ('A') the buyer's (seller's) offer, the parties trade a good of quality q_2 in exchange for the agreed price; if q_2 fails to conform to $\bar{q}_R(r, \theta)$, then compensation for the buyer is given by equation (5). Note that the negotiation game is asymmetric as to the parties' legal claims. By contract Z, the seller is given the right to deliver the second period good but forfeits this right by delivering a good with sufficiently low quality. Moreover, the breakup rule grants the buyer the right to exit the repeat transaction contract conditional on the seller's first delivery. I assume that by rejecting ('R') the seller's offer, the buyer does not waive this right. This implies that in case of a rejected take-it-or-leave-it offer, the buyer can choose between exiting 'E' or continuing 'C' the contract. His valuation of each of these options is determined by the conformity of this breakup. If $q_1 < \mu\bar{q}$, then the seller's total breach of contract ('T') renders buyer's exit "rightful", in which case he is able to recover damages for nondelivery, $q_2 = 0$. If, on the other hand, the seller's first period delivery is such that $q_1 \geq \mu\bar{q}$, then the seller is not in breach of the whole contract ('N') and buyer's termination is said to be "wrongful." In that case, the buyer is not complying with his contractual obligations and thus in breach of contract on his part. Since termination implies an end of the trade relationship with no trade surplus realized, parties' second period payoffs add up to zero. If the buyer chooses continuation of the contract upon rejection of the buyer's or seller's bargaining offer, then trade in period $t = 2$ is according to contract Z. The bargaining game is summarized as follows.

Stage-2-renegotiation. *Given q_1, the buyer (seller) makes a take-it-or-leave-it offer with probability β (probability $1 - \beta$). The seller (buyer) can accept 'A' or reject 'R' this offer. If it is* *accepted, the game ends and trade is according to Z_R. If the seller (buyer) rejects, then the buyer decides whether to exit 'E' or continue 'C' to trade under contract Z.*

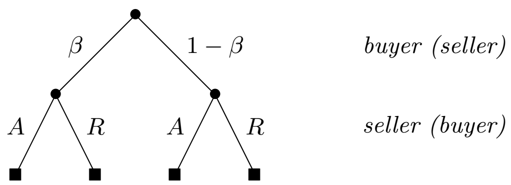


Once the buyer has chosen to exit the contract (either rightfully or wrongfully), the contract is terminated and respective damage claims exchanged at the end of the game. The buyer's payments in case of wrongful termination derive from the seller's contractual right to deliver. We can abstract from the seller's continuation outside option for $q_1 \geq \mu \bar{q}$ since it is fully captured by the buyer's liability in case of wrongful termination. The asymmetry that arises from assigning the exit option exclusively to the buyer is related to the bargaining setup in MacLeod and Malcomson (1993) or Shaked (1994).

3.3.2 Frictionless renegotiation

A frictionless renegotiation technology implies that the terms of trade in Z for both $i = 1, 2$ can be changed and adapted to the state (r, θ) realized in stage $t = 0$. Before the seller enters production of good 1, the parties meet to agree on $\bar{q}_R(r, \theta)$ and a transfer $\bar{p}_R$ that reflects their relative bargaining positions. As in the case under contract rigidity, I assume probabilistic take-it-or-leave-it offers for the bargaining routine. If no agreement is reached, then trade in the first round is under the terms of contract Z. After the delivery of good 1 parties may re-enter renegotiations under the stage-2-renegotiation routine. Note that by Definition 3, the breakup rule is conditional on the quality of the first delivery; exit 'E' is therefore not an option in stage-1-renegotiations.

Stage-1-renegotiation. *After state (r, θ) is realized, the buyer (seller) makes a take-it-or-leave-it offer with probability β (probability $1 - \beta$). The seller (buyer) can accept 'A' or reject 'R' this offer. If it is accepted, stage-1 is according to Z_R; it it is rejected, the parties trade under the terms of contract Z.*



4 Equilibrium strategies

Before discussing the implications of the possibility of contract termination on the efficiency of investment and trade, I first derive the contract parties' equilibrium strategies given some arbitrary breakup rule μ. Due to its conditionality on q_1, μ only enters the stage-2-renegotiation game. For this reason, I will first analyze the setup under contract rigidity and then proceed to the case without frictions. The insights from the semi-renegotiated contract will help understand the underlying dynamics, and the results for full-renegotiation case are straightforward implications. The subgame perfect equilibrium strategies are solved for by backward induction.

4.1 Stage-2-renegotiation

If stage-2-renegotiations fail and the buyer opts for 'C', then trade takes place as specified in Z. In that case, the seller maximizes her second period payoffs $\bar{p} - c(q_2, \theta) - d(q_2, \bar{q})$ over quality q_2. By equation (5) it is straightforward to see that it cannot be an optimal strategy to deliver a quality level above and beyond the level specified in the contract. This is because for any $q_2 > \bar{q}$, damages are equal to zero, yet costs of production are increasing in q_2. A supraconforming $q_2 > \bar{q}$ is therefore strictly dominated by $q_2 = \bar{q}$ for any state (r, θ). By rearranging the seller's payoffs, the second period quality can be written as

$$\sigma_2 \in \arg\max_{q_2 \leq \bar{q}} w(\rho^*, q_2, \theta) - \bar{b}(\rho^*, \bar{q}) \tag{7}$$

and is equal to $\sigma_2 = \min\{\sigma^*(\theta), \bar{q}\}$. This is by Definition 1 a first-best quality level for all θ such that $\sigma^*(\theta) \leq \bar{q}$. I will refer to such a first-best quality up to full conformity as *constrained first best* denoted by $\bar{\sigma}(\theta) = \min\{\sigma^*(\theta), \bar{q}\}$. Expectation damages make the seller the residual claimant since the buyer's absolute share of the trade surplus—his compensated payoffs $\bar{b}(\rho^*, \bar{q})$—is taken to be fixed, inducing optimal activity incentives for the seller. Damages in equation (5), however, are such that the seller delivers as if the buyer has invested efficiently and $r = \rho^*$. For this reason, quality levels are inefficiently high for the true $r < \rho^*$ and inefficiently low for $r > \rho^*$. While second period quality is independent of r, the period surplus from trade under contract Z is increasing in the level of investment and denoted by

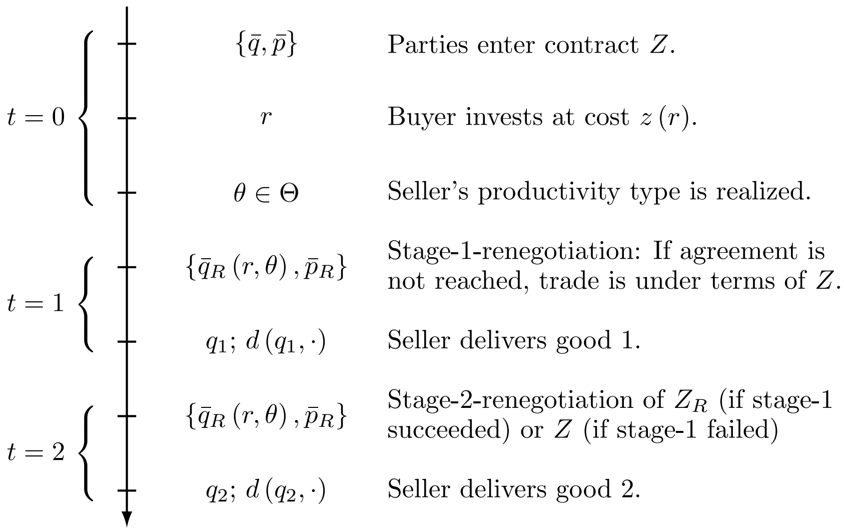
$$\bar{\pi}(r, \theta) = w(r, \bar{\sigma}(\theta), \theta) \tag{8}$$

If, for state (r, θ), stage-2-renegotiations succeed, then parties will have agreed on a quality level $\bar{q}_R(r, \theta)$ that maximizes the second period gains of trade,

$$\bar{q}_R(r, \theta) \in \arg\max_{q_2} w(r, q_2, \theta). \tag{9}$$

The revised contract Z_R is *simple* in the sense of Definition 2 and specifies a fixed quality $\bar{q}_R = \bar{q}_R(r, \theta)$ to be delivered in exchange for a fixed price $\bar{p}_R$. Note that while parties contract

Figure 2: Timing of the model with unrestricted renegotiation



under perfect information and agree on a Pareto-optimal quality level, the seller's actual quality decision may not be efficient. By equation (5), the seller may in fact deviate from contract provision $\bar{q}_R(r, \theta)$ and again deliver as if the buyer had efficiently invested. To see this, notice that the delivered second period quality is such that the seller's second period payoffs $\bar{p}_R - c(q_2, \theta) - d(q_2, \bar{q}_R)$ are maximized, hence

$$\sigma_R \in \arg \max_{q_2 \leq \bar{q}_R(r,\theta)} w(\rho^*, q_2, \theta) - \bar{b}_R \tag{10}$$

where $\bar{b}_R$ is a constant. In case of buyer's underinvestment $r < \rho^*$, the no-windfall-gains assumption implicit in equation (5), inducing the upper bound for σ_R, is a binding constraint. Given ρ^*, the quality from seller's unconstrained optimization is equal to $\sigma^*(\theta) > \sigma^o(r, \theta)$, which is, however, strictly dominated by a fully conforming $\bar{q}_R(r, \theta) = \sigma^o(r, \theta)$. The surplus $\pi(r, \theta)$ from trade under Z_R in this case is on the Pareto-frontier and denoted by

$$\pi\left(r, \theta \mid r \leq \rho^*\right) = w(r, \sigma^o(r, \theta), \theta). \tag{11}$$

If on other hand, the buyer's investment exceeds the efficient level, then the reverse logic applies, the no-windfall-gains assumption is not binding and $\sigma_R = \sigma^*(\theta) < \bar{q}_R(r, \theta)$ for all types θ. This yields a trade surplus of

$$\pi\left(r, \theta \mid r > \rho^*\right) = w(r, \sigma^*(\theta), \theta). \tag{12}$$

Here, the negative compensation bias from Lemma 1 serves as a binding constraint, inducing a suboptimal trade surplus $w(r, \sigma^*(\theta), \theta) < w(r, \sigma^o(r, \theta), \theta)$. As is shown in Lemma 2, renegotiation of Z is always in the mutual interest of both contract parties as there are never joint losses incurred from renegotiation.

Lemma 2 (Renegotiation surplus)**.** *The renegotiation surplus* $g(r,\theta) = \pi(r,\theta) - \bar{\pi}(r,\theta)$ *is nonnegative for all levels of investment* r *and productivity types* θ*.*

Trade under the renegotiated contract Z_R is never Pareto-inferior to trade under the initial agreement Z. As a matter of fact, renegotiation yields a Pareto-improvement for all but a single value of θ. This implies by the assumed information symmetry that renegotiation failure cannot be on the equilibrium path (although parties may agree on $Z_R = Z$). The contract's quality specification is given in equation (10), price $\bar{p}_R$ for the good delivered is determined by the stage-2-renegotiation bargaining routine presented in the previous section. Lemma 3 shows that this game yields an asymmetric Nash-bargaining solution, where the parties' legal claims from options 'C' and 'E' are the disagreement points and the buyer's offer probability β his bargaining share of the renegotiation surplus. Note that if the buyer can credibly exercise his (off-equilibrium) exit threat 'E', then the second period gains of trade are equal to zero and the renegotiation surplus simply $g(r,\theta) = \pi(r,\theta)$. The resulting payoffs $\tilde{b}(r,q_1,\theta)$ and $\tilde{s}(r,q_1,\theta)$ for the buyer and the seller, respectively, are referred to as *continuation values* of the contract.

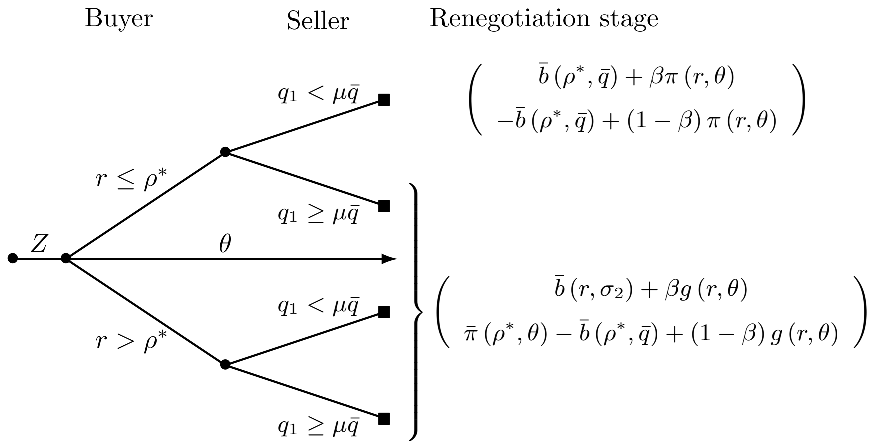
Lemma 3 (Continuation values)**.** *The continuation values* $\tilde{b}(r,q_1,\theta)$ *for the buyer and* $\tilde{s}(r,q_1,\theta)$ *for the seller as result of an asymmetric Nash-bargaining solution are equal to*

$$\left(\tilde{b}(r,q_1,\theta), \tilde{s}(r,q_1,\theta)\right) = \begin{cases} \begin{pmatrix} \bar{b}(\rho^*,\bar{q}) + \beta\pi(r,\theta), \\ -\bar{b}(\rho^*,\bar{q}) + (1-\beta)\pi(r,\theta) \end{pmatrix} & \text{if } q_1 < \mu\bar{q} \text{ and } r \le \rho^* \\ \\ \begin{pmatrix} \bar{b}(r,\sigma_2) + \beta g(r,\theta), \\ \bar{\pi}(\rho^*,\theta) - \bar{b}(\rho^*,\bar{q}) + (1-\beta) g(r,\theta) \end{pmatrix} & \text{if otherwise.} \end{cases}$$

As can be seen from the case differentiation, both parties can influence their second period payoffs by choosing appropriate levels of investment r and quality q_1. For the buyer, the investment level determines whether or not the exit threat 'E' is indeed credible. Lemma 3 establishes this credibility result and shows that if the buyer overinvests such that $r > \rho^*$, then the continuation values are independent of breakup rule μ and quality q_1. This is a straightforward implication of the renegotiation setup: Recall that if one of the two parties rejects a bargaining offer, it is never optimal for the buyer to exit the contract since by Lemma 1 the call option 'C' yields strictly larger payoffs than 'E'. This is by the negative compensation bias $h(r,\sigma_2) < 0$ for $r > \rho^*$ and the buyer's payoffs under contract Z strictly larger than the compensation for breakup, $\bar{b}(r,\sigma_2) = \bar{b}(\rho^*,\bar{q}) - h(r,\sigma_2) > \bar{b}(\rho^*,\bar{q})$. If, on the other hand, investment falls short of the efficient level, then the compensation bias is positive and $\bar{b}(r,\sigma_2) < \bar{b}(\rho^*,\bar{q})$. Hence, exit '$E$' is the buyer's best response to a rejection of his own (the seller's) renegotiation offer x_S (x_B).

Anticipating this, the seller can "choose" the renegotiation game (i.e. her outside option) to be played by presenting a sufficiently high quality q_1. Assumption 2 ensures that if the seller

Figure 3: The continuation game



delivers a good of quality $q_1 \ge \mu\bar{q}$, the buyer's only credible option is to continue 'C' and call for trade under contract Z. If, however, $q_1 < \mu\bar{q}$, then the buyer's exit threat is indeed credible and his dominant outside option choice is 'E.'

The continuation values are characterized by r, q_1, and θ. Moreover, the seller's equilibrium strategy for the subgame(s) starting at $t = 2$ is perfectly anticipated. Since the model is one of symmetric information, the game can be reduced to a two-stage sequential move game: First, after contract Z is entered the buyer invests in r. Then at the second stage, after observing θ, the seller delivers quality q_1 after which the reduced extensive form game ends. Both r and q_1 trigger renegotiation and continuation values as given in Lemma 3. Figure 3 depicts the structure of this *continuation game*.

4.2 First-period quality

Comparative static results for the continuation values with respect to q_1 are presented in Corollary 1. It can be seen that these continuation values exhibit a discontinuity at the breakup threshold $\mu\bar{q}$. Given some parameter restrictions, the seller benefits from a quality level that is sufficiently high to not yield an exit threat to the buyer.

Corollary 1. *For* $a \in \{b, s\}$ *let* $\delta(\tilde{a}) \equiv \tilde{a}\left(r, q_1, \theta \mid q_1 \ge \mu\bar{q}\right) - \tilde{a}\left(r, q_1, \theta \mid q_1 < \mu\bar{q}\right)$.

1. $\delta(\tilde{b}) \le 0$ *for all* β *and* r*; "<" if* $\theta > 0$ *and* $r < \rho^*$ *or for all* $\beta > 0$ *if* $\theta > 0$ *and* $r = \rho^*$.
2. $\delta(\tilde{s}) \ge 0$ *for all* β *and* r*; ">" if* $r < \rho^*$ *and for all* $\beta > 0$ *if* $r = \rho^*$.

By inducing the discontinuity of second period payoffs, the buyer's threat gives rise to an *ex-post* hold-up problem since the seller's strategic stage-1 "choice" of buyer's stage-2 outside option deviates from the optimal quality level. The seller will be inclined to exert excessive costs in order to prevent buyer's hold-up in stage-2-renegotiations. To see this, note that as valuation and cost functions are additively separable, the optimal quality level is equal to $\sigma^o(r,\theta)$. If the seller's optimization problem is time-separable, then, analogously to σ_2 in equation (7), she will deliver a good 1 of quality $q_1 = \bar{\sigma}(\theta)$. For $r > \rho^*$ the optimal level will be strictly larger than the first-best, for $r < \rho^*$ it will be lower than the *constrained* first-best for all θ such that $\sigma^o(r,\theta)$ and higher for all θ such that $\sigma^o(r,\theta) > \bar{q}$. Note, however, that by Corollary 1 the seller's first period optimization problem

$$\sigma_1 \in \arg\max_{q_1 \leq \bar{q}} w(\rho^*, q_1, \theta) - \bar{b}(\rho^*, \bar{q}) + \tilde{s}(r, q_1, \theta) \tag{13}$$

is not time-separable for all investment levels. The incremental effect of q_1 on $\tilde{s}(r,q_1,\theta)$, denoted by $\delta(\tilde{s})$, renders the seller's second period payoffs a function of the first period quality level. Her first period decision thus reflects her "choice" of the renegotiation game to be played. A sufficiently high q_1 will deprive the buyer of his exit threat and in return improve the seller's bargaining position by raising her outside option value. As is shown in Lemma 4, if $\delta(\tilde{s}) > 0$ and the buyer's exit threat is indeed credible, then there exists a subset $\widetilde{\Theta} \subset \Theta$ of productivity types θ for which a deviation from the constrained first-best strategy is dominant. Instead of delivering a good of quality $\sigma_1 = \sigma^*(\theta) < \mu\bar{q}$, these sellers will strategically *overshoot* and incur additional production costs to be able to deliver a good of quality $\sigma_1 = \mu\bar{q}$ and thus prevent the buyer from exercising his exit threat. As a result, for $r < \rho^*$ the delivered quality level will be even larger and thus more suboptimal, whereas for $r > \rho^*$ quality level σ_1 is unchanged since exit option 'E' is not a credible option. This asymmetry with respect to r follows from the negative compensation bias for overinvestment.

The incentive to overshoot holds for types $\theta \in \widetilde{\Theta}$ such that the additional costs of excessive quality $\mu\bar{q} > \sigma^*(\theta)$ in the first period are offset by the positive incremental effect of $\delta(\tilde{s})$ in the second period. The productivity type $\tilde{\theta}$ is the lowest for which this holds true. This implies that all types below this threshold will deliver a good of quality $\sigma_1 < \mu\bar{q}$, all types equal or above deliver $\sigma_1 \geq \mu\bar{q}$. The proof of Lemma 4 in the Appendix formally develops these conditions.

Lemma 4 (Quality)**.** *The seller's subgame perfect equilibrium strategy σ_1 will be constrained first-best if and only if $\delta(\tilde{s}) = 0$. If $\delta(\tilde{s}) > 0$, then for a nonatomic subset of types θ it holds that $\sigma_1 = \mu\bar{q} > \sigma^*(\theta)$, hence quality level q_1 is inefficiently high with strictly positive probability.*

Given μ, the seller's first period strategy for the subgame with $r > \rho^*$ is equal to a constrained first best, $\bar{\sigma}(\theta) = \min\{\sigma^*(\theta), \bar{q}\}$. For the case with a credible exit threat, $r \leq \rho^*$, the delivered quality of good 1 is denoted by

$$\tilde{\sigma}_1(\mu, r) = \begin{cases} \sigma^*(\theta) & \text{if } \theta < \tilde{\theta} \text{ or } \theta \in [\bar{\theta}^\mu, \bar{\theta}) \\ \mu\bar{q} & \text{if } \theta \in [\tilde{\theta}, \bar{\theta}^\mu) \\ \bar{q} & \text{if } \theta \geq \bar{\theta}, \end{cases} \tag{14}$$

where the threshold of efficient breach $\bar{\theta}$ such that $\sigma^*(\bar{\theta}) = \bar{q}$ and $\bar{\theta}^\mu$ such that $\sigma^*(\bar{\theta}^\mu) = \mu\bar{q}$. The hold-up problem stems from the efficiency losses associated with seller's excessive performance in $\widetilde{\Theta} = \left[\tilde{\theta}, \bar{\theta}^{\mu}\right)$ and is a straightforward implication of the breakup rule. Allowing the buyer to exit a repeat transaction contract gives him a bargaining leverage in *ex-post* renegotiations. The buyer holds up the seller and extracts a factor β of the second period gains of trade $\pi(r, \theta)$ by threatening the termination of the contract and legal enforcement of damages for total breach of contract. The less restricted the breakup rule, i.e. the higher μ, the more pronounced the distortion of the seller's performance incentives and the stronger the hold-up effect will be, as is established in Corollary 2.

Corollary 2. *For $\delta\left(\tilde{s}\right) > 0$, the probability of an excessive quality level $\sigma_1 = \mu\bar{q} > \sigma^*(\theta)$ is increasing in μ and decreasing in r.*

By fully restricting the buyer's exit option, i.e. by a breakup rule such that $\mu = 0$, the seller will never be inclined to deliver an excessively high quality level in period $t = 1$. Hence, the higher the buyer's rent-seeking opportunities, the more diluted the seller's performance incentives will be.

4.3 Specific investment

A full restriction of the buyer's exit option restores the seller's incentives to deliver goods of (constrained) efficient quality. Such an extreme breakup rule, however, may dilute the buyer's *ex-ante* incentives to invest. In order to reconcile the model's implication with the literature on breakup restrictions, I first briefly comment on the case where the seller rather than the buyer engages in (selfish) specific investment. For this purpose, suppose for a moment that r and $\vec{q}$ do not exhibit any complementary effects. While in such a case a positive breakup parameter μ gives the buyer *ex-post* a bargaining leverage over the seller, it does harm him *ex-ante* as he is not able to credibly commit not to threaten cancellation when a $q_1 < \mu\bar{q}$ is delivered. The main implications of Lemma 4 and Corollary 2 are thus in line with the existing law and economics literature on the restriction of contract breakup. Goldberg and Erickson (1987) among others, for instance, argue that harsh quality requirements and legal regulation that allows for "working to the rules" may give the buyer rent-seeking opportunities through an inefficient bargaining leverage over the seller. This will in return lead give rise to a hold-up problem and induce underinvestment by the seller. Williamson (1985; pp. 43–63), for instance, argues that due to asset specificity in transactions, continuity of contracts is of significant value, and protection from opportunism is desirable. Moreover, Crawford (1990) concludes that in settings of repeat trade with seller's relationship-specific investment, one-period contracts lead to inefficient underinvestment. Indeed, parties will then optimally choose to enter long-term contracts since single transaction deals based on repeated bargaining are "unattractive" due to hold-up and parties' rent-seeking. For the context under investigation here, this implies that restricting the buyer's right to prematurely exit the contract protects the seller's investment incentives (in addition to the effects in Lemma 4). The following Proposition—straightforward from Lemma 4 and the standard hold-up results of Crawford (1990) among others—summarizes these insights.

Proposition 1. *Suppose the seller invests in r' at cost $z(r')$ such that $c_{r'}(r', q_i, \theta) < 0$ and $c_{q_i r'}(r', q_i, \theta) < 0$. Then a breakup rule such that $\mu = 0$ is optimal.*

Proposition 1 reflects the main arguments brought forward in favor of a restriction of termination rights for the case when the victim of termination, i.e. the *seller*, is the investing party. In order to induce undiluted investment incentives, future period payoffs need to be protected from buyer's rent-seeking by restricting contract breakup. This result changes substantively, however, if it is instead assumed that the investing party is the buyer as the beneficiary of termination. To grasp the intuition, first consider two aspects with regard buyer's investment incentives that have been extensively discussed in the context of single transaction contracts (cf. Edlin, 1996) and whose implications carry over to repeat transaction contracts. First, an expectation damage remedy, when based on the realized investment level, may induce incentives that lead to overinvestment (see, e.g. Shavell, 1980; Rogerson, 1984). This will indeed be the case if expectation damages serve as a full insurance remedy that give the buyer the full value of investment with certainty, i.e. even when trade does not occur. Referring to Fuller and Perdue (1936) who suggest that only "reasonable" investment be protected by breach remedies, Cooter and Eisenberg (1985; p. 1467) limit expectation damages to what they are under efficient investment (cf. Craswell, 1989; Leitzel, 1989; Spier and Whinston, 1995). That way, if damages are based on the hypothetical efficient level and therefore independent of actual investment, the full insurance argument ceases to apply and the incentive to overinvest is eliminated.

Second, even if efficient expectation damages are the default remedy for seller's breach of contract, the buyer's investment incentives may be diluted due to an *ex-ante* hold-up problem as result of buyer's imperfect bargaining power in contract renegotiations. In general, investing parties will efficiently invest if they can recoup the full returns of their investment expenditures. If their share of the renegotiation surplus, however, is less than one, their incentives are distorted and underinvestment will be the result. Putting it in this paper's notation and trade technology: Given $\bar{q}$ such that there exists a positive renegotiation surplus $g(r, \theta) > 0$, if the probability β of the buyer's offer is less than unity then $r < \rho^*$.

This underinvestment result will hold for all $\beta < 1$, however, only if termination of the relationship is not an option and there is trade in the second period with certainty both on *and* off the equilibrium path, that means if breakup is noncredible for $\mu = 0$. To see this, suppose μ is strictly positive and, given that he underinvests for some $\beta < 1$, the buyer's exit threat credible. The "value" of this threat has two components: First, the effect on the buyer's first period payoffs through the impact of the exit threat on quality level $\sigma_1 = \tilde{\sigma}_1(\mu, r)$, amounting to $\bar{b}(r, \tilde{\sigma}_1(\mu, r)) - \bar{b}(r, \bar{\sigma}(\theta))$; second, the buyer's continuation value of option 'E' relative to 'C', equal to $-\delta(\tilde{b})$ by Corollary 1. The full *threat value* is equal to

$$\int_{\tilde{\theta}}^{\bar{\theta}^{\mu}} \left[h(r, \sigma^*(\theta)) - h(r, \mu\bar{q})\right] f(\theta)\, d\theta + \int_{0}^{\tilde{\theta}} \left[h(r, \sigma^*(\theta)) + \beta\bar{\pi}(r, \theta)\right] f(\theta)\, d\theta \tag{15}$$

and increasing in r for positive β, as can be seen from its first derivative with respect to r,

$$\int_{\tilde{\theta}}^{\bar{\theta}^{\mu}} \frac{\partial \left[v\left(r,\mu\bar{q}\right)-v\left(r,\sigma^{*}\left(\theta\right)\right)\right]}{\partial r} f\left(\theta\right) d\theta-\left(1-\beta\right)\int_{0}^{\tilde{\theta}} \frac{\partial v\left(r,\sigma^{*}\left(\theta\right)\right)}{\partial r} f\left(\theta\right) d\theta$$
$$+\frac{\partial\tilde{\theta}}{\partial r} f\left(\tilde{\theta}\right)\left[h\left(r,\mu\bar{q}\right)-\beta h\left(r,\sigma^{*}\left(\tilde{\theta}\right)\right)+\beta\pi\left(\rho^{*},\tilde{\theta}\right)\right] \;\; > \;\; 0. \qquad (16)$$

The buyer's bargaining leverage induced by μ thus yields additional returns on investment r. That way, the breakup rule enhances the buyer's (exogenous) bargaining power β, and if this rent-seeking effect is strong and his "break-up" rents high enough, it may fully restore his investment incentives when he would otherwise underinvest for $\beta < 1$. Lemma 5 formalizes these results. It states that for a positive breakup rule $\hat{\mu}\left(\beta,\bar{q}\right)$ the buyer efficiently invests, yet that for all $\mu < \hat{\mu}\left(\beta,\bar{q}\right)$ investment r falls short of the efficient level ρ^{*}. Moreoever, it also shows that the buyer will never overinvest even if his bargaining leverage exceeds the level of efficiency restoration. This implication is a direct consequence of the application of *efficient* expectation damages and negative compensation bias (Lemma 1) for $r > \rho^{*}$. By overinvesting, the buyer forfeits the credibility of his exit threat which deprives him of the positive investment returns.

Lemma 5 (Investment)**.** *Buyer's specific investment r is a function of the breakup rule μ that complements his bargaining power β. For a repeat transaction contract Z there exists a $\hat{\mu}\left(\beta,\bar{q}\right) > 0$ such that the buyer efficiently invests $r = \rho^{*}$ for $\mu \geq \hat{\mu}\left(\beta,\bar{q}\right)$ and underinvests for all β if $\mu < \hat{\mu}\left(\beta,\bar{q}\right)$.*

The Corollary to Lemma 5 gives comparative statics results of the investment restoring $\hat{\mu}\left(\beta,\bar{q}\right)$ and comments on its feasibility. As the buyer's incentive dilution, i.e. the degree of underinvestment, increases with lower β and $\bar{q}$, a stronger rent-seeking effect is required to restore efficient investment incentives. For low values of β and $\bar{q}$ an infeasible breakup rule $\hat{\mu}\left(\beta,\bar{q}\right)$ outside the unit interval may be the result.

Corollary 3. (1) $\hat{\mu}_{\beta}\left(\beta,\bar{q}\right) < 0$*;* (2) $\hat{\mu}_{\bar{q}}\left(\beta,\bar{q}\right) < 0$*;* (3) $\hat{\mu}\left(\beta,\bar{q}\right)$ *is not within the unit interval for sufficiently small values of β and $\bar{q}$.*

Given β and $\bar{q}$, for the semi-renegotiated contract under contract rigidity the *subgame perfect equilibrium (SPE)* strategies are functions of the breakup rule μ and denoted by $\vec{\rho}\left(\mu\right) = \left(\rho\left(\mu\right),\tau\right)$ for the buyer and $\vec{\sigma}\left(\mu,\theta\right) = \left(\sigma_{1}\left(\mu,\theta\right),\sigma_{2}\left(\mu,\theta\right)\right)$ for the seller. They are characterized by the results of Lemmata 4 and 5, and for $\tilde{\sigma}_{1}\left(\mu\right) \equiv \tilde{\sigma}_{1}\left(\mu,\rho\left(\mu\right)\right)$ are given as

$$\left\{\vec{\rho}\left(\mu\right),\vec{\sigma}\left(\mu,\theta\right)\right\} = \begin{cases} \left\{\left(\rho\left(\mu\right) < \rho^{*},C\right),\left(\bar{\sigma}\left(\theta\right),\sigma^{o}\left(\rho\left(\mu\right),\theta\right)\right)\right\} & \text{if } \mu = 0 \\ \left\{\left(\rho\left(\mu\right) < \rho^{*},C\right),\left(\tilde{\sigma}_{1}\left(\mu\right),\sigma^{o}\left(\rho\left(\mu\right),\theta\right)\right)\right\} & \text{if } 0 < \mu < \hat{\mu}\left(\beta,\bar{q}\right) \\ \left\{\left(\rho^{*},C\right),\left(\tilde{\sigma}_{1}\left(\mu\right),\sigma^{*}\left(\theta\right)\right)\right\} & \text{if } \hat{\mu}\left(\beta,\bar{q}\right) \leq \mu. \end{cases} \qquad (17)$$

In the next section, I investigate the properties of this SPE with respect to the breakup rule. So far μ has been viewed as an exogenous model parameter. For the remainder of the paper I will treat it as additional decision variable and analyze its strategic dimension. On the one hand, one may look at it from a *public* solution perspective. That means a lawmaker specifies a detailed default rule that simply needs to be enforced by a court of law, or it remains vague in its ruling which allows for a litigator's discretionary policy. On the other hand, the decision over μ may be seen as *private* solution: Parties do not rely on the lawmaker or third party litigators to fully assess their trade relationship but specify the exact breakup rule in their contract and rely on its enforcement only. In any case, since the given model does not exhibit any external effects on other agents,[11] if the public solution is founded on welfare maximization principles and does not differ in terms of transaction costs, then it will simply replicate the private contractual solution. I will therefore abstract from the question of who specifies the breakup rule and simply report results on existence or nonexistence of a μ^* that implements the first-best outcome.

5 Optimal breakup rules

The class of repeat transaction contracts is defined as the set of simple contracts that specify a price and quality for the goods to be delivered. Since the quality level is by assumption restricted such that $\bar{q} < q^{\max}$ and thus some θ for which $\sigma^*(\theta) > \bar{q}$, a first-best quality level for good i, given $r = \rho^*$ and the no-windfall-gains assumption in equation (5), will only be delivered for all θ if the contract is renegotiated. Recall that the choice set $\overline{Q}_R$ for $\bar{q}_R$ is unrestricted. This first-best quality up to full conformity was defined as *constrained first-best* $\bar{\sigma}(\theta) \equiv \min\{\sigma^*(\theta), \bar{q}\}$. The fact, that the first period quality level cannot be first-best for all θ in a semi-renegotiated contract framework implies that a first-best outcome as introduced in Definition 1 is not an appropriate benchmark. Hence, for the case of semi-renegotiation, I consider a first-best equilibrium outcome with the first period quality level an efficient $\sigma^*(\theta)$ up to full conformity $\bar{q}$. Note that if an outcome is first-best it is also constrained first-best, but not vice versa.

Definition 4. *An equilibrium outcome is constrained first-best if the parties' strategies are equal to* $\left\{\bar{\rho}^*, \left(\bar{\sigma}(\theta), \sigma^*(\theta)\right)\right\}$.

5.1 Second-best under contract rigidity

The following Proposition presents the efficiency properties of the SPE under contract rigidity with the sequence of actions depicted in Figure 1. From equation (17) it has already become clear that the equilibrium strategies are not constrained first-best. This is because the seller will only deliver a first-best second quality if the buyer invests efficiently for $\hat{\mu}(\beta, \bar{q})$. The resulting bargaining leverage, however, will induce the seller to inefficiently overshoot in the first period (*ex-post* hold-up). A constrained first-best quality in $t = 1$ will only be delivered for $\mu = 0$; in that case, if $g(\rho^*, \theta) > 0$ for some θ, the buyer, being deprived of his breakup

[11] See Ganglmair (2007) for a related analysis accounting for externalities.

rents, will underinvest for all β (*ex-ante* hold-up).[12] Then, the second period quality falls short of the efficient level, $\sigma^o(r,\theta) < \sigma^*(\theta)$ for all θ. A second-best breakup rule μ^{**} thus balances the effects of buyer's rent-seeking and trades off the inefficiencies from underinvestment (and second period quality) and excessive first period quality.

Proposition 2 (Contract rigidity)**.** *Let the contract be semi-renegotiated. A breakup rule μ^* such that the equilibrium outcome is constrained first-best does not exist. A second-best equilibrium outcome is implemented by a strictly positive breakup rule μ^{**}.*

As long as $\bar{q} > 0$ and $\beta > 0$, the seller will always overshoot for any $r \leq \rho^*$ and $\mu > 0$. Under the assumption of contract rigidity, a (constrained) first-best can therefore only be implemented if $\mu = 0$ and $\bar{q}$ and β such that $\hat{\mu}(\beta,\bar{q}) = 0$. This is accomplished if there are no types θ such that the traded quality level is insufficient and the buyer has full bargaining power, hence in case of unrestricted contract choice such that $\bar{q} = q^{\max}$ and $\beta = 1$. The first condition implies that the returns on investment are not suboptimal, the second ensures that the buyer indeed receives the full returns and thus exhibits undiluted investment incentives at stage 0. Corollary 4 summarizes this polar case; note that for such a *Cadillac contract* (Edlin, 1996) the quality level $\bar{\sigma}(\theta) = \sigma^*(\theta)$ is unconstrained for all θ and the benchmark a first-best $\{\vec{\rho}, \vec{\sigma}^*(\theta)\}$.

Corollary 4 (Cadillac contract)**.** *Suppose that $\bar{q} = q^{max}$, then $\mu^* = 0$ implements the benchmark outcome if and only if $\beta = 1$.*

Given any restricted $\bar{q} \in \overline{Q}$, the assumption of contract rigidity renders the first-best benchmark non-implementable since the buyer underinvests even for full bargaining power $\beta = 1$, and additional bargaining leverage through $\mu > 0$ is required to restore his efficient incentives. If contract choice is unrestricted and $\bar{q} = q^{\max}$, then only an offer probability of $\beta = 1$ yields undiluted investment incentive, and rent-seeking through $\mu > 0 = \hat{\mu}(1, q^{\max})$ is not favorable as it distorts the seller's quality decisions. Hence, for the setup with contract rigidity such that Z is only semi-renegotiated the hold-up problem prevails for buyer's imperfect bargaining power. Its negative efficiency effects, however, can be mitigated by specifying an appropriate breakup rule.

5.2 First-best under frictionless renegotiation

For the final part of the paper, I assume renegotiation of Z to be without any frictions. In such a setting, the equilibrium results for the semi-renegotiated contract serve as disagreement point payoffs for stage-1-renegotiations. The argument for this is straightforward: If parties fail to agree in stage 1, they will trade good 1 under the terms of contract Z and re-enter renegotiations before the delivery of good 2 (cf. Figure 2). At this point they will engage in

[12]Since $\bar{q} < q^{\max}$ in order for $g(\rho^*,\theta) > 0$ and since the first period not renegotiated, the fact that $\bar{\sigma}_1 = \bar{q} < \sigma^*(\theta)$ and $v_r(r,\bar{q}) < v_r(r,\sigma^*(\theta))$ for some θ, dilutes the buyer's investment incentives even if he receives the entire stage-2-renegotiation surplus. See also the proof of Lemma 5 in the Appendix and Corollary 4.

stage-2-renegotiations with continuation values as given in Lemma 3. When engaging in stage-1-renegotiations, the disagreement point payoffs are equal to what the parties will receive if trade is under the terms of Z in $t = 1$ and of Z_R in $t = 2$. Given μ, r and θ, by equation (17) these payoffs amount to

$$\widetilde{S}\left(r, \tilde{\sigma}_1\left(\mu, r\right), \theta\right) = w\left(\rho^*, \tilde{\sigma}_1\left(\mu, r\right), \theta\right) - \bar{b}\left(\rho^*, \bar{q}\right) + \tilde{s}\left(r, \tilde{\sigma}_1\left(\mu, r\right), \theta\right) \tag{18}$$

for the seller and

$$\widetilde{B}\left(r, \tilde{\sigma}_1\left(\mu, r\right), \theta\right) = \bar{b}\left(r, \tilde{\sigma}_1\left(\mu, r\right)\right) + \tilde{b}\left(r, \tilde{\sigma}_1\left(\mu, r\right), \theta\right) \tag{19}$$

for the buyer. Because state (r, θ) is observable to both parties and constant over time, from equation (9) it is known that the new time-invariant quality level for delivery of good 1 and good 2 is equal to $\bar{q}_R\left(r, \theta\right)$ and maximizes the gains of trade $W\left(r, \vec{q}, \theta\right)$. In equilibrium, $\rho\left(\mu\right) \leq \rho^*$ holds, thus by equation (10) the seller delivers a quality level $\sigma_R = \bar{q}_R\left(r, \theta\right)$ in both periods. Moreover, $\sigma_R \geq \mu\bar{q}_R\left(r, \theta\right)$ for all μ, hence the seller is not inclined to overshoot and $\sigma_1 = \sigma_2 = \bar{q}_R\left(r, \theta\right)$ independent of μ. The equilibrium quality levels are therefore $\vec{\sigma}^o\left(r, \theta\right) = \left(\sigma^o\left(r, \theta\right), \sigma^o\left(r, \theta\right)\right)$. As the buyer's investment is a function of breakup rule μ and denoted by $r = \rho\left(\mu\right)$, the seller's equilibrium strategy vector can be rewritten as $\vec{\sigma}^o\left(\rho\left(\mu\right), \theta\right)$. Analogously to Lemma 5, an appropriate $\mu = \hat{\mu}\left(\beta, \bar{q}\right)$, if it exists given β and $\bar{q}$, restores the buyer's investment incentives. Hence, if the public or private choice of the breakup rule is $\mu = \hat{\mu}\left(\beta, \bar{q}\right)$, then $r = \rho\left(\hat{\mu}\left(\beta, \bar{q}\right)\right) = \rho^*$ and $\vec{\sigma}^o\left(\rho\left(\hat{\mu}\left(\beta, \bar{q}\right)\right), \theta\right) = \vec{\sigma}^o\left(\rho^*, \theta\right) = \vec{\sigma}^*\left(\theta\right)$.

Proposition 3 (Full-renegotiation). *If the repeat transaction contract Z is fully renegotiated, then there exists a positive $\mu = \hat{\mu}\left(\beta, \bar{q}\right) = \mu^*$ such that the first-best outcome is implemented.*

Recall from Lemma 3 that the buyer forfeits his exit threat if he overinvests. That means for any investment level $r > \rho^*$ the threat value in equation (15) is equal to zero, and overinvestment is therefore strictly dominated by $r = \rho^*$. This implies that, if μ is such that it ensures efficient investment, any breakup rule higher than this investment restoring level does not affect the buyer's incentives. His increased bargaining leverage yields a higher threat value, but, despite the positive effect on the marginal investment returns in equation (16), still induces efficient investment incentives. Hence, since the seller's equilibrium strategy vector $\sigma^*\left(\theta\right)$ is independent of μ, the SPE is first-best for all $\mu > \hat{\mu}\left(\beta, \bar{q}\right)$. As a result, the parties' joint expected surplus is constant for sufficiently high levels of μ. The buyer's increased *ex-post* bargaining leverage will be fully priced in *ex-ante*; it will, however, result in *ex-post* redistribution.

Corollary 5 (Redistribution). *Any breakup rule $\mu > \mu^*$ implements a first-best outcome and redistributes the realized gains of trade from the seller to the buyer.*

Given Proposition 3 and Corollary 5, the SPE for a repeat transaction contract with frictionless renegotiation can be rewritten as

$$\{\vec{\rho}(\mu), \vec{\sigma}(\mu,\theta)\} = \begin{cases} \{(\rho(\mu) < \rho^*, C), \\ \quad (\sigma^o(\rho(\mu),\theta), \sigma^o(\rho(\mu),\theta))\} & \text{if } 0 < \mu < \hat{\mu}(\beta,\bar{q}) \\ \{(\rho^*, C), (\sigma^*(\theta), \sigma^*(\theta))\} & \text{if } \hat{\mu}(\beta,\bar{q}) \leq \mu. \end{cases} \tag{20}$$

The seller overshoots only off the equilibrium path. By the assumption of perfect state observability, the parties are able to agree on equilibrium quality levels on the Pareto-frontier, the optimization problem with respect to μ is therefore reduced to inducing efficient equilibrium investment. Allowing the buyer to engage in rent-seeking, by granting the breakup option with positive probability, has a positive social value. The buyer's opportunism is in fact required to achieve a first-best outcome. Suppose the buyer were able to fully commit not to cancel the contract, i.e. exercise his exit threat, by $\mu = 0$ or an upfront payment that ensures that he will never do so (cf. Edlin, 1996), then his investment incentives will be diluted (unless $\bar{q} = q^{\max}$ and $\beta = 1$). Hence, having the ropes untied by his seamen might not be a bad strategy for Ulysses after all.

In Corollary 3, I briefly commented on the existence of an investment restoring $\hat{\mu}(\beta,\bar{q})$. While in case of contract rigidity a $\hat{\mu}(\beta,\bar{q}) > 1$ may still allow for a second-best breakup rule within the bounds of the unit interval, $\mu^{**} < 1$, a first-best rule μ^* exists if and only if $\hat{\mu}(\beta,\bar{q})$ exists. Corollary 6 complements the existence arguments.

Corollary 6 (Existence). *Let $\underline{q}(\beta) \in \overline{Q}_R$ such that $\hat{\mu}(\beta, \underline{q}(\beta)) = 1$. Then for any contract Z with $\bar{q} \in [\underline{q}(\beta), q^{max}]$ and Assumption 2 satisfied, there exists an appropriate breakup rule such that buyer's rent-seeking restores the first-best outcome $\{\vec{\rho}^*, \vec{\sigma}^*(\theta)\}$.*

5.3 Legal implications

As mentioned in the introductory section, U.S. contract law explicitly accounts for repeat transaction contracts ("installment contract") and stipulates a breakup rule that is conditional on the seller's performance rather than the likelihood of future nonconformities.[13] Section §2-612 of the Uniform Commercial Code (American Law Institute, 2000; White and Summers, 2000) defines such an installment contract as one over "the delivery of goods in separate lots to be separately accepted." It rules that if a nonconformity in one of the installments "substantially impairs" the value of the whole contract, then there is total breach of contract. In that case the buyer can anticipatorily reject any future installments and is entitled to full compensation for these nondelivered goods. A strict compliance rule, i.e. a *lax breakup rule*, thuse expands the buyer's right to terminate, that means increases the probability of a credible exit option 'E.'

[13] International commercial law gives rules "consistent" (Speidel, 1992; p. 140) with the ones observed in the United States (see also Bugge, 1999; Katz, 2005), although with different terminology: The *Convention on Contracts for the International Sale of Goods (CISG)* requires "fundamental breach" in order for the buyer to "avoid" (cancel, exit) the contract (Hull, 2005; p. 150).

Comment 6 of that Section offers guidelines as to the nature of nonconformities that may be considered when determining such substantial impairment. It states that "whether the nonconformity in any given installment justifies cancellation as to the future depends not on whether such nonconformity indicates an intent or likelihood that the future deliveries will also be defective, but whether the nonconformity substantially impairs the value of the whole contract." The breakup rule in Definition 3 accounts for this conditionality on seller's actual performance and has implications on the bargaining routines in stage-1 and stage-2-renegotiations. The game to be played (via the buyer's outside options) in the latter setup is by parties' choice. In the former scenario the buyer can anticipate the seller's (off-equilibrium) delivery of the first quality level, yet cannot threaten a termination of the contract upon observation of a sufficiently low type $\theta < \tilde{\theta}$. Notice that if the breakup rule were conditional on the seller's type, we would obtain a constrained first-best outcome even under contract rigidity (cf. Proposition 2). To see this, suppose θ is verifiable, yet writing a fully contingent contract is prohibitively costly, hence Z incomplete and simple. While in stage-2-renegotiations the buyer exercises his exit threat if θ is sufficiently low, the seller will not benefit from overshooting as the breakup rule is now conditional on a state variable. Efficient expectation damages imply that she will deliver a constrained first-best quality vector for all θ while the breakup rule can be adjusted such that the buyer's investment incentives are undiluted. The model's results suggest that under certain conditions (in particular verifiability of state variable θ) the guidelines in Comment 6 of Section §2-612 of the Uniform Commercial Code may indeed distract trade and facilitate suboptimal outcomes.

The legal literature on contract termination restrictions has argued in favor of a deviation from the strict compliance rules in order to protect investment incentives.[14] These implications, however, only hold true if the investing party is the victim of termination (cf. Proposition 1), i.e. the seller. If the investor is indeed the buyer, a restriction of the exit option aligns the seller's performance incentives, yet it may render the buyer's investment incentives diluted. Allowing for buyer's opportunistic rent-seeking and thus increasing his returns on investment can restore a second or even first-best outcome. Moreover, if the buyer's bargaining power is sufficiently low, a strict compliance rule such that $\mu = 0$ may indeed be necessary to induce efficient investment. As provocative as it may sound, insisting on a *substantial* rather than a *strict compliance standard* of performance, as promoted for instance by Llewellyn (1937; pp. 375ff), may in the end lead to insufficient investment.

6 Conclusions

I consider a repeat transaction model with buyer's specific investment and show that if termination of trade is in the buyer's choice set, then simple renegotiable contracts can implement a first-best outcome if termination is restricted by an appropriate linear breakup rule (*public*

[14]See, e.g., Goldberg and Erickson (1987) for long-term contracts or Goetz and Scott (1981), Baird, Gertner, and Picker (1994; p. 232), or Schwartz and Scott (2003) for *mandatory acceptance of substantial performance.*

solution, legal default rule; or *private solution*, contract clause). This result will hold as long as contract renegotiation is frictionless and the entire contract can be adapted to the realized state. Then, an optimal breakup rule, that is conditional on the seller's performance, gives the buyer the right to exit the contract with strictly positive probability. In *ex-post* renegotiations, the buyer will exploit this threat and expropriate future rents from the seller. These expected "breakup rents" increase his returns on investment. The bargaining leverage that arises from the breakup rule therefore complements his *ex-post* bargaining power and restores his *ex-ante* investment incentives when he would otherwise underinvest. A breakup rule may thus "correct" for deviations from full bargaining power and mitigate the resulting hold-up problem.

When the contract is not fully flexible, i.e. the contract can be renegotiated only after the first commodity has been delivered, then the buyer's exploitation of the exit threat holds up the seller who in equilibrium will overshoot in order not to grant the buyer the right to terminate. For such a setting with contract rigidity, a first-best outcome cannot be implemented by a simple contract and a conditional breakup rule. This is because the seller will efficiently perform only for a full restriction of buyer's termination, which in return deprives the buyer of his "breakup rents" and dilutes his investment incentives. A second-best outcome is implemented by a breakup rule that allows both for seller's excessive performance and buyer's inefficiently low investment.

The contract literature has brought forward an array of complex contractual solutions that implement a first-best outcome. In reality, however, contracts are observed to be much simpler than is theoretically predicted (see, e.g., Macaulay, 1963; Hart and Holmström, 1987). One possible reason, as argued by Huberman and Kahn (1988) among others is that in order to save on contracting costs, agents substitute for complex contracts and enter simple agreements that are renegotiated after uncertainties are resolved. Similarly, parties may rely on (efficient) legal default rules and standards to fill gaps in their contracts and thus shift the burden of transactions costs to the public (see, e.g., Ayres and Gertner, 1989; Schwartz, 1992). The insights from the semi-renegotiated contract (cf. also Watson, 2007) suggest that entering simple, renegotiable contracts is only reliable if renegotiation is without frictions.

In both presented renegotiation scenarios, a positive breakup rule allows for buyer's opportunistic rent-seeking that mitigates the hold-up problem from less-than-perfect bargaining power. The buyer's opportunism thus generates social value; put differently, without his opportunistic behavior a first-best outcome is not reached. This result has interesting implications for the literature on compliance rules. The conventional wisdom is that restricting premature contract termination protects specific investment in long-term contractual relationships. The right to terminate is thus not granted for trivial defects of delivery (strict compliance) but if a nonconformity is substantial. This, however, will not hold true if the investing party is not the victim of termination. If one party decides both on the level of specific investment and the continuation or termination of trade, then a *strict compliance standard* may indeed be optimal as it restores rather than distorts investment incentives.

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Appendix

Proof of Lemma 1 (Compensation bias)

Proof. The buyer's true expectation interest given r is equal to $v(r,\bar{q}) - \bar{p}$. By equation (5) he is compensated as if he had efficiently invested. His effective payoffs, given damages in (5) amount to $\bar{b}(r,q_i) = v(r,q_i) - \bar{p} + v(\rho^*,\bar{q}) - v(\rho^*,q_i)$. Rearranging this yields $\bar{b}(r,q_i) = v(\rho^*,\bar{q}) - \bar{p} - h(r,q_i)$. The difference between the compensated payoffs and the true expectation interest is given as

$$\begin{aligned}\bar{b}(r,q_i) - (v(r,\bar{q}) - \bar{p}) &= v(\rho^*,\bar{q}) - \bar{p} - h(r,q_i) - v(r,\bar{q}) + \bar{p} \\ &= v(\rho^*,\bar{q}) - v(r,\bar{q}) - h(r,q_i) \\ &= h(r,\bar{q}) - h(r,q_i)\end{aligned}$$

By definition of $h(\cdot)$, this expression is equal to zero for $r = \rho^*$. By the assumption of positive cross-derivatives $v_{q_i r} > 0$ it is straightforward that the compensation bias is positive for underinvestment $r < \rho^*$ and negative if $r > \rho^*$, given $q_i < \bar{q}$. For a fully or supraconforming $q_i \geq \bar{q}$ the buyer is not compensated. Q.E.D.

Proof of Lemma 2

Proof. Let there be three cases: *1.* $r < \rho^*$, *2.* $r = \rho^*$, and *3.* $r > \rho^*$.

1. For $r < \rho^*$: It is to be shown that $\pi(r,\theta) = w(r,\sigma^o(r,\theta),\theta) \geq w(r,\sigma_2,\theta) = \bar{\pi}(r,\theta)$ for $\sigma_2 = \min\{\sigma^*(\theta),\bar{q}\}$. As $\sigma^o(r,\theta) \in \arg\max_{q_2} w(r,q_2,\theta)$ the inequality holds strict for all θ such that $\sigma^o(r,\theta) \neq \bar{q}$ and is in equality if, given r, the optimal quality is just conforming, $\sigma^o(r,\theta) = \bar{q}$.
2. For $r = \rho^*$: Similar to the argument in *1.*, the inequality is strict if θ such that $\sigma^*(\theta) \neq \bar{q}$.
3. For $r > \rho^*$: Since $\sigma_R = \sigma^*(\theta)$, $\pi(r,\theta) = w(r,\sigma^*(\theta),\theta) \geq w(r,\sigma_2,\theta) = \bar{\pi}(r,\theta)$ holds by the argument of constrained maximization (no-windfall-gains assumption) under Z. Q.E.D.

Proof of Lemma 3 (Continuation values)

Proof. The parties' outside option payoffs are as follows:

$$\text{buyer plays continue `}C\text{'} \quad : \quad \left(\bar{b}(r,\sigma_2), \bar{\pi}(\rho^*,\theta) - \bar{b}(\rho^*,\bar{q})\right) \tag{A1}$$

$$\text{buyer plays exit `}E\text{'} \quad : \quad \begin{cases} \left(\bar{b}(\rho^*,\bar{q}), -\bar{b}(\rho^*,\bar{q})\right) & \text{if } q_1 < \mu\bar{q} \\ \left(-\bar{s}_2^e, \bar{s}_2^e\right) & \text{if } q_1 \geq \mu\bar{q}. \end{cases} \tag{A2}$$

The seller will accept the buyer's renegotiation offer x_S if it grants her payoffs that are at least as high as under as her respective outside option value. Analogously, the buyer will accept the seller's offer x_B if he is at least as well off as under the respective outside option.

For the subgame starting after the rejection of an offer x_S or x_B, the buyer's play $\tau = E$ is strictly dominated if $r > \rho^*$. This implies that at this stage of the game the buyer will not exercise his break-up option and an exit threat is not credible. The relevant outside option is therefore 'C.' To see this, not that by Lemma 1 it holds that $\bar{b}(\rho^*,\bar{q}) < \bar{b}(r,\sigma_2) = \bar{b}(\rho^*,\bar{q}) - h(r,q_2)$. If $r \leq \rho^*$ and $\bar{b}(\rho^*,\bar{q}) \geq \bar{b}(r,q_2)$, Assumption 2 ensures that the buyer's exit threat is credible (i.e. the payoffs from exit not dominated in the subgame starting after rejection) if and only if $q_1 < \mu\bar{q}$. Suppose the buyer plays 'E' if $q_1 \geq \mu\bar{q}$; then it needs to hold that $-\bar{s}_2^e > \bar{b}(r,\sigma_2) = \bar{b}(\rho^*,\bar{q}) - h(r,\sigma_2)$. Rearranging this expression yields $\mathbb{E}(\bar{\pi}(\rho^*,\theta)) < h(r,\sigma_2)$ with $\mathbb{E}$ an expectation operator over *cdf* $F(\theta)$. By monotinicity of $v(\cdot)$ in r and q_2 it holds that $h(r,\sigma_2)$ is maximized for $r = 0$ and θ such that $\sigma_2 = \bar{q}$. Since by Assumption 1 the inequality is violated, it does not hold for all possible pairs of r and q_2, establishing the non-credibility of 'E' if $q_1 \geq \mu\bar{q}$.

Let $r > \rho^*$. With probability β, the buyer makes an offer x_S yielding his payoffs (if accepted) of $\pi(r,\theta) - x_S$, where $\pi(r,\theta)$ is defined in Lemma 2. Similarly, with probability $1-\beta$ the seller's offer x_B

yields her own payoffs $\pi(r,\theta) - x_B$. The payoff vectors are

$$\begin{aligned}
\begin{pmatrix} \pi(r,\theta) - x_S \\ x_S \end{pmatrix} &= \begin{pmatrix} \pi(r,\theta) - \bar{\pi}(\rho^*,\theta) + \bar{b}(\rho^*,\bar{q}) \\ \bar{\pi}(\rho^*,\theta) - \bar{b}(\rho^*,\bar{q}) \end{pmatrix} \\
\begin{pmatrix} x_B \\ \pi(r,\theta) - x_B \end{pmatrix} &= \begin{pmatrix} \bar{b}(r,\sigma_2) \\ \pi(r,\theta) - \bar{b}(r,\sigma_2) \end{pmatrix}.
\end{aligned}$$

This yields continuation values

$$\begin{aligned}
\tilde{b}\left(r,q_1,\theta \mid r > \rho^*\right) &= \beta(\pi,\theta(r) - x_S) + (1-\beta)x_B \\
&= \beta\left[\pi(r,\theta) - \bar{\pi}(\rho^*,\theta) + \bar{b}(\rho^*,\bar{q})\right] + (1-\beta)\bar{b}(r,\sigma_2) \\
&= \bar{b}(r,\sigma_2) + \beta\left[\pi(r,\theta) - \bar{\pi}(\rho^*,\theta) + h(r,\sigma_2)\right] \\
&= \bar{b}(r,\sigma_2) + \beta\left[\pi(r,\theta) - \bar{\pi}(r,\theta)\right] \\
&= \bar{b}(r,\sigma_2) + \beta g(r,\theta) \qquad \text{(A3)}
\end{aligned}$$

for the buyer and

$$\begin{aligned}
\tilde{s}\left(r,q_1,\theta \mid r > \rho^*\right) &= \beta x_S + (1-\beta)(\pi(r,\theta) - x_B) \\
&= \beta\left(\bar{\pi}(\rho^*,\theta) - \bar{b}(\rho^*,\bar{q})\right) + (1-\beta)\left(\pi(r,\theta) - \bar{b}(r,\sigma_2)\right) \\
&= \bar{\pi}(\rho^*,\theta) - \bar{b}(\rho^*,\bar{q}) + (1-\beta)\left[\pi(r,\theta) - \bar{\pi}(\rho^*,\theta) + h(r,\sigma_2)\right] \\
&= \bar{\pi}(\rho^*,\theta) - \bar{b}(\rho^*,\bar{q}) + (1-\beta)g(r,\theta) \qquad \text{(A4)}
\end{aligned}$$

for the seller. By the above credibility argument it holds true that the renegotiation game yields the continuation values in (A3) and (A4) also for $r \leq \rho^*$ and $q_1 \geq \mu\bar{q}$, i.e. $\tilde{b}\left(r,q_1,\theta \mid r > \rho^*\right) = \tilde{b}\left(r,q_1,\theta \mid r \leq \rho^*, q_1 \geq \mu\bar{q}\right)$ and $\tilde{s}\left(r,q_1,\theta \mid r > \rho^*\right) = \tilde{s}\left(r,q_1,\theta \mid r \leq \rho^*, q_1 \geq \mu\bar{q}\right)$.

For $r \leq \rho^*$ and $q_1 < \mu\bar{q}$, continuation values $\tilde{b}$ and $\tilde{s}$ are determined in the same way. The renegotiation payoffs for buyer's and seller's take-it-or-leave-it offer are

$$\begin{aligned}
\begin{pmatrix} \pi(r,\theta) - x_S \\ x_S \end{pmatrix} &= \begin{pmatrix} \pi(r,\theta) + \bar{b}(\rho^*,\bar{q}) \\ -\bar{b}(\rho^*,\bar{q}) \end{pmatrix} \\
\begin{pmatrix} x_B \\ \pi(r,\theta) - x_B \end{pmatrix} &= \begin{pmatrix} \bar{b}(\rho^*,\bar{q}) \\ \pi(r,\theta) - \bar{b}(\rho^*,\bar{q}) \end{pmatrix}.
\end{aligned}$$

The resulting continuation values are

$$\tilde{b}\left(r,q_1,\theta \mid r \leq \rho^*, q_1 < \mu\bar{q}\right) = \bar{b}(\rho^*,\bar{q}) + \beta\pi(r,\theta) \qquad \text{(A5)}$$

for the buyer and

$$\tilde{s}\left(r,q_1,\theta \mid r \leq \rho^*, q_1 < \mu\bar{q}\right) = -\bar{b}(\rho^*,\bar{q}) + (1-\beta)\pi(r,\theta) \qquad \text{(A6)}$$

for the seller. It is straightforward to see that the renegotiation game proposed in Section 3 implements an asymmetric Nash-bargaining solution with the outside option payoffs in equations (A1) and (A2) as disagreement point payoffs and β the buyer's bargaining share of the renegotiation surplus $g(r,\theta)$ (and $\pi(r,\theta)$ in case of a credible exit threat for $q_1 < \mu\bar{q}$). Q.E.D.

Proof of Corollary 1

Proof. 1. (a) For $r \leq \rho^*$: By the payoffs in Lemma 3:

$$\begin{aligned}
\tilde{b}\left(r,q_1,\theta \mid q_1 \geq \mu\bar{q}\right) &\leq \tilde{b}\left(r,q_1,\theta \mid q_1 < \mu\bar{q}\right) \\
\bar{b}(r,\sigma_2) + \beta g(r,\theta) &\leq \bar{b}(\rho^*,\bar{q}) + \beta\pi(r,\theta) \\
-h(r,\sigma_2) + \beta g(r,\theta) &\leq \beta\pi(r,\theta) \\
-\beta\bar{\pi}(r,\theta) &\leq h(r,\sigma_2) \qquad \text{(A7)}
\end{aligned}$$

Note that $h(r, \sigma_2) = 0$ if $r = \rho^*$ or $\sigma_2 = 0$. Since $\tau = E$ is not an equilibrium strategy for the buyer, $\sigma_2 = 0$ if and only if $\theta = 0$. In that case, the expression in equation (A7) is reduced to $-\beta 0 = 0$. If $r = \rho^*$, then the inequality is strict only if the LHS of (A7) is negative, which is true for $\beta > 0$ and $\theta > 0$. If $r < \rho^*$ and $\theta > 0$, then the RHS is strictly positive, the inequality in (A7) is strict for all β.

(b) For $r > \rho^*$: Straightforward by the payoffs in Lemma 3.

2. (a) For $r \leq \rho^*$: By the payoffs in Lemma 3,

$$\begin{aligned} \tilde{s}\left(r, q_1, \theta \;\middle|\; q_1 \geq \mu\bar{q}\right) &\geq \tilde{s}\left(r, q_1, \theta \;\middle|\; q_1 < \mu\bar{q}\right) \\ \bar{\pi}(\rho^*, \theta) - \bar{b}(\rho^*, \bar{q}) + (1-\beta)\, g(r, \theta) &\geq -\bar{b}(\rho^*, \bar{q}) + (1-\beta)\, \pi(r, \theta) \\ \bar{p}i(\rho^*, \theta) &\geq (1-\beta)\, \bar{\pi}(r, \theta) \\ w(\rho^*, \sigma_2, \theta) &\geq (1-\beta)\, w(r, \sigma_2, \theta). \end{aligned} \tag{A8}$$

Recall from equation (7) that $\sigma_2 \in \arg\max_{q_2 \leq \bar{q}} w(\rho^*, q_2, \theta)$, and for $r < \rho^*$ it holds true for all θ that

$$w(r, \sigma_2, \theta) = v(r, \sigma_2) - c(\sigma_2, \theta) < v(\rho^*, \sigma_2) - c(\sigma_2, \theta) = w(\rho^*, \sigma_2, \theta).$$

Hence, the inequality in equation (A8) is strict for all β. If, on the other hand, $r = \rho^*$, then $w\left(r, \sigma_2, \theta \;\middle|\; r = \rho^*\right) = w(\rho^*, \sigma_2, \theta)$, then the inequality in (A8) is strict if and only if $\beta > 0$.

(b) For $r > \rho^*$: Straightforward by the payoffs in Lemma 3. Q.E.D.

Proof of Lemma 4 (Quality)

Proof. The proof consists of two parts: I first argue that for $\delta(\tilde{s}) > 0$ the seller's production incentives are distorted; I then show that for some parameter restrictions this is true with strictly positive probability.

1. The seller's decision problem in $t = 1$ is to maximize her payoffs $\widetilde{S}(r, q_1, \theta)$ over q_1, given as

$$\sigma_1 \in \arg\max_{q_1 \leq \bar{q}} \widetilde{S}(r, q_1, \theta) = w(\rho^*, q_1, \theta) - \bar{b}(\rho^*, \bar{q}) + \tilde{s}(r, q_1, \theta).$$

If the incremental effect of q_1 on $\tilde{s}(r, q_1, \theta)$ is equal to zero, then the seller's production will be undistorted and constrained first best, $\sigma_1 = \bar{\sigma}(\theta) \equiv \min\{\sigma^*(\theta), \bar{q}\}$. If $\delta(\tilde{s}) > 0$, however, the seller will account for the intertemporal effect of q_1 on her second period payoffs.

2. To determine the range of seller types that will overshoot and deliver quality $\sigma_1 = \mu\bar{q} > \sigma^*(\theta)$, let r and β such that $\delta(\tilde{s}) > 0$ (Corollary 1). By Lemma 3, the seller's first period optimization problem can then be characterized as

$$\tilde{\sigma}_1(\mu, r) \in \arg\max_{q_1 \leq \bar{q}} w(\rho^*, q_1, \theta) - \bar{b}(\rho^*, \bar{q}) + 1_{(q_1 \geq \mu\bar{q})}\left[w(\rho^*, \sigma_2, \theta) - (1-\beta)\, w(r, \sigma_2, \theta)\right]$$

with $1_{(q_1 \geq \mu\bar{q})}$ equal to unity if $q_1 \geq \mu\bar{q}$, zero otherwise. $1_{(q_1 \geq \mu\bar{q})}\left[w(\rho^*, \sigma_2, \theta) - (1-\beta)\, w(r, \sigma_2, \theta)\right]$ gives the incremental effect of a delivery $\mu\bar{q}$ on $\widetilde{S}(r, q_1, \theta)$. The seller's payoffs thus exhibit a discontinuity at this break-up threshold. Moreover, let $\bar{\theta}^\mu$ such that $\sigma^*\left(\bar{\theta}^\mu\right) = \mu\bar{q}$, then the intertemporal effect translates into a discontinuity at the borderline productivity type $\bar{\theta}^\mu$,

$$\lim_{\theta \to \bar{\theta}^\mu}\left[\widetilde{S}(r, \mu\bar{q}, \theta) - \widetilde{S}(r, \sigma^*(\theta), \theta)\right] = w\left(\rho^*, \mu\bar{q}, \bar{\theta}^\mu\right) - (1-\beta)\, w\left(r, \mu\bar{q}, \bar{\theta}^\mu\right) > 0 \tag{A9}$$

for all $r < \rho^*$ or $\beta > 0$. This expression gives the seller's value of *overshooting*. For $\theta > \bar{\theta}^\mu$ she will deliver a quality $\sigma_1 = \bar{\sigma}(\theta)$. For lower types, $\theta < \bar{\theta}^\mu$, however, she will not deliver an optimal quality $q_1 = \sigma^*(\theta)$ as long as this (second period) value of $\mu\bar{q} > \sigma^*(\theta)$ more than offsets the additional costs of excessive delivery (first period payoff losses), i.e. as long as $\widetilde{S}(r, \sigma^*(\theta), \theta) <$

$\widetilde{S}(r,\mu\bar{q},\theta)$ or, for $\sigma_2 = \sigma^*(\theta)$ since $\theta < \bar{\theta}^\mu$,

$$w(\rho^*,\mu\bar{q},\theta) > (1-\beta)\, w(r,\sigma^*(\theta),\theta)$$

Let $\tilde{\theta}$ be the seller type for which the additional costs of excessive $q_1 = \mu\bar{q}$ just offset the second period gains and

$$w\left(\rho^*,\mu\bar{q},\tilde{\theta}\right) = (1-\beta)\, w\left(r,\sigma^*\left(\tilde{\theta}\right),\tilde{\theta}\right) \tag{A10}$$

By equation (A9) it is straightforward that $\tilde{\theta} < \bar{\theta}^\mu$ for all β (for all $\beta > 0$ if $r = \rho^*$). Note that $(1-\beta)\, w\left(r,\sigma^*\left(\tilde{\theta}\right),\tilde{\theta}\right)$ is non-negative, hence $0 < \tilde{\theta}$ since $w(\rho^*,\mu\bar{q},0) < 0$ for $\mu > 0$ and $\bar{q} > 0$. Let $\widetilde{\Theta} = \left[\tilde{\theta},\bar{\theta}^\mu\right)$, then by $0 < \tilde{\theta} < \bar{\theta}^\mu$ it holds true that $\widetilde{\Theta} \nsubseteq \emptyset$ and $\widetilde{\Theta} \subset \Theta$.

Seller types larger equal $\tilde{\theta}$ and lower than $\bar{\theta}^\mu$ will by the continuity of $F(\theta)$ with positive probability deliver an excessive quality level $q_1 = \mu\bar{q} > \sigma^*(\theta)$. The quality σ_1 as result of the seller's first period optimization problem is given as

$$\tilde{\sigma}_1(\mu,r) = \begin{cases} \sigma^*(\theta) & \text{if } \theta < \tilde{\theta} \text{ or } \theta \in \left[\bar{\theta}^\mu,\bar{\theta}\right) \\ \mu\bar{q} & \text{if } \theta \in \left[\tilde{\theta},\bar{\theta}^\mu\right) \\ \bar{q} & \text{if } \theta \geq \bar{\theta}. \end{cases}$$

Note that $\tilde{\sigma}_1(\mu,r) = \bar{\sigma}(\theta)$ if $\mu = 0$. Q.E.D.

Proof of Corollary 2

Proof. Let $\left|\widetilde{\Theta}\right|$ the measure of overshooting types and as such the probability of inefficiently quality delivery. This probability is *1.* increasing in μ and *2.* decreasing in r.

1. Let by definition of $\tilde{\theta}$ in equation (A10), $H \equiv w\left(\rho^*,\mu\bar{q},\tilde{\theta}\right) - (1-\beta)\, w\left(r,\sigma^*\left(\tilde{\theta}\right),\tilde{\theta}\right) = 0$. By the implicit function theorem it is known that $\partial\tilde{\theta}/\partial\mu = -\left(H_\mu/H_{\tilde{\theta}}\right)$ where H_μ and $H_{\tilde{\theta}}$ denote first derivatives of H with respect to μ and $\tilde{\theta}$, respectively,

$$\begin{aligned} H_\mu &: \frac{\partial w\left(\rho^*,\mu\bar{q},\tilde{\theta}\right)}{\partial q_1}\bar{q} < 0 \\ H_{\tilde{\theta}} &: \underbrace{\frac{\partial w\left(\rho^*,\mu\bar{q},\tilde{\theta}\right)}{\partial\tilde{\theta}} - (1-\beta)\frac{\partial w\left(r,\sigma^*\left(\tilde{\theta}\right),\tilde{\theta}\right)}{\partial\tilde{\theta}}}_{>0;\ =0 \text{ for } r=\rho^* \text{ and } \beta=0} \underbrace{- (1-\beta)\frac{w\left(r,\sigma^*\left(\tilde{\theta}\right),\tilde{\theta}\right)}{\partial\sigma^*\left(\tilde{\theta}\right)}\frac{\partial\sigma^*\left(\tilde{\theta}\right)}{\partial\tilde{\theta}}}_{<0;\ =0 \text{ for } r=\rho^* \text{ or } \beta=1} > 0. \end{aligned}$$

   The second term for $H_{\tilde{\theta}}$ is negative by concavity of w in q_i and the fact that for $r < \rho^*$ a quality level of $\sigma^*(\theta)$ is excessive. Further note that for a fixed q_i the gains of trade increase with the buyer productivity type. Thus, due to $v_{q_i r} > 0$, the difference in the first term is positive, rendering $H_{\tilde{\theta}} > 0$. Hence, $\partial\tilde{\theta}/\partial\mu > 0$ if r and β such that $\delta_{q_1}\tilde{s}(r,q_1) > 0$.
   Since both $\bar{\theta}^\mu$ and $\tilde{\theta}$ are increasing in μ and $\bar{\theta}^\mu = \tilde{\theta} = 0$ if μ, to establish $\left|\widetilde{\Theta}\right|_\mu > 0$ it needs to hold that $\partial\tilde{\theta}/\partial\mu < \partial\bar{\theta}^\mu/\partial\mu$. The following equality holds by the definition of $\bar{\theta}^\mu$ and equation (A10):

$$w\left(\rho^*,\mu\bar{q},\bar{\theta}^\mu\right) - w\left(\rho^*,\sigma^*\left(\bar{\theta}^\mu\right),\bar{\theta}^\mu\right) = w\left(\rho^*,\mu\bar{q},\tilde{\theta}\right) - (1-\beta)\, w\left(r,\sigma^*\left(\tilde{\theta}\right),\tilde{\theta}\right).$$

   Note that $\tilde{\theta}$ is monotonically decreasing in β. I only establish the result for $\beta = 1$, the general results follows straight from these arguments. The expression is rewritten as

$$w\left(\rho^*,\mu\bar{q},\bar{\theta}^\mu\right) - w\left(\rho^*,\sigma^*\left(\bar{\theta}^\mu\right),\bar{\theta}^\mu\right) = w\left(\rho^*,\mu\bar{q},\tilde{\theta}\right).$$

Suppose $\partial\tilde{\theta}/\partial\mu \geq \partial\bar{\theta}^{\mu}/\partial\mu$. As both $\tilde{\theta}$ and $\bar{\theta}^{\mu}$ are increasing in μ, the equality holds if $w\left(\rho^*, \sigma^*\left(\bar{\theta}^{\mu}\right), \bar{\theta}^{\mu}\right)$ is decreasing in $\bar{\theta}^{\mu}$, which leads to a contradiction.

2. First note that $\bar{\theta}^{\mu}$ is independent of r. For $\left|\widetilde{\Theta}\right|_r < 0$ it needs to hold that $\tilde{\theta}_r > 0$; $\partial\tilde{\theta}/\partial r = -\left(H_r/H_{\tilde{\theta}}\right) > 0$. From (a) we know that $H_{\tilde{\theta}} > 0$, moreover

$$H_r \quad : \quad -(1-\beta)\frac{\partial w\left(r, \sigma^*\left(\tilde{\theta}\right), \tilde{\theta}\right)}{\partial r} < 0$$

which is straightforward by $v_r > 0$. As $\tilde{\theta} < \bar{\theta}^{\mu}$, $\tilde{\theta}_r > 0$ and $\bar{\theta}^{\mu}_r =$, the probability of overshooting is decreasing in r. Q.E.D.

Proof of Lemma 5 (Investment)

Proof. The buyer maximizes his expected payoffs $\widehat{B}(r) = \mathbb{E}\widetilde{B}(r,\theta) - z(r)$ over investment r, where $\widetilde{B}(r,\theta) = \bar{b}(r, \tilde{\sigma}_1(\mu, r)) + \tilde{b}(r, \tilde{\sigma}_1(\mu r), \theta)$ and

$$\rho \in \arg\max_{r \in \mathbb{R}} \widehat{B}(r) = \int_{\Theta} \widetilde{B}(r,\theta) f(\theta)\, d\theta - z(r).$$

For $r \leq \rho^*$ the expected first and second period payoffs as function of the seller's equilibrium strategy $\sigma_1(r)$ are given as

$$\begin{aligned}
\mathbb{E}\bar{b}\left(r, \tilde{\sigma}_1(\mu, r) \mid r \leq \rho^*\right) \;&=\; \int_0^{\tilde{\theta}} \left[\bar{b}(\rho^*, \bar{q}) - h(r, \sigma^*(\theta))\right] f(\theta)\, d\theta + \int_{\tilde{\theta}}^{\bar{\theta}^{\mu}} \left[\bar{b}(\rho^*, \bar{q}) - h(r, \mu\bar{q})\right] f(\theta)\, d\theta + \\
&\quad \int_{\bar{\theta}_{\mu}}^{\bar{\theta}} \left[\bar{b}(\rho^*, \bar{q}) - h(r, \sigma^*(\theta))\right] f(\theta)\, d\theta + \int_{\bar{\theta}}^{1} \left[\bar{b}(\rho^*, \bar{q}) - h(r, \bar{q})\right] f(\theta)\, d\theta \\
&=\; -\int_0^{\tilde{\theta}} h(r, \sigma^*(\theta)) f(\theta)\, d\theta - \int_{\tilde{\theta}}^{\bar{\theta}^{\mu}} h(r, \mu\bar{q}) f(\theta)\, d\theta - \int_{\bar{\theta}_{\mu}}^{\bar{\theta}} h(r, \sigma^*(\theta)) f(\theta)\, d\theta \\
&\quad -\int_{\bar{\theta}}^{1} h(r, \bar{q}) f(\theta)\, d\theta + \bar{b}(\rho^*, \bar{q}), \qquad \text{(A11)}
\end{aligned}$$

and

$$\begin{aligned}
\mathbb{E}\tilde{b}\left(r, \tilde{\sigma}_1(\mu, r), \theta \mid r \leq \rho^*\right) \;&=\; \int_0^{\tilde{\theta}} \left[\bar{b}(\rho^*, \bar{q}) + \beta w(r, \sigma_R, \theta)\right] f(\theta)\, d\theta + \int_{\tilde{\theta}}^{\bar{\theta}} \left[\bar{b}(r, \sigma^*(\theta)) + \beta g(r, \theta)\right] f(\theta)\, d\theta \\
&\quad + \int_{\bar{\theta}}^{1} \left[\bar{b}(r, \bar{q}) + \beta g(r, \theta)\right] f(\theta)\, d\theta \\
&=\; \beta \int_{\Theta} w(r, \sigma_R, \theta) f(\theta)\, d\theta - \int_{\tilde{\theta}}^{\bar{\theta}} \left[h(r, \sigma^*(\theta)) + \beta w(r, \sigma^*(\theta), \theta)\right] f(\theta)\, d\theta \\
&\quad - \int_{\bar{\theta}}^{1} \left[h(r, \bar{q}) + \beta w(r, \bar{q}, \theta)\right] f(\theta)\, d\theta + \bar{b}(\rho^*, \bar{q}), \qquad \text{(A12)}
\end{aligned}$$

for $r > \rho^*$ they are equal to

$$\mathbb{E}\bar{b}\left(r, \tilde{\sigma}_1(\mu, r) \mid r > \rho^*\right) = \bar{b}(\rho^*, \bar{q}) - \int_0^{\bar{\theta}} h(r, \sigma^*(\theta)) f(\theta)\, d\theta - \int_{\bar{\theta}}^{1} h(r, \bar{q}) f(\theta)\, d\theta \qquad \text{(A13)}$$

and since $\sigma_R = \sigma^*(\theta)$

$$\begin{aligned}\mathbb{E}\tilde{b}\left(r, \tilde{\sigma}_1(\mu, r), \theta \mid r > \rho^*\right) &= \beta \int_\Theta w(r, \sigma^*(\theta), \theta) f(\theta)\, d\theta - \int_0^{\tilde{\theta}} [h(r, \sigma^*(\theta)) + \beta w(r, \sigma^*(\theta), \theta)] f(\theta)\, d\theta \\ &\quad - \int_{\bar{\theta}}^1 [h(r, \bar{q}) + \beta w(r, \bar{q}, \theta)] f(\theta)\, d\theta + \bar{b}(\rho^*, \bar{q}). \end{aligned} \tag{A14}$$

To establish the results of Lemma 5, I first show that there is no overinvestment such that $r > \rho^*$ and then proof the claims made.

1. An investment level $r > \rho^*$ is a strictly dominated strategy for the buyer, since (a) his expected payoffs $\widehat{B}(r)$ exhibit a negative discontinuity at $r = \rho^*$ and (b) marginal payoffs for $r > \rho^*$ are negative. The buyer's choice of r can thus be restricted to $r \in [0, \rho^*]$.
   (a) For any level above ρ^* the buyer forfeits his exit threat for $\theta < \tilde{\theta}$ with a value of

   $$\lim_{\Delta \to 0} \left[\widehat{B}\left(r \mid r = \rho^*\right) - \widehat{B}\left(r \mid r = \rho^* + \Delta\right)\right] = \beta \int_0^{\tilde{\theta}} w(\rho^*, \sigma^*(\theta), \theta) f(\theta)\, d\theta > 0 \tag{A15}$$

   for $\mu > 0$ and $\beta > 0$.
   (b) The FOC for $r > \rho^*$ to maximize the buyer's payoffs $\widehat{B}(r)$ is given as

   $$\begin{aligned} 2\left[\int_0^{\bar{\theta}} \frac{\partial v(r, \sigma^*(\theta))}{\partial r} f(\theta)\, d\theta + \int_{\bar{\theta}}^1 \frac{\partial v(r, \bar{q})}{\partial r} f(\theta)\, d\theta\right] + \\ \beta \int_{\bar{\theta}}^1 \left[\frac{\partial v(r, \sigma^*(\theta))}{\partial r} - \frac{\partial v(r, \bar{q})}{\partial r}\right] f(\theta)\, d\theta - \frac{\partial z(r)}{\partial r} &\overset{!}{=} 0 \end{aligned} \tag{A16}$$

   From equation (4) in Definition 1 it is known, that the buyer's investment is first-best if

   $$\int_\Theta \frac{\partial \widehat{W}\left(r, \vec{\sigma}^*(\theta), \tau, \theta \mid \tau = C\right)}{\partial r} = 0.$$

   By the assumptions for $v(\cdot)$ and $z(\cdot)$, the sufficient condition is satisfied and a $\rho^* > 0$ exists. Note that in equilibrium $\tau = C$. Since the repeat interaction contract is by assumption (Definition 3) such that $\bar{q} < q^{\max}$, i.e. there exist some θ such that $\sigma^*(\theta) > \bar{q}$, by the value-enhancing assumption of specific investment, $v_{q_1 r} > 0$, it holds that

   $$\int_{\bar{\theta}}^1 \frac{\partial v(r, \bar{q})}{\partial r} f(\theta)\, d\theta < \int_{\bar{\theta}}^1 \frac{\partial v(r, \sigma^*(\theta))}{\partial r} f(\theta)\, d\theta.$$

   This implies that even for $\beta = 1$ the buyer will never overinvest. The FOC in equation (A16) is negative for any $r > \rho^*$,

$$\left[\int_\Theta \frac{\partial v(r, \sigma^*(\theta))}{\partial r} f(\theta)\, d\theta + \int_0^{\bar{\theta}} \frac{\partial v(r, \sigma^*(\theta))}{\partial r} f(\theta)\, d\theta + \int_{\bar{\theta}}^1 \frac{\partial v(r, \bar{q})}{\partial r} f(\theta)\, d\theta - \frac{\partial z(r)}{\partial r}\right]_{r > \rho^*} < 0.$$

2. For $r \leq \rho^*$, the first order condition $\frac{\partial \widehat{B}(r)}{\partial r} \stackrel{!}{=} 0$ for ρ to be maximizer of $\widehat{B}(r)$ is equal to

$$\begin{aligned} \frac{\partial z(r)}{\partial r} \stackrel{!}{=} & \frac{\partial \tilde{\theta}(r)}{\partial r} f\left(\tilde{\theta}\right)\left[h(r, \mu \bar{q})-(1-\beta) h\left(r, \sigma^*\left(\tilde{\theta}\right)\right)+\beta w\left(r, \sigma^*\left(\tilde{\theta}\right), \tilde{\theta}\right)\right]+ \\ & \int_0^{\tilde{\theta}}\left[\frac{\partial v\left(r, \sigma^*(\theta)\right)}{\partial r}+\beta \frac{\partial v\left(r, \bar{q}_R\right)}{\partial r}\right] f(\theta) d \theta+\int_{\tilde{\theta}}^{\bar{\theta}^\mu}\left[\frac{\partial v(r, \mu \bar{q})}{\partial r}+\beta \frac{\partial v\left(r, \bar{q}_R\right)}{\partial r}\right] f(\theta) d \theta+ \\ & \int_{\bar{\theta}^\mu}^{\bar{\theta}}\left[\frac{\partial v\left(r, \sigma^*(\theta)\right)}{\partial r}+\beta \frac{\partial v\left(r, \bar{q}_R\right)}{\partial r}\right] f(\theta) d \theta+\int_{\bar{\theta}}^1\left[\frac{\partial v(r, \bar{q})}{\partial r}+\beta \frac{\partial v\left(r, \bar{q}_R\right)}{\partial r}\right] f(\theta) d \theta \end{aligned} \tag{A17}$$

where by $\bar{q}_R(r, \theta)$ in equation (10) it holds that $\frac{\partial w(r, \bar{q}_R(r, \theta), \theta)}{\partial r} = \frac{\partial v(r, \bar{q}_R)}{\partial r}$. Suppose that $\beta = 1$, i.e. the buyer makes a take-it-or-leave-it offer in the renegotiation game with probability 1 and thus receives the entire renegotiation surplus $g(r, \theta)$ for $\theta \geq \bar{\theta}$ and the entire second period trade surplus of $\pi(r, \theta)$ for $\theta < \tilde{\theta}$. He thus receives the full returns for each unit of investment r. Moreover, let $\mu = 0$, then $\tilde{\theta} = \bar{\theta}^\mu = \frac{\partial \tilde{\theta}(r)}{\partial r} = 0$ and the FOC in equation (A17) simplifies and reads

$$\int_0^{\bar{\theta}}\left[\frac{\partial v\left(r, \sigma^*(\theta)\right)}{\partial r}+\frac{\partial v\left(r, \bar{q}_R\right)}{\partial r}\right] f(\theta) d \theta+\int_{\bar{\theta}}^1\left[\frac{\partial v(r, \bar{q})}{\partial r}+\frac{\partial v\left(r, \bar{q}_R\right)}{\partial r}\right] f(\theta) d \theta \stackrel{!}{=} \frac{\partial z(r)}{\partial r}. \tag{A18}$$

By $\bar{q}_R(\rho^*, \theta) = \sigma^*(\theta)$ for all θ (equations (9) and (10)) and $\bar{q} < q^{\max}$, it holds that

$$\int_{\bar{\theta}}^1 \frac{\partial v(r, \bar{q})}{\partial r} f(\theta) d \theta<\int_{\bar{\theta}}^1 \frac{\partial v\left(r, \sigma^*(\theta)\right)}{\partial r} f(\theta) d \theta$$

and the LHS in equation (A18) smaller than necessary by FOC (4) for $r = \rho^*$. By concavity of $z(r)$, the buyer will invest $r < \rho^*$ for $\beta = 1$ and a break-up rule $\mu = 0$. This underinvestment effect will be stronger for lower $\bar{q}$.

To show that $\mu > 0$ improves the efficiency properties of r, note that for $\beta = 1$ and $\mu > 0$ the following holds true: $\tilde{\theta} > 0$, $\bar{\theta}^\mu > 0$, and $\frac{\partial \tilde{\theta}(r)}{\partial r}$. Both $\bar{\theta}$ and $\bar{q}_R(r, \theta)$ are unaffected by μ. The effect of μ on the buyer's investment incentives is characterized by the difference between the RHS in equation (A17) (for $\beta = 1$) and the LHS in (A18):

$$\frac{\partial \tilde{\theta}(r)}{\partial r} f\left(\tilde{\theta}\right)\left[h(r, \mu \bar{q})+w\left(r, \sigma^*\left(\tilde{\theta}\right), \tilde{\theta}\right)\right]+\int_{\tilde{\theta}}^{\bar{\theta}^\mu}\left[\frac{\partial v(r, \mu \bar{q})}{\partial r}-\frac{\partial v\left(r, \sigma^*(\theta)\right)}{\partial r}\right] f(\theta) d \theta>0. \tag{A19}$$

It is straightforward to check that the first term on the LHS is positive. The second term, too, is positive since $\sigma^*(\theta) < \mu\bar{q}$ for all $\theta < \bar{\theta}^\mu$. This is a direct consequence of the value-enhancing effect of r. Recall, $h(r, q_1) = v(\rho^*, q_1) - v(r, q_1)$. By equation (A11), for $r < \rho^*$ the expected buyer's first period payoffs are increasing in the actual quality level q_1. This is because for a positive μ the seller overshoots, implying that, in expectations, the seller delivers higher quality—inefficiently though—than for $\mu = 0$ and $\tilde{\sigma}_1\left(\mu, r \mid \mu = 0\right) = \bar{\sigma}(\theta)$. Hence, the buyer break-up threat drives the delivered quality and increases the buyer's marginal return on investment. Q.E.D.

Proof of Corollary 3

Proof. 1. $\hat{\mu}_\beta(\beta, \bar{q}) < 0$: As is straightforward from equation (A17) for $\mu = 0$ and $\beta < 1$, the buyer's underinvestment incentives are stronger the lower his (Nash-)bargaining power β. Moreover, (A19) is less pronounced for $\beta < 1$, the effect of $\mu > 0$ on investment r thus weaker. Hence, $\hat{\mu}(\beta, \bar{q})$ decreases in β.

2. $\hat{\mu}_{\bar{q}}(\beta, \bar{q}) < 0$: As by equation (A18) a lower $\bar{q}$ aggravates the underinvestment effect for $\mu = 0$ for a given β, it increases the efficiency restoring break-up rule parameter $\hat{\mu}(\beta, \bar{q})$ that ensures equation (A19) be equal to zero.

3. The existence of a $\hat{\mu}(\beta, \bar{q})$ within the unit interval is not granted. As $\hat{\mu}(\beta, \bar{q})$ grows larger for small values of β and $\bar{q}$, there may not exist a pair $(\beta, \bar{q})$ such that $\hat{\mu}(\beta, \bar{q}) \leq 1$. For instance, for $\beta = 0$

the value of the buyer's exit threat evaluated at $r = \rho^*$ is equal to zero and close to zero in the neighborhood of ρ^* (cf. equation (16)). In that case, the lower $\bar{q}$, the less likely a breakup rule $\mu = 1$ be able to restore the buyer's investment incentives. Q.E.D.

Proof of Proposition 2 (Semi-renegotiation) Given the SPE strategies in equation (17), the parties' joint expected surplus is denoted by

$$\widehat{\Pi}(\mu) = \int_{\Theta} W(\vec{\rho}(\mu), \vec{\sigma}(\mu,\theta), \theta) f(\theta)\, d\theta - z(\rho(\mu)),$$

where

$$W(\vec{\rho}(\mu), \vec{\sigma}(\mu,\theta), \theta) = w(\rho(\mu), \sigma_1(\mu), \theta) + w(\rho(\mu), \sigma^o(\rho(\mu), \theta), \theta). \tag{A20}$$

1. The nonexistence of a first-best outcome is straightforward from equation (17). By Lemma 5, the buyer's investment is efficient only if $\mu = \hat{\mu}(\beta, \bar{q}) > 0$. By Lemma 4 and the buyer's equilibrium investment $r \leq \rho^*$, the seller will overshoot with positive probability if $\mu > 0$. Efficient quality delivery (up to $\bar{q}$ in period $t = 1$) is achieved with $\mu = 0$. A first-best outcome as in Definition 1 cannot be implemented under the given institutional framework.

2. A second-best break-up rule μ^{**} trades off the inefficiencies from overshooting and underinvestment and is bounded by 0 and $\hat{\mu}$. This rule is defined as

$$\mu^{**} \in \arg\max_{\mu \in [0,1]} \widehat{\Pi}(\mu). \tag{A21}$$

Recall that $\sigma_2 = \sigma^o(\cdot) \in \arg\max_{q_2} w(\rho(\mu), q_2, \theta)$. The first order condition for this optimization problem is equal to

$$\begin{aligned} &\frac{\partial \rho(\mu)}{\partial \mu} \left\{ \frac{\partial \tilde{\theta}}{\partial \rho(\mu)} \beta w\left(\rho(\mu), \sigma^*\left(\tilde{\theta}\right), \tilde{\theta}\right) f\left(\tilde{\theta}\right) + \int_{\Theta} \frac{\partial w(\rho(\mu), \sigma_1(\mu,\theta), \theta)}{\partial \rho(\mu)} f(\theta)\, d\theta + \right. \\ &\left. \int_{\Theta} \frac{\partial w(\rho(\mu), \sigma_2, \theta)}{\partial \rho(\mu)} f(\theta)\, d\theta - \frac{\partial z(\rho(\mu))}{\partial \mu} \right\} + \frac{\partial \tilde{\theta}}{\partial \mu} \beta w\left(\rho(\mu), \sigma^*\left(\tilde{\theta}\right), \tilde{\theta}\right) f\left(\tilde{\theta}\right) + \\ &\bar{q} \int_{\tilde{\theta}}^{\bar{\theta}^{\mu}} \frac{\partial w(\rho(\mu), \mu\bar{q}, \theta)}{\partial \sigma_1} f(\theta)\, d\theta \overset{!}{=} 0. \end{aligned} \tag{A22}$$

Substituting for the FOC of the buyer's optimization problem with respect to r in equation (A17), the FOC in (A22) can be rewritten as

$$\begin{aligned} &\frac{\partial \rho(\mu)}{\partial \mu} \left\{ -\frac{\partial \tilde{\theta}}{\partial \rho(\mu)} f\left(\tilde{\theta}\right) \left[h(\rho(\mu), \mu\bar{q}) - (1-\beta) h\left(\rho(\mu), \sigma^*\left(\tilde{\theta}\right)\right)\right] + \right. \\ &\left. (1-\beta) \int_{\Theta} \frac{\partial w(\rho(\mu), \sigma_2, \theta)}{\partial \rho(\mu)} f(\theta)\, d\theta \right\} + \frac{\partial \tilde{\theta}}{\partial \mu} \beta w\left(\rho(\mu), \sigma^*\left(\tilde{\theta}\right), \tilde{\theta}\right) f\left(\tilde{\theta}\right) + \\ &\bar{q} \int_{\tilde{\theta}}^{\bar{\theta}^{\mu}} \frac{\partial w(\rho(\mu), \mu\bar{q}, \theta)}{\partial \sigma_1} f(\theta)\, d\theta \overset{!}{=} 0. \end{aligned} \tag{A23}$$

Evaluated at $\mu = 0$, the FOC is positive and equal to

$$\frac{\partial \rho(\mu)}{\partial \mu} (1-\beta) \int_{\Theta} \frac{\partial w(\rho(\mu), \sigma_2, \theta)}{\partial \rho(\mu)} f(\theta)\, d\theta > 0.$$

The second-best rule therefore allows for some break-up to induce investment closer to the efficient level. It thus trades off efficiencey in investment and first period quality.

Proof of Corollary 4 (Cadillac contract)

Proof. For $\bar{q} = q^{\max} = \sigma^* (1)$, the FOC in equation (A17) reads for $\mu = 0$

$$\int_\Theta \left[\frac{\partial v (r, \sigma^* (\theta))}{\partial r} + \beta \frac{\partial v (r, \bar{q}_R)}{\partial r} \right] f (\theta) \, d\theta \overset{!}{=} \frac{\partial z (r)}{\partial r}$$

and holds for $r = \rho^*$ if $\beta = 1$. If $\beta < 1$, then by Definition 1 the LHS is smaller than the RHS when evaluated at $r = \rho^*$. Q.E.D.

Proof of Proposition 3 (Full-renegotiation)

Proof. The proof follows directly from Lemmata 4 and 5. It is easy to see that the underlying bargaining structure yields an asymmetric Nash-bargaining solution (cf. Lemma 3). The parties will agree on a price $\bar{p}_R$ such that both receive their disagreement point payoffs plus a share β of the first-stage renegotiation surplus $G (r, \theta)$. Since, given r the equilibrium quality levels are optimal and $\vec{\sigma}^o (r, \theta) = (\sigma^o (r, \theta), \sigma^o (r, \theta))$, the negotiation surplus is equal to the difference between the optimal trade surplus and the trade surplus from the semi-renegotiated contract as given in equation (A20),

$$G (r, \theta) = W (r, \vec{\sigma}^o (r, \theta), \theta) - \widetilde{W} (\vec{\rho} (\mu), \vec{\sigma} (\mu, r), \theta),$$

with $\vec{\sigma} (\mu, r) = (\tilde{\sigma}_1 (\mu, r), \sigma^o (r, \theta))$. Since the second period payoffs are $\pi (r, \theta)$ in both scenarios, the renegotiation surplus can be rewritten as

$$G (r, \theta) = w (r, \sigma^o (r, \theta), \theta) - w (r, \tilde{\sigma}_1 (\mu, r), \theta).$$

The seller will deliver optimal quality levels given r, and the buyer's investment decision (as in Lemma 5) is a function of β, $\bar{q}$, and μ. He maximizes his expected payoffs

$$\widehat{B} (r) = \int_\Theta \left[\widetilde{B} (r, \tilde{\sigma}_1 (\mu, r), \theta) + \beta G (r, \theta) \right] f (\theta) \, d\theta - z (r).$$

Suppose $\beta = 1$ and $\mu = 0$. By Lemma 4 it follows that $\tilde{\sigma}_1 (\mu, r) = \bar{\sigma} (\theta)$, and

$$\rho \in \arg\max_r \widehat{B} (r) = \int_\Theta \widehat{W} \left(r, \tau, \vec{\sigma}^o (r, \theta), \theta \;\middle|\; \tau = C \right) f (\theta) \, d\theta - \bar{S}^e$$

with $\bar{S}^e$ the seller's expected payoffs under contract Z and off-equilibrium quality levels $\tilde{\sigma}_1 (\mu, r)$ and $\sigma_2 = \bar{\sigma} (\theta)$. Since $\bar{S}^e$ is independent of r, by the definition of the first-best investment level in equation (4) the buyer will efficiently invest, $\rho = \rho^*$. Hence, for $\beta = 1$ and complete rent extraction by the buyer, the first-best outcome is implemented for $\mu = 0$. For $\beta < 1$ and less-than-complete rent extraction, the implications are as in Lemma 5. A positive break-up parameter μ complements the buyer's bargaining power $\beta < 1$. For sufficiently high β there exists a $\mu = \hat{\mu} = \mu^*$ such that $\rho = \rho^*$ Q.E.D.

Proof of Corollary 5 (Redistribution)

Proof. By Lemma 5 it holds that overinvestment is a strictly dominated strategy, hence $\rho \leq \rho^*$ for all μ. Since the seller will always deliver quality level $\sigma^o (r, \theta)$ in the full-renegotiation scenario, any $\mu \geq \mu^*$ implements first-best quality and investment levels. By $\tilde{\theta}_\mu > 0$, the buyer's threat value in equation (A15) and hence his overall expected payoffs $\widehat{B} \left(\rho (\mu) \;\middle|\; \mu \geq \mu^* \right) = \widehat{B} (\rho^*)$ are increasing in μ while the realized gains of trade $\widehat{W} \left(\mu \;\middle|\; \mu \geq \mu^* \right)$ are unaffected. Q.E.D.

Proof of Corollary 6 (Existence)

Proof. The proof follows straight from Corollary 3 and Proposition 3. Q.E.D.