Cancellation of Installment Contracts: A "Legal" Solution for Yet Another Hold-Up Problem?*

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Abstract

We study the effect of the "substantial impairment requirement" for cancellation of multi-trade contracts on parties' equilibrium performance strategies. In contrast to the "perfect tender rule" for single-shot deals, US contract law grants an aggrieved buyer the right to cancel multi-trade contracts upon delivery of a defective good only if this defect substantially impairs the value of the entire contract. In a two-period trade model we allow for renegotiation of the second installment and show that if a defective performance indeed triggers the buyer's right to cancel, he will gain a bargaining leverage and *ex-post* hold up the seller by threatening inefficient cancellation. In order to avoid this second period exploitation low productivity sellers will exert excessive effort in the first period and perform an inefficiently high yet substantially conforming good with positive probability. Indeed we show that a first best performance in the first trade period is not a subgame perfect equilibrium strategy for the seller. This *over-shooting* dampens the parties' expected joint surplus. The effect increases with the degree of substantiality, i.e. the ease at which the buyer may cancel, and the buyer's bargaining power. We argue in favor of a restriction of the buyer's cancellation rights as seems to be the consent in the literature. Our results, however, are not driven by the existence of relationship-specific investment but rather abstract therefrom and isolate the rule's effects on *ex-post* performance. Our results are related to the discussion on causation and liability in the tort literature and endorse the position of avoiding "sharp" incentives by properly aligning liability and actual damages.

JEL classification: D86, K12, K13, L14.

Keywords: Installment contracts, substantial impairment requirement, Uniform Commercial Code; incomplete contracts, hold-up effect, commitment, bargaining leverage; causation, liability.

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1 Introduction

Trading (customized) goods can be a very complex endeavor. Parties do not only have to agree on the commodity's specifications, but also on its price, payments schemes, delivery options, warranties, and other clauses that regulate the details of exchange. This is in principle true for any trade agreement. If the trade relationship concerns a multiple number of goods, yet another dimension comes into play: the (relative) timing of production, trade, delivery, and payment. In this paper we consider an exchange of two units of a commodity that by technological restrictions cannot be produced simultaneously. If trade is to be through one single contract, parties have two stylized options: They can either enter a single-shot contract that stipulates simultaneous delivery or an installment contract with sequential delivery and sequential acceptance. The most significant difference between these two options is the fact that the promisor, by delivering the first commodity, reveals information about her type which the promisee may then exploit when the second commodity is tendered. Put differently, the buyer is given the possibility to react to the seller's delivery and potentially improve his payoffs by extracting some of the seller's information rents. If delivery is simultaneous no such possibilities exist.

The two contract options also differ in the legal remedies they give rise to. Under US contract law, a buyer may reject any commercial unit and recover his expectation interest if the seller's delivery is defective. Such a lax cancellation rule implies that the buyer can exit the contract for any non-conformity. In case of an installment contract, the buyer is given the right to do so only if a defect of an installment *substantially* impairs the value of the whole contract. This restriction as to the buyer's cancellation rights means that if a non-conformity of the first installment is sufficiently high, then the buyer may anticipatorily reject the delivered first as well as the non-delivered second installment and recover his expectation interest. If the defect, however, is of minor degree, he may neither send back the first installment nor may he reject the second, but has to accept it and recover his expectation interest only upon delivery.

Our paper is concerned with this *threshold of substantiality* and the question of why buyer's cancellation rights are to be restricted. Even if the producer's type is common knowledge and she does not reveal any private information to the buyer through her first period performance, she still reveals "legal information" and allows for the buyer to extract renegotiation rents in the second period. We assume fully compensatory expectation damages in an incomplete contract framework with fixed-price, fixed-quantity contracts, which means that the seller fully internalizes the buyer's costs of a non-conforming first period performance. Since she is the residual claimant beyond the buyer's constant contracted share her periodic performance incentives are first best, i.e. she will efficiently breach the contract if she is of low productivity and the costs of conforming performance are higher than the buyer's valuation. The fact that her first period performance serves as such "legal information" and gives the buyer the right to cancel the contract, has a distorting effect, though. We allow for renegotiation of the second installment under generalized Nash-bargaining and show that whenever he given the right to do so by the seller's first period performance, the buyer will threaten to cancel the contract and thus dictate the seller's outside option payoffs. These payoffs are negative in case of contract cancellation and strictly larger if the contract is reinstated instead. This way the buyer can hold up the seller and recoup a significant portion of her payoffs. In order to avoid the buyer's opportunism and protect her second period payoffs, the seller will deliver a substantially conforming first period good even if her costs are higher than the buyer's valuation. She will therefore exert excessive effort and send a conforming "message" to the buyer if the second period renegotiation gains are larger than the first period costs of this inefficient performance.

We show that, unless the seller has full bargaining power or the buyer is never given the right to cancel, a first best performance for all realized types is not a subgame perfect equilibrium strategy. We observe seller's excessive first period effort as response to the buyer's hold-up threat with positive probability. As a result, the expected joint surplus of this two period trade relationship is impaired. Given a constant surplus sharing rule, the buyer would *ex-ante* actually prefer to exploit the seller, i.e. commit to contract reinstatement in the second period; lack of commitment, however, gives rise to a second-best result only. If feasible, the parties will add a clause to their contract that prohibits cancellation for any defect of the first period performance (with "some cancellation" being the legal default). This corresponds to the results obtained by Comino, Nicolò, and Tedeschi (2006) who show that parties will never want to add a clause that indeed allows cancellation under certain circumstances (with "no cancellation" the default). We further show that the upper bound result in Muehlheusser (2006) can be applied. If the cancellation damages are bounded away from the true damages by default or by the contract, i.e. if the buyer pays a positive "cancellation tax", then first best performance with probability one can be restored as subgame perfect equilibrium strategy.

The legal literature offers several explanations for the restriction of the buyer's cancellation rights in installment contracts. Apart from saving on transaction costs, distributional arguments (Whaley, 1974; Lawrence, 1994), and efficiency gains from learning (Schwartz and Scott, 1991), the prevention of hold-up and protection of relationship-specific investment is brought forward as main motivation for the applied rules, both by legal and economic scholars (Joskow, 1985, 1987; Hart and Holmström, 1987; Goldberg and Erickson, 1987; Schwartz and Scott, 2003). We add another dimension to the discussion. By abstracting from (*ex-ante*) relationship-specific investment and inter-temporal complementarities, thus inducing the contract to be without "memory", we show that the sub-optimality of the (*ex-post*) equilibrium strategy is driven by the cancellation damages and the bargaining leverage the buyer obtains from his cancellation rights. By restricting these rights and thus improving the seller's relative bargaining position, her excessive first period effort arising from the buyer's hold-up is mitigated.

The paper is organized as follows: In Section 2 we discuss the respective legal background and present the legal and economic arguments brought forward in favor of the special cancellation rules for multi-stage contracts. We then relate our setting and results to the existing literature. In Section 3 the model is presented and analyzed in Section 4. We solve the model by backward induction and characterize the subgame perfect equilibrium performance strategies. In Section 5 we discuss the equilibrium outcome in the context of the legal rules applied and argue in favor of restricted cancellation rights or a "cancellation tax" to restore the first best in equilibrium. In Section 6 we conclude and comment on a number of possible extensions of the presented analysis. Proofs for the paper's results are given in the appendix.

2 The legal background and related literature

Business relationships between commercial actors are rarely one-time encounters, yet potential business partners often meet to enter contracts repeatedly to exchange goods and services or cooperate in projects to mutually gain from the surplus they create. Similarly, a single contract might as well span over several periods and consist of more than one contract performance. This time dimension of contracts has been subject of a rapidly growing literature in economic contract theory.

The law of installment contracts The legal literature has seen a long tradition in the discussion of the need for protection of long-term relationships. In an early treatise on warranties of quality of performance and their enforcement, Llewellyn (1937; p. 375) observes an increasing use of "standing relations" as substitutes for single-occasion deals and acknowledges the fact that "[o]ur contract-law has as yet built no tools to really cope with this vexing and puzzling situation." He continues in his elaborations stating that the implications of such standing relations are "still legally inarticulate" and that any such tools will have to acknowledge that in "*most* [...] cases"[1] the "*commercial* (substantial) standard of performance" needs to substitute for the "*mistakenly* strict legal standard" [emphasis added] (Llewellyn, 1937; p. 378). hence, not only does he call for a special treatment of long-term business relationships, but he also directly criticizes the application of strict compliance standards (the so called "perfect tender rule") in multi-stage settings. Generally, such standards grant an aggrieved party the right to cancel the contract (and repudiate all future deliveries) if the first or any later installment shows *any* defect.

Llewellyn's stipulations, however, are in clear contradiction to what scholars before him had written. Bohlen (1900a; pp. 397f) states that in commercial contracts courts cannot "force upon [the contract parties] the duty to accept anything differing in the most minute detail from which they have contracted for." For instance, in a leading common law case, *Norrington v. Wright*, the U.S. Supreme Court rules (for contracts governing the sale of goods to be delivered in separate installments and paid for on delivery) that if the seller made a non-conforming,

[1]This does not apply to "ultimate consumers [...], family or manufacturing" that are "entitled to something which both really goes and does not offend the eye" (Llewellyn, 1937; p. 378). Priest (1978; p. 970) offers the following interpretation: "Llewellyn contended that merchant buyers, more often than consumer buyers, were able to use defective goods." See also Schwartz and Scott (2003; p. 544) for a general discussion on differences between private and sophisticated commercial actors.

defective delivery with respect to one installment this then gives rise to a buyer's right to treat the whole contract as breached and to terminate.[2] In the later case of *Fullam v. Wright*, the court decided accordingly and stipulated that "[w]here there is a contract to sell goods to be delivered in installments and the seller in violation of the contract tenders as a first installment goods inferior to the requirements thereof, the buyer may not only refuse to accept the installment, but he may also rescind the contract *in toto*."[3] Indeed, no reference to Llewllyn's commercial substantial standard of performance is offered. In a companion paper, Bohlen (1900b; p. 484) finds clear evidence for the application of strict compliance in state and federal jurisdiction and summarizes that "if either party be guilty of a breach either in delivery or payment, either as to the first or any subsequent portion, then the other party at his option may terminate all of the contract which is still executory." His case for "perfect tender" is thus made.

Later decisions, however, are more in line with Llewellyn's interpretations. In *Helgar v. Warner's Features*, for instance, the court rules that in case of non-payment of the first installment the aggrieved party has no right to refuse further deliveries (i.e. terminate the contract) unless a "seriousness of the damage suffered by him" can be shown.[4] Llewellyn's views have prevailed and "standing relations" have eventually found their way into modern law of commercial transactions via Article 2 of the *Uniform Commercial Code*. Section 2-612 of the *UCC* governs "installment contracts" which Llewellyn (1937; p. 375) characterizes as "half-way stage toward standing relations." While Section 2-307 stipulates that in general goods are to be delivered in a single lot, it also accounts for multiple delivery if the circumstances allow so. This exemption from the single tender requirement is explicitly spelt out in 2-612. It states that under the *UCC* an installment contract is "one which requires or authorizes the delivery of goods in separate lots to be separately accepted" (2-612(1)). Separate acceptance of separate deliveries is crucial, separate payments, however, are not essential and "may be demanded" (2-307), but are not required for a contract to fall within the provisions of the code.[5] We will account for this degree of freedom in the model presented in the next section and do not restrict the size of the payments exchanged to be an perfect apportionment of the value of the whole contract.

Installment contracts go beyond single-occasion deals and thus cover more than just a one-shot contract, however, need not necessarily be thought of as extending over the lifetime of a business relationship as numerous textbook examples show. In *Hubbard v. UTZ* a potato chips producer ordered 11,000 hundredweights of potatoes from a potato farmer to be delivered in

[2] *Norrington v. Wright (1885) 115 U.S. 188*, discussed in Notes (1907; p. 595).

[3] *Fullam v. Wright & Colton Wire Cloth Co. (1907) 196 Mass. 474, 82 N.E. 711.*

[4] *Helgar Corp. v. Warner's Features, Inc. (1918) 58 N.Y.L.J. 1780, 119 N.E. 113*, discussed in Notes (1918).

[5] UCC 2-612, cmt. 2. In an early draft of the *UCC*, Section 2-612(1) required that goods "be separately accepted and paid for" in order for an installment contract to fall under 2-612. The UCC Editorial Board, however, in its 1956 recommendations for changes of the code called for the deletion of the words "and paid for." See Patterson (1987; p. 185, fn. 34) for more details on the revision process of the *UCC*. Interestingly enough, Farnsworth (2004; p. 574, §8.18) lists the requirement of separate payment as characteristic of installment contracts ("contracts for the sale of goods in which a seller is to deliver separate lots to be separately paid for").

five to six weekly installments of 2,000 to 4,000 hundredweights each. Analogously, in *Midwest Mobile v. Dynamics* a furnisher of medical equipment to hospitals buys four trailers for mobile medical use to be delivered in monthly installments.[6] In both cases the parties did not or could not necessarily be expected to terminate doing business together after the contract had been fully performed. On the other hand, it is apparent that a fixed quantity and fixed price potato delivery contract that spans over four to five weeks is not directly comparable to a 30 or 40-year long-term coal supply contract with open price and quantity terms.[7] One feature that distinguishes *Hubbard v. UTZ* from *Midwest Mobile v. Dynamics* is the fact that Hubbard had delivered potatoes to UTZ prior to the considered contract while no such information is given for Midwest Mobile (although past or future encounters are likely since the market for mobile magnetic resonance imaging systems is anything but thick). This contract relationship under dispute is therefore nested in a longer lasting business relationship, it concerns one contract among possibly many. Such repeated interaction between two contract parties may be seen as an additional level of multiplicity beyond the multiple deliveries as to a single contract. In our analysis, however, we will abstain from such implied reputation considerations.

Being more than just a single-delivery contract but covering a limited number of transactions with a clear understanding of quantity and price, installment contracts constitute some kind of "hybrid" construct[8] and call for special attention. Courts have acknowledged that parties face a different set of rights to reject, cure, and cancel under an installment contract than defined for a single-delivery contract (e.g. *Midwest Mobile v. Dynamics*). Foremost, for one-shot contracts the *UCC* stipulates in Section 2-601 that "if the goods or the tender of delivery fail in any respect to conform to the contract, the buyer may (a) reject the whole; or (b) accept the whole; or (c) accept any commercial unit or units and reject the rest." This perfect tender rule requires a very high standard of conformity for single delivery contracts, analogous to what was held in *Norrington v. Wright* for installment contracts under earlier common law. Under 2-612, however, the right to reject a single installment or cancel the entire contract is far more limited. Patterson (1987; p. 189) attests the *UCC* a "bias in favor of the [...] continuation of contracts in general and installment contracts in particular", while Quinn (1978; p. 2-385) plainly asserts that the "*UCC* loves the installment contract, and, once it is in place, bends over backwards to keep it in place." This leeway to the perfect tender rule is found in sections 2-612(2) and 2-612(3).[9] The former states that the buyer may reject any installment that does not conform to the contract terms if the defect *substantially* impairs the value of this installment and cannot be cured. Section 2-612(3) stipulates that a buyer may cancel the whole contract only if a defect

[6] *Hubbard v. UTZ Quality Foods (1995) 903 F.Supp. 444*; *Midwest Mobile Diagnostic Imaging v. Dynamics Corporation of America (1997) 965 F.Supp. 1003.* See the discussion of these cases in Schwartz and Scott (1991) or Hull (2005).

[7] See the work of Joskow (1985; 1987; 1990), Masten and Crocker (1985), Goldberg and Erickson (1987), Crocker and Masten (1991), or Goldberg (2002).

[8] Thanks to Alan Schwartz for this characterization.

[9] For a case review on 2-612(2) see Vaserstein (1998).

with respect to one or more installments *substantially* impairs the value of the entire contract; such a non-conformity consequently constitutes total breach of contract.[10]

Contract law thus exempts the buyer from his obligations and allows him to *rightfully* cancel the contract if a seller's non-conforming first installment substantially impairs his valuation of the entire contract. Hence, if the impact of the good's non-conformity is beyond a certain threshold, the code's provisions enable the buyer to exit the contract, be released from his obligation to accept the second delivery but at the same time retain the remedy for the unperformed installment.[11] If, however, a buyer *wrongfully* cancels a contract, the seller is entitled to compensation for buyer's breach of contract.

It is important to understand that the key feature of the stipulations in 2-612(3) is not the fact that *rightful* cancellation is possible only for a *substantial* rather than any deviation. The *UCC* generally allows for deviations from the perfect tender rule even for single-delivery contracts. What is central to the analysis in this paper is the understanding that, from a buyer's perspective, rejection and cancellation of installment contracts are more restricted than the would be under the rules in place for single shot contracts. Whether the perfect tender rule is strictly applied is irrelevant, what matters is the more pronounced application of the substantial impairment requirement for multi-delivery contracts.[12]

An ultimate answer to *What?* constitutes a *substantial* impairment of the buyer's value of the contract or guidelines on how to determine this are not given in the code, and courts have accepted this question to be a matter of fact.

> If the default is the result of accident or misfortune, [...] there may be one conclusion. If the breach is willful, if there is no just ground to look for prompt reparation, if the delay is substantial, of if the needs of the vendor are urgent [...], in these and other circumstances, there may be another conclusion. (Farnsworth, 2004; p. 574, §8.18; citing Justice Cardozo in *Helgar v. Warner's Features*)

[10]Both sections come with reservations: Section 2-612(2) allows the promisor to cure (if the defect is curable) and, unless the non-conformity substantially impairs the value of the whole contract, to give adequate assurance of such cure. For single-delivery contracts section 2-508 gives the seller the right to cure "if the time of performance has not passed [and] the seller had reason to believe that the goods were in conformity with the contract." Because 2-612(3) allows cancellation only if the non-conformity impairs the value of the *whole* contract, courts have argued that for installment contracts there is no reference needed to 2-508; "the seller's right to cure is implicitly defined by 2-612." See *Midwest Mobile v. Dynamics*, fn. 6, or *Neufer v. Video Greetings (6th. Cir., 1991) 931 F.2d 56.*

[11]2-711(1b). The *UCC* distinguishes between contract *cancellation* and *termination*: "'Cancellation' occurs when either party puts an end to the contract for breach by the other and its effect is the same as that of 'termination' except that the canceling party also retains any remedy for breach of the whole contract or any unperformed balance" (2-106). The first part of the analysis of this paper concerns cancellation and the aggrieved party's expectation interest, in a later section we will evaluate the model under a rule of "termination" and an aggrieved party's restitution interest. Moreover, *cancellation* and *termination* refer to non-delivered future installments, while *rejection* is with respect to goods already delivered.

[12]See also Kremer (2002; pp. 85f). In his comparative work he studies German, UN as well as US contract law with respect to remedies in case of partial performance.

White and Summers (2000; p. 315, §8.3) argue the substantial impairment test to be related to the determination of "material breach" known from common law. In his view the latter is "at least a first cousin to the concept of 'substantial conformity.'"[13]

Legal and economic motivation A much more fundamental issue relating to the substantial impairment requirement for installment contracts is the question of *Why?* there is need for separate handling of multi-period as opposed to to single-delivery contracts.[14] The reasons for restricting the buyer's rights to cancel a contract and thus granting the seller protection beyond the right to cure, leading to a "seller's world" (Quinn, 1978), do not seem self-evident. It has in fact been suggested that the substantial impairment requirement is primarily applied to protect both parties from themselves rather than from one another, that means protecting the contract as a whole. In *Midwest Mobile v. Dynamics*[15] the court noted that the "very purpose of the substantial impairment requirement of [2-612(3)] is to preclude parties from canceling an installment contract for trivial defects." The reasons for which a party may have an incentive to cancel the contract can be manifold. A buyer[16] might turn out to have a very low valuation for the delivered good or be able to generate higher payoffs in a contract with a third party and thus want to exit the contract. A strict compliance rule would give him the chance to do so for any trivial defect. Whether or not the seller's extended protection is socially beneficial and therefore desirable from economic efficiency perspective, however, again is a question of fact (or rather a matter of the proper set of assumptions for the economic modeler).

Information that emerges as the parties perform their contractual obligation may give rise to possible adaption of the contract's provisions. Discussing the *ex-ante* and *ex-post* efficiency properties of performance rules (*perfect tender* vs. *substantial performance*), Schwartz and Scott (1991; pp. 230ff) (and Speidel (1992; pp. 139f) for the analogous rules in the CISG) argue that if the law requires substantial performance rather than a perfectly conforming tender, the buyer is encouraged to cooperate with the seller in order to find out which modifications are needed to come closest to his needs (smallest deviation in terms of value) at least cost to the seller. If in such a long-term relationship for instance we observe asymmetric information with respect to the

[13]Restatement (Second) of Contracts, §241. Speidel (1992; fn. 31) further states that the "'substantial impairment' test replaces the 'material breach' test in §45 of the Uniform Sales Act." The *Convention on Contracts for the International Sale of Goods (CISG)* requires "fundamental breach" in order for the buyer to "avoid" (cancel) the contract (Hull, 2005; p. 150). See for instance Koch (1999) for a general treatment of "fundamental breach" and Karollus (1995) for applications of the CISG in Germany. International commercial law gives rules "consistent" (Speidel, 1992; p. 140) with the ones observed in the United States (see also Bugge, 1999; Katz, 2006). It has been indicated to the author that even if there is no doctrinal difference with respect to the "fundamental breach" breach provision between single and multi-delivery contract, in practice the buyer's cancellation rights for the latter type are expected to be more restrictive.

[14]See Priest (1978), Schwartz and Scott (1991), and also Russ (1996) for a discussion of the substantial impairment requirement in the context of revocation of acceptance (2-608), and Craswell (1990) with respect to anticipatory repudiation (2-610).

[15]See also *Emanuel Law Outlines v. Multi-State Legal Studies (1995) 899 F.Supp. 1081* and *Hubbard v. UTZ.*

[16]In our analysis we assume the seller to be the primary contract breacher. For consistency, we let the buyer be the aggrieved party in the exposition of the literature.

seller's type (cost or productivity), then the first period performance reveals interim information that can be used to modify the contract specifications to the benefit of both parties. Strausz (2006) analyzes such a contractual relationship with *ex-ante* asymmetric information and shows that the interim information may mitigate the adverse selection problem over time. Such a "learning effect", however, cannot arise and potential efficiency gains are destroyed if trivial defects trigger a buyer's cancellation decision.

Another argument in favor of Section 2-612 brought forward by Whaley (1974) and recited by Lawrence (1994; fn. 86) is primarily of a distributive nature. Their claim is that the substantial impairment requirement exists to avoid the termination of a long-term contract because in contracts calling for multiple deliveries minor non-conformities are likely to occur. Allowing the buyer to cancel for any such defect would give him an "unreasonable commercial advantage" over the seller. Thinking their argument out, restricting these cancellation rights should shift the parties' commercial leverage from the buyer to the seller, and as a consequence redistribute payoffs. As long as the distribution of the parties' joint surplus does not affect their incentives, notions of "commercial advantage" or "fairness" are of second order relevance since Kaldor-Hicks is implicitly applied.[17] If this commercial advantage, however, allows for or gives rise to buyer's inefficient rent-seeking, then Whaley's (1974) call for redistribution of contractual rights is indeed (unintentionally) backed by optimality concerns.[18] In this paper we focus on the buyer's threat of cancellation and his ability to extract some or all of the seller's payoffs when renegotiating the contract. We show that a buyer's commercial advantage, an extended cancellation right, adversely affects the seller's incentive and indeed gives rise to inefficient rent-seeking.

A result along these lines is obtained by Goldberg and Erickson (1987). In their work on long-term coal contracts, which are to a great extent characterized by relationship-specific investment, they conclude that price-adjustment rules may prevent "wasteful behavior" (p. 388). Examples for such behavior are an insistence on seller's strict conformity with the contract's quality provisions or "[reading] the contract literally." If the legal rules governing a contract allow for such "working to the rules", the buyer may gain a bargaining leverage over the seller, resulting in ex-ante under-investment due to hold-up (Goldberg, 1976; Klein, Crawford, and Alchian, 1978; Williamson, 1985). Consequently, relaxing the quality requirements with respect to the buyer's right to cancel—and with damage remedies as to the defective installment unaffected—may in certain situations improve the outcome of the contract. Given this, strict compliance is wasteful not only because it reduces the incentive to modify the contract ex-post, as argued by Schwartz and Scott (1991), but also because resulting hold-up problem and seller's under-investment.[19]

[17] Kaplow and Shavell (2002) offer a thorough (pro-efficiency) discussion of the potential conflict between fairness and welfare.

[18] An unfair distribution in favor of the buyer may also trigger (inefficient) punishment (out of spite or retaliation) by the seller. Such behavioral aspects become more and more important both in the economic and legal literature. For a symbiotic treatment see for instance Sunstein (2000).

[19] A similar wastefulness result for strict compliance rules in general can be found in the work by Goetz and

In the economic literature, the relationship between non-contractible investment and the period of time covered by a contract is well established. Williamson (1985; pp. 43–63) concludes that due to asset specificity in transactions, continuity of contracts is of significant value and protection of opportunism is desirable. More generally, Hart and Holmström (1987; p. 129) argue that "a fundamental reason for long-term relationships to be entered is the existence of investments that are to some extent party-specific." This is backed by Joskow (1987) among others who finds empirical evidence from coal contracts which shows that longer term agreements are entered as relationship-specific investment gets more important. Moreover, Crawford (1990) concludes that in such settings one-period contracts lead to inefficient under-investment. Indeed, parties will then optimally choose to enter long-term contracts since single-period deals based on repeated bargaining are "unattractive" due to hold-up and parties' rent-seeking.[20] A more general result is obtained by Fellingham, Newman, and Suh (1985). They find that if a contract does not exhibit any memory, i.e. if for instance a later payment or action does not depend on an earlier action, then in a model with full commitment a multi-period installment contract and a series of sequential one-stage contracts both implement the first best outcome. There are therefore no gains to a long-term contract and the repeated game can be played myopically. Renegotiation, however, will render the no-memory requirement violated, as do relationship-specific investments.

Goldberg and Erickson's (1987) wastefulness result and the need for protection of long-term contracts due to non-contractible investment is an obvious consequence of the above implications. We can motivate this by an incomplete contract choice argument: If parties enter a long-term, installment contract they are likely to do so to align *ex-ante* investment incentives by avoiding a hold-up problem that would otherwise arise from repeated bargaining. Under a perfect tender rule the buyer may threaten cancellation for any defect of a delivered good, which leaves the seller with lower payoffs than in case of reinstatement. By such a cancellation threat the buyer is able to impose a "bad" disagreement point onto the seller during renegotiations and extract some or all of her future period rents. An installment contract signals consensual desire for "protection" of investment incentives, which conversely implies that had the need for such investment alignment not existed, the parties would not have entered the installment contract to begin with. This "hypothetical consent" (Craswell and Schwartz, 1994; p. 27) suggests a default rule that accounts for these circumstances. The substantial impairment requirement

Scott (1981), Baird, Gertner, and Picker (1994; p. 232) or Schwartz and Scott (2003) on "mandatory acceptance of substantial performance", particularly in construction contracts. Here, simple one-shot contracts over highly customized goods are analyzed. A strict compliance rule gives the buyer a chance to hold up the seller since a perfect tender is difficult to accomplish for a complex industry such as construction (cf. Whaley, 1974).

[20] See also Joskow (1985) and the empirical work cited in Joskow (1987; fn. 2). For a more general picture, Hart and Holmström (1987) is an early source on dynamic contract theory in general. Bolton and Dewatripont (2005; part III) give a thorough treatment also of "fairly recent research [...] synthesized here for the first time." They caution, however, that "the concepts and methods explored [...] are not as well digested [as for single-shot contracts in part I] and may well evolve significantly in response to future research breakthroughs" (Bolton and Dewatripont, 2005; pp. 366f).

may serve as such a rule meeting the parties' "needs." In a more general context, Ayres and Gertner (1989) discuss both "majoritarian" (what would the parties have agreed on had they discussed the matter) and "penalty" rules that give at least one party an incentive to contract around the default rule. Since material breach is a question of fact, the substantial impairment requirement is a tailored, non-penalty default rule. In general, whether or not the default should be constructively filling the gap or penalizing the parties for not choosing what they would have wanted is a matter of the costs of information acquisition. That means if parties' *ex-ante* costs of bargaining over certain provisions are lower than a court's *ex-post* costs of determining their hypothetical consent, then a penalty default is appropriate. We will resume this point in the concluding discussion.

Research question and related literature The benefits of long-term contracts in mitigating the hold-up problem have been extensively analyzed.[21] Indeed, as we have seen, the desire for protection of a long-term contract stems from the technological need of relationship specific investment. This is because buyer's opportunistic behavior may distort the parties' investment incentives and lead to a Pareto-inferior outcome, which is the main motivation and predominant explanation for the *substantial impairment requirement*.

In this paper we show for a model (Section 3) with a perfect judiciary and simple, renegotiable installment contracts that a restriction of the buyer's cancellation right leads to a Pareto-improvement even if non-contractible investments are not technologically required. This result arises from the fact that the buyer can "hold up" the seller in *ex-post* renegotiations by threatening to cancel the contract if an earlier delivery is substantially non-conforming (Section 4). Cancellation will result in significantly lower payoffs for the seller. In order to avoid such a disadvantageous bargaining position the seller will exert excessive effort in an early delivery and therefore not grant the buyer the right to cancel, i.e. not give him an *ex-post* bargaining leverage. By further assuming that parties split the generated trade surplus along a constant sharing rule, the proclaimed commercial *advantage* of the buyer (Whaley, 1974) indeed turns out to be a *disadvantage*. This is because the more extended the buyer's cancellation rights, the more distorted the seller's incentives and the lower the expected joint surplus will be (Section 5).

Our analysis generalizes the usual motivation by establishing a result not hinging on the existence of relationship-specific investment. We can conclude that if the buyer is not able to commit *ex-ante* not to engage in coercive renegotiation *ex-post*, it is a subgame perfect equilibrium strategy for a particular subset of sellers to avoid the resulting hold-up effect by inefficiently over-performing. This implies that the wastefulness result in Goldberg and Erickson (1987) among others carries over to this simpler and more general setup. We consider the model without investment to isolate the incentive effects of the damage rules from those stemming from the standard hold-up results. Regarding the choice of entering long-term contracts, the

[21]See the discussion above, see also Farrell and Shapiro (1989), MacLeod and Malcomson (1993), Guriev and Kvasov (2005) or Watson (2005).

classical view in the property rights literature is the argument that parties enter such contracts in order to get rights and obligations that encourage investment and therefore improve the expected outcomes.[22] Hart and Moore (2006; p. 2) among others, however, argue that this "emphasis [...] seems overplayed." For instance, specific investment is a less important motive for franchising contracts (see e.g. Lafontaine and Slade, 1997, 2000) since assets may be re-employed in alternative use at reasonably low cost (Klein, 1995). Hart and Moore (2006) further refer to Williamson's (1985) "fundamental transformation" to motivate the existence of long-term contracts without obvious relationship-specific investments. We thus feel on the safe side when refraining from this contract choice issue and making an *adhoc* assumption on the existence of an installment contract.[23]

In addition to the work discussed above, our paper further contributes to a number of strands of the literature on contracts and contract law. We relate our results to the vast literature on the hold-up problem (reviews by Schmitz (2001), Shavell (2005) or Fares (2006)) as well as commitment-induced performance inefficiencies. Earlier work is by Williamson (1983) on the use of hostage assets to bind parties to a contract; Rey and Salanié (1990) among others in a unifying treatment on commitment as opposed to renegotiation obtain efficiency results for long-term contracts. Accounting for the legal situation in the United States, Jolls (1997) discusses contracts in terms of a commitment device. Given asymmetric information, Baron and Besanko (1984) show in a regulation context that if a regulator cannot commit to her policy the agent will have inefficient performance and information revelation incentives. Strausz (2000), for instance, discusses this issue in the context of the political economy literature, Hermalin (2005) shows an excessive effort, *rat-race* result for executives in a promotion game.

We also have something to add to the formal results on contract termation. In the spirit of Comino, Nicolò, and Tedeschi (2006) or Muehlheusser (2006) (exogenous switching in labor contracts)[24] we look at cancellation rules and damages without third party effects that are analyzed for instance in Aghion and Bolton (1987) (market entry). Our findings are in line with Comino, Nicolò, and Tedeschi's (2006) no-termination-clause result as well as Muehlheusser's (2006) optimal upper bound for cancellation damages. Related to these results is the discussion on levels of liability for negligent behavior in the tort literature. We show a link to our results

[22]Other suggested reasons for the use of long-term contracts are the desire to control free-riding or to avoid unproductive search costs (see Masten, 2000), income or consumption smoothing, informational linkages between periods (via information revelation facilitated by a multi-period contract or relationship), non-enforceability of explicit contracts (via reputation effects), income effects and risk aversion, or monitoring of performance (Joskow, 1987; p. 169).

[23]The assumption is not as *adhoc* as it initially appears, but driven by the timing of contracts. If parties simultaneously enter two separate agreements for the delivery of two goods, the restriction is imposed by law since *UCC* 2-612(1) states that such agreements are to be treated as *one* installment contract even if the documents stipulate separate treatments. The code thus restricts contract choice and drives parties into installment contracts. Nothing, however, hinders parties to contract over the second good upon delivery of the first. Without relationship-specific investment, hold-up arising from sequential contracting is apparently not an issue.

[24]Interesting approaches are also found in rather recent discussion papers by Zenger (2007) (with an application to electoral rules) and Stremitzer (2007) (one-period sales contracts without renegotiation).

in argue in favor of the position by Grady (1983) and Kahan (1989) and contra Cooter (1982) or Shavell (1986).

The modeling approach we take is not novel but similar for instance to the "multiple-trading-periods model" in a recent paper by Watson (2005). Our basic setup, however, differs in three distinct features. Firstly, Watson requires non-contractible relationship-specific investment for efficiency reasons. As we will argue, restricting the buyer's cancellation rights makes economic sense even in a business relationship without such investment. Secondly, Watson (2005) is more general by assuming T time periods. Thirdly, we explicitly model the legal background and analyze how full compensation breach remedies and the buyer's cancellation rights affect parties' equilibrium strategies. [25]

3 Model

We construct a simple buyer-seller model with standard assumptions. Parties face an *ex-ante* uncertainty that is resolved in the first period, they are risk-neutral and not wealth-constrained. In order to keep the analysis simple we consider the case of a non-durable good traded in two subsequent periods without discounting, valuation and cost functions are assumed to be time-separable. Allowing for Nash-bargaining renegotiation of the second installment upon observation of the first, we study the effect of the *UCC*'s default cancellation rule for installment contracts on parties' equilibrium strategies. The modeling framework is further one of verifiable actions and complete yet non-verifiable information, where the seller's action space is continuous and the buyer's discrete. We assume a (non-strategic) third party enforcer that receives information of the parties' actions and compels the exchange of damage payments.

Let a **seller** (she) produce and deliver a good of quantity or quality s_1 at date 1 and a good s_2 at date 2. We denote this performance vector by $\mathbf{s} = (s_1, s_2) \in S \times S \subseteq \mathbb{R}^2_+$. Her costs of producing $\mathbf{s}$ are denoted by $C(\mathbf{s}, \theta) = c(s_1, \theta) + c(s_2, \theta)$. By the sequential nature we rule out advanced production which may introduce relationship-specific investment type effects. At the start of production of $\mathbf{s}$ she observes her *relationship-specific productivity* $\theta \in \Theta \equiv [0, 1]$, which negatively affects $C(\mathbf{s}, \theta)$ with strictly increasing cdf $F(\theta)$.[26] This productivity type is observable yet non-verifiable. We assume that $C(\mathbf{s}, \theta) \geq 0 \ \forall \theta$ for any non-negative s_i, twice differentiable, convex and monotonically increasing in s_i for $i = 1, 2$; the Inada conditions hold. Moreover, let the single-crossing property hold, i.e. given $s_i' > s_i$ and s_j, then $C(s_i', s_j, \theta) -$

[25] Watson (2005) further assume time-variant productivity types. In the appendix we show that our results hold for any (positive) correlation, for the sake of simplicity the exposition is thus based on a time-invariant productivity type.

[26] One could assume θ to be a *project-specific* productivity type that only prevails over the lifetime of the project rather than of the entire business relationship. Since we abstract from repeated interaction, i.e. repeated agreement upon installment contracts, this distinction is not relevant in our setting. On the other hand, speaking of a *contract-specific* productivity type might be misleading, because parties can enter either one or two contracts for goods s_1 and s_2. The seller's type prevails over all periods and is a special case of periodic production uncertainty with states of nature θ_i realized before the production of goods s_i, $i = 1, 2$. We thus assume $\operatorname{cov}(\theta_1, \theta_2) = 1$. In the appendix we show for an unrestricted $\operatorname{cov}(\theta_1, \theta_2)$ that the results qualitatively hold.

$C(s_i, s_j, \theta)$ is decreasing in θ. The seller's payoff function is quasi-linear and given as $B = -C(\mathbf{s}, \theta) + Z$, where Z is some monetary transfer.

The installment vector $\mathbf{s}$ directly enters the **buyer**'s utility $V(\mathbf{s}) = v(s_1) + v(s_2)$. We assume that $V(\mathbf{s}) \geq 0$ for any non-negative s_i, twice differentiable, quasi-concave, monotonically increasing in s_i for $i = 1, 2$; the Inada conditions hold. The buyer's overall payoff is quasi-linear and denoted by $A = V(\mathbf{s}) - Z$.

Let **social welfare** $W(\mathbf{s}, \theta)$ be the sum of buyer's and seller's payoffs, or equivalently, the difference between the buyer's valuation and the seller's costs of $\mathbf{s} = (s_1, s_2)$, $W(\mathbf{s}, \theta) = V(\mathbf{s}) - C(\mathbf{s}, \theta)$. By the assumptions for C and V it follows that $W(\mathbf{s}, \theta) \geq 0$ for any non-negative s_i, $i = 1, 2$. Finally, the first best solutions for s_1 and s_2, (σ_1^*, σ_2^*), are the maximizers of $W(\mathbf{s}, \theta)$ and satisfy the first order conditions for $i = 1, 2$,

$$\frac{\partial v(s_i)}{\partial s_i} - \frac{\partial c(s_i, \theta)}{\partial s_i} \stackrel{!}{=} 0. \tag{1}$$

By the given assumptions, the periodic surplus functions $w(s_i, \theta)$ behave "nicely" with σ_i^* their unique maximizers that are continuous and strictly increasing in θ.

The **timing** of the model as depicted in Figure 1 is as follows:

***t* = 0** The *threshold of substantial impairment* μ is common knowledge at the outset of the game. We can think of it as either deduced from the judicial system's case history or credibly announced by the third party enforcer. Before the seller's productivity type is observed, parties contract over goods to be delivered and the transfers the buyer has to pay at date 1 and 2. Parties are expected utility maximizers and agree upon a simple fixed-price, fixed-quantity installment contract. We define such an installment contract along *UCC* Section 2-612(1):

Definition 1 (Installment contracts)**.** *An installment contract is a multi-delivery contract that authorizes or requires the seller to separately deliver and the buyer to separately accept the goods delivered.*

Let the contracted quantity or quality of goods to be tendered by the seller be denoted by $\bar{\mathbf{s}} = (\bar{s}_1, \bar{s}_2) \in \overline{S}^2$ with $\bar{s}_1 = \bar{s}_2$. The parties' choice set for the two contract provisions is given as $\overline{S} : \{\bar{s}_i | \bar{s}_i = \sigma_i^*(\theta), \theta \in \Theta, \bar{s}_i > 0, i = 1, 2\}$. This means we restrict parties to contract installments that are commercially practicable, i.e. we rule out $\bar{s}_i > \sigma_i^*(\theta)$. Edlin (1996; p. 106) defines and analyzes a contract over "as large a quantity or quality as is generally efficient" and labels such a deal a *Cadillac* contract. Consider for instance, if the New York Port Authority decides to install a new elevator in the Empire State Building, it will be able to order a really fast one, but it will not enter a contract over equipment that allows for visitors to be beamed up to the 86th floor observatory platform. Similarly, the Persian carpet you order for your new weekend hang-out in the Hamptons may be the finest available, but the finest is certainly not magic and you will still have to hop on your helicopter to get out there. Moreover, we abstract from zero contracts.

The installment vector $\bar{\mathbf{s}}$ is chosen such that the parties' expected joint surplus is maximized. We assume a generalized Nash-bargaining solution for monetary transfers $\bar{p} = \bar{p}_1 + \bar{p}_2$, $\bar{\mathbf{p}} = (\bar{p}_1, \bar{p}_2)$, that split this surplus along the sharing rule (α, β) with $\alpha \in [0,1]$ the buyer's and $\beta = 1 - \alpha$ the seller's share. Installments $\bar{s}_i$ are by assumption non type-contingent, giving rise to an incomplete contract $\mathbb{I} \equiv \mathbb{I}(\bar{\mathbf{s}}, \bar{\mathbf{p}})$. This incompleteness at the "formation" rather than the "execution" stage is assumed to result from either transaction costs and costs of writing contracts[27] or some notion of bounded rationality, that is the "limited capacity of transactors to anticipate, identify and describe optimal responses to future events" (Masten, 2000; p. 27). At $\boldsymbol{t = 0.5}$ between formation of the contract and the first performance the seller's productivity type $\theta \in \Theta$ is realized and observed by the parties upon production of s_1.

$\boldsymbol{t = 1}$ *The parties exchange the first installment and the agreed price, the buyer is compensated for non-conformities.* Under contract $\mathbb{I}$, it is the seller's obligation to deliver $\bar{s}_i$ for any realized θ and the buyer's obligation to accept the seller's tender and pay $\bar{p}_i$ at for installment i. We assume $\mathbb{I}$ to be fully enforceable *ex-post* by a third party. The seller's performances $\mathbf{s}$ are both observable and costlessly verifiable, hence, any deviation from $\bar{\mathbf{s}}$ is verifiable and will give rise to the default remedies for breach of contract given by law. We follow the literature on the properties of particular contract breach remedies and apply expectation damages as the predominant default remedy of the buyer for seller's breach of contract, and vice versa.[28] If the seller tenders below the contracted level of performance $\bar{s}_i$, she is in breach with respect to installment i and bound by law to pay monetary compensation that puts the buyer "in as good a position as if [she] had fully conformed to the contract."[29] We assume a frictionless judiciary, i.e. going to court is costless and damages are fully compensatory.

Definition 2 (Expectation interest)**.** *Let* $\mathbf{s}^d = \left(s_1^d, s_2^d\right)$*, where* $s_i^d = s_i$ *if* $s_i < \bar{s}_i$ *and* $s_i^d = \bar{s}_i$ *if* $s_i \geq \bar{s}_i$*, then the buyer's damages of a defective installment* i *are*

$$d\left(s_i^d, \bar{s}_i\right) = v\left(\bar{s}_i\right) - v\left(s_i^d\right), \quad i = 1, 2, \tag{2}$$

which are fully compensated by the seller.

The construction of s_i^d extends the setup of Edlin (1996), who initially assumes that parties write *Cadillac* contracts only, to ensure that the buyer is not compensated for any windfall

[27] These may include "legal fees, negotiation costs, drafting and printing costs, the costs of researching the effects and probability of a contingency, and the costs to the parties and the courts of verifying whether a contingency occurred." Contractual incompleteness may also result from strategic behavior (This reason, however, applies to settings with private information which is not the case in our model) (Ayres and Gertner, 1989; pp. 92ff).

[28] For an informal analysis see Posner (1977). Diamond and Maskin (1979) provide an insightful equilibrium analysis of contract breach. For a formal approach to expectation damages refer to Shavell (1980, 1984), Rogerson (1984), see also Shavell (2004) or Hermalin, Katz, and Craswell (2006) for a comprehensive literature review.

[29] *UCC* 1-305(a) gives the general idea of expectation damages, the specifics are found in Art. 2, Section 7.

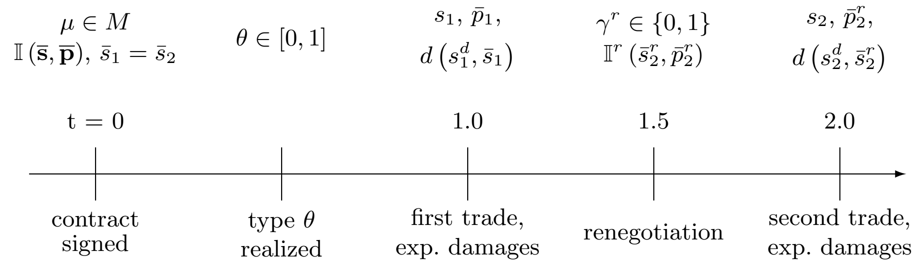
gains. His contractual obligation is to accept the good delivered and pay the agreed price. If the seller's s_i, however, is non-conforming, the buyer may rightfully reject the full delivery and claim damages. Since he is fully compensated for any non-conformity of the seller's tender, a rightful rejection of the good cannot make the buyer better off than accepting the defective delivery and collecting damages for the non-conformity, $d\left(s_i^d, \bar{s}_i\right)$, rather than the whole delivery, $d\left(0, \bar{s}_i\right)$. If the seller can resell a good s_i for a price less than $\bar{p}_i$ only, she will prefer acceptance over rejection and the payment of partial damages rather than full. We can assume that the buyer will never reject a good that has already been tendered.[30]

***t* = 1.5** *The buyer announces his cancellation decision and parties renegotiate the second installment.* By definition of an installment contract, delivery and acceptance of s_1 and s_2 are of sequential nature. This allows the parties to renegotiate the second installment and its price prior to production and delivery of s_2. The parties will agree upon a renegotiated installment $\bar{s}_s^r$ such that their joint surplus is maximized. Since θ is publicly observed in period $t = 1$, the renegotiated second performance will be *ex-post* efficient, $\bar{s}_2^r = \sigma_2^*(\theta) \equiv \arg\max_{s_2 \in \overline{S}} w(s_2, \theta)$. The respective price, too, is contingent on θ and such that it splits the surplus along the sharing rule (α, β). The price provision $\bar{p}_2^r$ in the renegotiated contract $\mathbb{I}^r(\bar{s}_2^r, \bar{p}_2)$, however, will also depend on the seller's first period performance. This will be the result of the fact that the buyer has the opportunity to threaten cancellation of the contract and thus improve his bargaining position relative to the seller's. In the previous section we examined the default rules for rightful cancellation of an installment contract, discussing that the *Uniform Commercial Code* allows the buyer to reject future installments in advance if the non-conformity of a delivered good substantially impairs his valuation of the whole contract. If the seller delivers such a substantially non-conforming installment, then the buyer may announce rightful cancellation of the contract as his disagreement point in *ex-post* renegotiations. If the the seller, however, delivers a first installment that does not substantially impair the entire contract, buyer's cancellation is wrongful, triggering the seller's claim of expectation damages and possibly rendering the cancellation threat non-credible. Let's denote the buyer's announcement by $g \in G \equiv \{0, 1\}$ where $g = 1$ means cancellation.

The *substantial impairment requirement* for rightful cancellation has been argued to be closely related to the *material breach test.* For the remainder of this analysis we will follow this assertion and assume that the input-driven test of material breach is a conclusive approximation of the output-driven test of substantial impairment. We assume that a non-conformity as to the first installment tendered by the seller substantially impairs the buyer's valuation of the whole

[30] At the time of delivery the seller may always grant the buyer an infinitesimally small price reduction z, inducing a break of the buyer's tie and him to accept the non-conforming tender. See Jackson (1978) who discusses rejection and rescission, allowing for a third party seller. In our setup, rescission (rejection without a damage claim, since there is no reliance in our model) will leave the buyer with a surplus of zero. This implies that as long as his first period payoffs $\bar{a}_1 = v(\bar{s}_1) - \bar{p}_1$ are non-negative, he will not prefer rescission over acceptance or rejection.

Figure 1: Time structure of the model



contract if and only if this defect constitutes a material breach of the contract. This simplifying assumption allows us to apply the substantial impairment test not through how the buyer values the non-conformity but through the seller's input s_1. Let the *threshold of substantial impairment* be denoted by $\mu \in M \equiv [0,1]$. If the seller tenders a first installment such that $s_1 < \mu \bar{s}_1$, then she is in material breach. The respective impairment of the buyer's valuation constitutes total breach of contract giving him the option to rightfully cancel, $g = 1$, and claim damages not only for the non-conforming first but also the non-delivered second installment.[31]

Definition 3 (Substantial impairment requirement)**.** *If $s_1 < \mu \bar{s}_1$ and $\mu \in [0,1]$, then the non-conformity of the first installment substantially impairs the buyer's valuation of the entire contract, $V(s_1, \bar{s}_2) - \bar{p}$. This allows the buyer to rightfully cancel the entire contract and claim damages $d(s_1^d, \bar{s}_1)$ for the defect in the first and $d(s_2^d, \bar{s}_2) - \bar{p}_2$ for the second installment, with $s_2 = 0$.*

If renegotiations shall fail, by the assumption of full compensation, the buyer will be indifferent between reinstating the contract $g = 0$ (accepting the seller's second period performance and collecting partial damages $d(s_2^d, \bar{s}_2)$), and canceling the contract $g = 1$ (collecting full damages $d(0, \bar{s}_2)$). The seller's payoffs in this case, however, are not necessarily equal in the two situations. She might indeed favor reinstatement to avoid the payment of full compensation damages. Lower payoffs for the seller in case of a credible cancellation threat thus improve the buyer's bargaining position. He can force a "bad" contract $\mathbb{I}^r$ with low payments $\bar{p}_2^r$ onto the seller.

[31] Before the buyer is given the right to cancel, 2-508 allows a seller to "cure" a defect if the time of delivery has not expired, or if she has reasonable grounds to believe that the tender was conforming. Let the time of delivery be discrete, i.e. by assumption the seller cannot deliver before date 1. Recalling that she has full control over her output, we can see both conditions of cure are not given. At the same time, it does not seem implausible to assume that the costs of cure are at least as high as initial performance costs. If the seller were willing to cure a non-conforming tender, she would have properly performed to begin with. Hence, we rule out the cure provision for this analysis.

$\boldsymbol{t = 2}$ *The parties exchange the second installment and the agreed price, the buyer collects damages.* The seller delivers s_2 such that her second period payoffs are maximized. The buyer pays the price $\bar{p}_2^r$, and if s_2 is non-conforming he collects expectation damages $d\left(s_2^d, \bar{s}_2^r\right)$.

4 Analysis

We abstract from the parties' contract choice of *one* multi-delivery installment contract over a *series* of one-delivery contracts and focus on the effect of the default rules for contract cancellation *given* such an installment contract. We solve the proposed model by backward induction to determine parties' subgame perfect equilibrium strategies in this three-stage model (seller–buyer–seller). Allowing for renegotiation of the second installment we study the effects of the substantial impairment requirement on these strategies. We show that if the buyer is granted the right to cancel, then in equilibrium the parties will agree upon a contract (out of the class of simple fixed-price, fixed quantity contracts) that renders their equilibrium strategies second best only. Parties' equilibrium strategies induce first best performance only if the buyer may never cancel the contract. Put differently, if the buyer may ex-post cancel, then a first best performance in $t = 1$ is not a subgame perfect equilibrium strategy.

If parties end up not agreeing upon a renegotiated contract $\mathbb{I}^r$ in period $t = 1.5$, then in $t = 2$ the seller's performance will depend on the buyer's credible cancellation announcement g. For $g = 1$, the seller does not get to perform and $s_2 = 0$. If $g = 0$ and the buyer does not threaten to cancel the contract, then the seller gets the chance to perform and will deliver s_2 to maximize her second period payoffs $b\left(s_2, \bar{s}_2, \theta\right) = \bar{p}_2 - c\left(s_2, \theta\right) - d\left(s_2^d, \bar{s}_2\right)$. Since $d\left(s_2^d, \bar{s}_2\right) = 0$ for any $s_2 \geq \bar{s}_2$ and the production costs increasing in s_2, the seller will not deliver more—or a good of better quality—than is stipulated. Let $\theta^*\left(\bar{s}_2\right)$ be the seller's productivity type for which delivery of $\bar{s}_2$ is first best such that $\sigma_2^*\left(\theta^*\left(\bar{s}_2\right)\right) = \bar{s}_2$. Hence, if $\bar{s}_2$ is such that there are productivity types θ for which over-performance is efficient, $\sigma_2^*\left(\theta\right) > \bar{s}_2$ and $w\left(\sigma_2^*\left(\theta\right), \theta\right) > w\left(\bar{s}_2, \theta\right)$, then the set of sellers performing inefficiently low at the top end of the type space is non-empty. We denote this set by $\overline{\Theta}\left(\bar{s}_2\right) \equiv \left[\theta^*\left(\bar{s}_2\right), 1\right] \subseteq \Theta$, its complement by $\overline{\Theta}_2^*\left(\bar{s}_2\right) = \Theta \setminus \overline{\Theta}\left(\bar{s}_2\right)$.

The seller maximizes $b\left(s_2, \bar{s}_2, \theta\right) = \bar{p}_2 - c\left(s_2, \theta\right) - d\left(s_2^d, \bar{s}_2\right) = w\left(s_2, \theta\right) - \bar{a}_2$ over $s_2 \leq \bar{s}_2$. Her payoffs are the period 2 joint surplus $w\left(s_2, \theta\right)$ minus the buyer's contracted share, a constant $\bar{a}_2 = v\left(\bar{s}_2\right) - \bar{p}_2$. By the first order condition in equation (1) we see that the seller's performance is equal to $\sigma_2^*\left(\theta\right)$ for $\theta \leq \theta^*\left(\bar{s}_2\right)$ and $\bar{s}_2$ for all other $\theta > \theta^*\left(\bar{s}_2\right)$. We can thus denote her period 2 (out-of-equilibrium) strategy for disagreement in renegotiations as

$$\sigma_2\left(g, \theta\right) \equiv \begin{cases} 0 & \text{if } g = 1 \\ \arg\max\limits_{s_2 \leq \bar{s}_2} b\left(s_2, \bar{s}_2, \theta\right) = \begin{cases} \sigma_2^*\left(\theta\right) & \text{if } \theta \notin \overline{\Theta}\left(\bar{s}_2\right) \\ \bar{s}_2 & \text{if } \theta \in \overline{\Theta}\left(\bar{s}_2\right) \end{cases} & \text{if } g = 0. \end{cases} \tag{3}$$

For notational simplicity we will denote $\sigma_2\left(0, \theta\right)$ by $\sigma_2\left(\theta\right)$ and shall point out that $s_2 = 0$ is an out-of-equilibrium outcome. If parties agree to agree in period $t = 1.5$ renegotiations, then the seller's second period performance is *ex-post* efficient

$$\sigma_2^r(\theta) \arg\max_{s_2 \leq \bar{s}_2^r} w(s_2, \theta) - \bar{a}_2^r = \sigma_2^r(\theta) = \bar{s}_2^r(\theta) = \sigma_2^*(\theta). \tag{4}$$

This result is easily established. As already discussed in the previous section, in period $t = 1.5$ parties will agree upon $\bar{s}_2^r$ such that their joint surplus is maximized, i.e. $\bar{s}_2^r \equiv \arg\max_{s_2 \in \overline{S}} w(s_2, \theta)$. This $\bar{s}_2^r$ satisfies the first order condition in equation (1), hence by the model's regularity assumptions the second installment will be $\bar{s}_2^r(\theta) = \sigma_2^*(\theta)$. The seller maximizes $b(s_2, \bar{s}_2^r(\theta), \theta) = w(s_2, \theta) - \bar{a}_2^r(\theta)$ over $s_2 \in S$, where $\bar{a}_2^r(\theta) = v(\bar{s}_2^r(\theta)) - \bar{p}_2^r$. Since $\bar{a}_2^r(\theta)$ is independent of s_2, the seller's performance incentives are aligned with the social performance incentives, yielding $\sigma_2^r(\theta) = \sigma_2^*(\theta)$.

The parties will agree upon a price which splits the renegotiation surplus along the general Nash-bargaining solution with α and $\beta = 1 - \alpha$ the buyer's and seller's bargaining power, respectively:

$$\bar{p}_2^r \equiv \arg\max_{p \in \mathbb{R}} [v(\bar{s}_2^r(\theta)) - p - q_A]^{\alpha} [p - c(\bar{s}_2^r(\theta), \theta) - q_B]^{\beta} \tag{5}$$

where $q = (q_A, q_B)$ denotes the parties' disagreement point payoffs. Recall that when initially negotiating the contract $\mathbb{I}(\bar{\mathbf{s}}, \bar{\mathbf{p}})$ we assumed the payoffs from parties' outside options to be equal to zero. They were not bound by a standing contract, and implicitly modeling a bilateral monopoly would not generate any surplus with other contract parties. At the renegotiation stage the payoffs from their outside options, i.e. what they engage in if they do not agree on a new contract $\mathbb{I}^r$, however, will not necessarily be zero but are determined by the existing contract. By $\mathbb{I}(\bar{\mathbf{s}}, \bar{\mathbf{p}})$ it is the seller's obligation to deliver what is contracted and the buyer's obligation to accept. In case of renegotiation, the buyer may now threaten cancellation of the contract and impose a detrimental disagreement point onto the seller—but also on the buyer himself. Notice that the law grants him the right to cancel if the seller's first period performance does not meet certain quality or quantity provisions. Suppose cancellation were rightful, then the buyer might collect compensation damages for the non-delivered, "anticipatorily rejected" second period installment. Since the seller were not to perform in that case, her second period payoffs would simply be given by the transfer to the buyer. If cancellation were wrongful, the buyer would be in breach and the seller entitled to her expectation damages, i.e. her payoffs from individually rational performance in period $t = 2$.

Before the parties enter renegotiations, the buyer observes the seller's first period performance which may or may not induce rightful cancellation. Let $\kappa \in \{0, 1\} \equiv K$ denote whether or not the seller has *substantially* conformed to the first installment provisions, with $\kappa = 1$ if it is indeed the case and $\kappa = 0$ if the defect in s_1 substantially impairs the whole contract. Consequently, for κ equal to unity cancellation is wrongful, and rightful otherwise. Given μ, the buyer announces his cancellation threat $\gamma^r \in \{0, 1\} \equiv G$ where $\gamma^r = 1$ denotes cancellation,

Figure 2: γ^r, κ, and parties' disagreement points under non-verifiable θ

Disagreement point payoffs	$s_1 \geq \mu \bar{s}_1,\ \kappa = 1$	$s_1 < \mu \bar{s}_1,\ \kappa = 0$
$\gamma^r = 1$	$q_1(1) = \big(-\max\left[\mathbb{E}_\theta\, b(\sigma_2(\theta), \bar{s}_2, \theta), 0\right], \max\left[\mathbb{E}_\theta\, b(\sigma_2(\theta), \bar{s}_2, \theta), 0\right]\big)$	$q_0(1) = \big(\max[\bar{a}_2, 0], -\max[\bar{a}_2, 0]\big)$
$\gamma^r = 0$	$q_1(0) = \big(\bar{a}_2, b(\sigma_2(\theta), \bar{s}_2, \theta)\big)$	$q_0(0) = \big(\bar{a}_2, b(\sigma_2(\theta), \bar{s}_2, \theta)\big)$

zero otherwise. This results in four $(K \times G)$ possible scenarios; the respective payoffs from the disagreement points $q_\kappa(\gamma^r) = (q_{A\kappa}(\gamma^r), q_{B\kappa}(\gamma^r))$ are summarized in Figure 2.

Notice that only $\gamma^r = 1$ triggers damages for non-performance in the second period while $\gamma^r = 0$ implies that damages $d\left(s_2^d, \bar{s}_2\right)$ are for partial performance $s_2 > 0$. We assume that neither the buyer nor the seller may collect windfall gains from breach, which is the case for the max operator in the upper quadrants of Figure 2. Consider for instance $q_0(1)$: If $\bar{a}_2 < 0$, i.e. if the buyer pays for $\bar{s}_2$ a higher price than his valuation for that installment, then the seller would collect windfall gains from a non-conforming first performance if the buyer decided to rightfully cancel the contract. Similarly, if the seller's second period performance were negative, the buyer would be given additional incentive to cancel the contract even if it were wrongful to do so.

We can immediately reduce the model by acknowledging that if a buyer's threat $\gamma^{r\prime}$ is non-credible, then he will in equilibrium not announce to cancel but instead reinstate the contract, or vice versa. If announcing an *ex-post* non-credible decision, the buyer does not incur any costs, but it is not effective. This is anticipated by the seller and the effective or "true" disagreement point then turns out to be $q_\kappa(\neg\gamma^{r\prime}) = q_\kappa(1 - \gamma^{r\prime})$ for given s_1 and μ. By comparing the buyer's outside option payoffs for both $\kappa \in \{0, 1\}$ we find the following with respect to the credibility[32] of his cancellation threat γ^r:

Lemma 1 (Credible threats). *Suppose that indifference gives rise to a credible threat, then* $\gamma^r(s_1, \mu, \theta) = 1 \Leftrightarrow \kappa(s_1, \mu) = 0$.

While the renegotiated second installment is *ex-post* efficient for all s_1, μ, or θ, the payment $\bar{p}_2^r$ will be a function of these three parameters through the disagreement point payoffs. By the

[32] For the implicit bilateral monopoly setup it is straightforward that "no trade" in the second period is inefficient since $w(\sigma_2^*(\theta), \theta)$ is positive for all $\theta > 0$. Some authors argue that an inefficient threat is unrealistic. Tirole (1999) for instance discusses the issue in the context of agreeing on *ex-ante* renegotiation design, while on the other hand Schmitz (2001; p. 8) asks in case of a credible threat in period 2, "why should one rule out contracts that may lead to inefficient out-of-equilibrium outcomes at date 0?" Lemma 1 shows that cancellation will indeed be an out-of-equilibrium outcome. We will resume the discussion in the context of Proposition 3.

generalized Nash-bargaining solution with a split-the-difference sharing rule (α, β) this price is

$$\bar{p}^r_{2,\kappa}\left(s_1, \mu, \gamma^r, \beta, \theta\right) = c\left(\bar{s}^r_2\left(\theta\right), \theta\right) + \beta w\left(\bar{s}^r_2\left(\theta\right), \theta\right) + \alpha q_{B\kappa}\left(\gamma^r\right) - \beta q_{A\kappa}\left(\gamma^r\right). \qquad (6)$$

We can see that $\alpha q_{B\kappa}(\gamma^r) - \beta q_{A\kappa}(\gamma^r)$ gives the relative bargaining leverage of the parties. Suppose bargaining patience is equal for both parties, hence $\alpha = \frac{1}{2}$, then equal disagreement point payoffs imply that parties will equally share the renegotiation surplus as well as the overall second period trade surplus. As the payoffs exhibit divergence, the party with the relatively higher one recoups a larger share of the overall trade surplus. This implies that the more detrimental a disagreement point payoff the buyer can impose on the seller, the lower the price which the buyer will have to pay for $\bar{s}^r_2(\theta)$ will be.

The buyer's period two payoffs $\phi^r_2(s_1, \mu, \beta, \theta) = v(\bar{s}^r_2(\theta)) - \bar{p}^r_{2,\kappa}(s_1, \mu, \gamma^r, \beta, \theta)$ evaluated in $t = 1$ are given as

$$\begin{aligned}\phi^r_2\left(s_1, \mu, \beta, \bar{a}_2, \theta\right) \;&=\; \left(1 - \kappa\left(s_1, \mu\right)\right)\left[\left(1 - \beta\right) w\left(\bar{s}^r_2\left(\theta\right), \theta\right) + \max\left[\bar{a}_2, 0\right]\right] + \\ &\kappa\left(s_1, \mu\right)\left[\left(1 - \beta\right)\left(w\left(\bar{s}^r_2\left(\theta\right), \theta\right) - w\left(\sigma_2\left(\theta\right), \theta\right)\right) + \bar{a}_2\right] \qquad (7)\end{aligned}$$

and decreasing in κ for all $\beta < 1$ or $\beta = 1$ and $\bar{a}_2 < 0$. Analogously to the buyer's payoffs, only if $\beta = 1$ and $\bar{a}_2 \geq 0$ will the seller's second period payoffs $\psi^r_2(s_1, \mu, \beta, \theta) = \bar{p}^r_{2,\kappa}(s_1, \mu, \gamma^r, \theta) - c(\bar{s}^r_2(\theta,), \theta)$, denoted by

$$\begin{aligned}\psi^r_2\left(s_1, \mu, \beta, \bar{a}_2, \theta\right) \;&=\; \left(1 - \kappa\left(s_1, \mu\right)\right)\left[\beta w\left(\bar{s}^r_2\left(\theta\right), \theta\right) - \max\left[\bar{a}_2, 0\right]\right] + \\ &\kappa\left(s_1, \mu\right)\left[\beta\left(w\left(\bar{s}^r_2\left(\theta\right), \theta\right) - w\left(\sigma_2\left(\theta\right), \theta\right)\right) + b\left(\sigma_2\left(\theta\right), \bar{s}_2, \theta\right)\right], \qquad (8)\end{aligned}$$

be independent of $\kappa(s_1, \mu)$—hence independent of the seller's first period performance s_1. Moreover, if $\beta < 1$ (or $\beta = 1$ and $\bar{a}_2 < 0$), by Lemma 1 the seller strictly prefers for any $\theta > 0$ the buyer not to exercise his cancellation threat since her payoffs in equation (8) are increasing in κ. This implies that $\psi^r_2(s_1, \mu, \bar{a}_2, \beta, \theta)$ is increasing in s_1 (positive discontinuity at $s_1 = \mu\bar{s}_1$) for any positive buyer's bargaining power. From equation (8) we can further see that she prefers the contract to be such that $\bar{a}_2$ is non-negative.

Lemma 2. *Let $\beta < 1$, then the buyer's anticipated second period payoffs are decreasing in κ,*

$$\phi^r_2\left(s_1, \mu, \beta, \bar{a}_2, \theta\right)\big|_{s_1 \geq \mu\bar{s}_1} < \phi^r_2\left(s_1, \mu, \beta, \bar{a}_2, \theta\right)\big|_{s_1 < \mu\bar{s}_1}$$

for all $\theta > 0$, while the seller's payoffs are increasing in κ,

$$\psi^r_2\left(s_1, \mu, \beta, \bar{a}_2, \theta\right)\big|_{s_1 \geq \mu\bar{s}_1} > \psi^r_2\left(s_1, \mu, \beta, \bar{a}_2, \theta\right)\big|_{s_1 < \mu\bar{s}_1}$$

for all $\theta > 0$. Moreover,

$$\psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta)\big|_{\bar{a}_2 \geq 0} > \psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta)\big|_{\bar{a}_2 < 0}$$

for all β.

The positive effect of κ on seller's anticipated period 2 payoffs, stemming from exploitation by the buyer, imply that, given some $\bar{s}_1$, a first best performance cannot be a subgame perfect equilibrium strategy for all θ. The intuition for this is straightforward: If low first period performance results in really low second period payoffs, a sufficiently high first delivery, however, has a positive effect on the seller's bargaining position through the substantial impairment requirement, giving her a "fair" share of the renegotiation surplus, then she will have an incentive to deliver more or better than is efficient. Such an excessive performance will not maximize her payoffs she receives in period $t = 1$, $b(s_1, \bar{s}_1, \theta)$, but may through her improved bargaining position maximize her overall payoffs. Hence, her action in period 1 will have an effect on her payoffs in period 2, which violates the time-separability assumption for the first best performance $\sigma_1^*(\theta)$

Let the seller's first period performance in $t = 1$ be $s_1 = \sigma_1(\mu, \beta, \bar{a}_2, \theta)$. She maximizes her overall payoffs over s_1, anticipating the positive effect of s_1 on the price she will receive for $\bar{s}_2^r$ in second period. Her first period payoffs are given as $b(s_1, \bar{s}_1, \theta) = \bar{p}_1 - c(s_1, \theta) - d\left(s_1^d, \bar{s}_1\right) = w(s_1, \theta) - \bar{a}_1$; her maximization problem solves

$$\sigma_1(\mu, \beta, \bar{a}_2, \theta) \equiv \arg\max_{s_1 \leq \bar{s}_1} w(s_1, \theta) - \bar{a}_1 + \psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta). \tag{9}$$

Again, by the construction of s_1^d it is straightforward that she will not perform above and beyond what is her contractual obligation. Because $d\left(s_1^d, \bar{s}_1\right) = 0$ and $\psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta)$ constant for $s_1 \geq \bar{s}_1$, but costs are strictly increasing in all s_1, her first period payoffs are strictly decreasing in $s_1 \geq \bar{s}_1$. Thus, let $\theta^*(\bar{s}_1)$ such that $w(\sigma_1^*(\theta), \theta) > w(\bar{s}_1, \theta)$ for all $\theta > \theta^*(\bar{s}_1)$ and $\overline{\Theta}(\bar{s}_1) \equiv [\theta^*(\bar{s}_1), 1] \subseteq \Theta$, then $\sigma_1(\mu, \beta, \bar{a}_2, \theta) = \bar{s}_1$ for all $\theta \in \overline{\Theta}(\bar{s}_1)$.

By the first order condition in equation (1), $\sigma_1(\mu, \beta, \bar{a}_2, \theta)$ is first best only if $\theta \notin \overline{\Theta}(\bar{s}_1)$ and $\psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta)$ does not affect the seller's choice of s_1. Suppose the seller is myopic and ignorant of the effects of her first period performance on the buyer's announced threat γ^r, then $\frac{\partial \psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta)}{\partial s_1} = 0$ and she will indeed deliver the first best $s_1 = \sigma_1^*(\theta)$ for sufficiently small θ. For a sophisticated seller who understands the effects of her performance on the buyer's incentives it may be worthwhile, however, to deliver $\sigma_1(\mu, \beta, \bar{a}_2, \theta) \geq \mu\bar{s}_1$ even if a substantially non-conforming tender $\sigma_1^*(\theta) < \mu\bar{s}_1$ is first best.

The buyer's cancellation threat will have a distorting effect for exactly the subset of seller types $\widehat{\Theta}$ for which the excessive costs of substantial conformity $\mu\bar{s}_1$ beyond the first best are equal or lower than the second period (bargaining) gains from such substantial conformity. We denote these excessive costs by $\Delta_B \equiv -\big(b(\mu\bar{s}_1, \bar{s}_1, \theta) - b(\sigma_1^*(\theta), \bar{s}_1, \theta)\big)$. Moreover, let the second period gains from substantial conformity be defined as $\Delta_\psi \equiv \psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta)\big|_{\kappa=1} - \psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta)\big|_{\kappa=0}$ or $\Delta_\psi \equiv \psi_2^r(\mu \bar{s}_1, \mu, \beta, \bar{a}_2, \theta) - \psi_2^r(\sigma_1^*(\theta), \mu, \beta, \bar{a}_2, \theta)$.

The installment contract $\mathbb{I}(\bar{\mathbf{s}}, \bar{\mathbf{p}})$ is to satisfy the buyer's first period participation constraint, i.e. the price of the first installment is not higher than the buyer's valuation and $\bar{a}_1 \geq 0$.[33] With $\bar{a}_1$ a constant, Δ_B can be simplified to read

$$\Delta_B(\theta) = w(\sigma_1^*(\theta), \theta) - w(\mu \bar{s}_1, \theta). \tag{10}$$

The second period gains from substantial conformity are equal to $\Delta_\psi = (1-\beta)\, w(\sigma_2(0, \theta), \theta) - \min[\bar{a}_2, 0]$. Notice, however, that if it is efficient for the seller to deliver above $\mu \bar{s}_1$ then she will not perform below this threshold of substantial conformity since no additional gains can be generated if $\kappa = 1$ and $\Delta_\Psi = 0$ for all $\theta \geq \theta^*(\mu \bar{s}_1)$. Hence, we can restrict the set $\widehat{\Theta}$ to be a subset of $\overline{\Theta}_2^*(\bar{s}_2)$, yielding

$$\Delta_\psi(\theta, \beta, \bar{a}_2) = (1-\beta)\, w(\sigma_2^*(\theta), \theta) - \min[\bar{a}_2, 0]. \tag{11}$$

Notice that damages are asymmetric as to the buyer's valuation of installment i. For $\bar{a}_2 \geq 0$, the buyer's damages of rightful cancellation are fully accounted for. If $\bar{a}_2 < 0$ then the buyer's damages are bounded from below by zero, in case of reinstatement, however, the seller fully benefits from the "high price" of the second installment. As a result, the seller's gains from a substantially conforming $\mu \bar{s}_1$ in equation (11) are higher if $\bar{a}_2 < 0$. Since Δ_B is not a function of it, a negative $\bar{a}_2$ will give the seller an additional incentive for excessive first period effort. Such inefficient performance, however, lowers the parties' expected joint surplus which will induce them to agree on $\mathbb{I}$ such that $\bar{a}_2 \geq 0$. We thus restrict the further analysis accordingly and drop $\bar{a}_2$ from the exposition. In Proposition 2 we will argue that indeed both participation constraints will in equilibrium be satisfied.

A type θ seller will *over-shoot* and tender an inefficient $\sigma_1(\mu, \beta, \theta) = \mu \bar{s}_1 > \sigma_1^*(\theta)$ if $\Delta_B(\theta) < \Delta_\psi(\theta, \beta)$. Reversely, if the excessive costs of substantial conformity more than offset the relative gains from second period performance, the seller will not *over-shoot* but deliver $s_1 = \sigma_1^*(\theta) \equiv \arg\max_{s_1 \leq \bar{s}_1} w(s_1, \theta) - \bar{a}_1$. She will eventually be indifferent if the excessive costs of $\mu \bar{s}_1$ just offset the gains from period two, the borderline type $\theta = \hat{\theta}(\bar{s}_1, \mu, \beta)$ then satisfies

$$w(\mu \bar{s}_1, \theta) = \beta w(\sigma_1^*(\theta), \theta). \tag{12}$$

This is straightforward from equations (10) and (11). Notice that by the model assumptions

[33] We have argued that the buyer does not threaten to reject a delivered and initially accepted first delivery s_1. By the no-windfall-gains assumption he will, however, not accept a non-conforming first installment if $\bar{a}_1 < 0$. This is because rejection of s_1 yields first period payoffs of zero, while for acceptance with compensation for partial performance they will be negative. We implicitly assume a bilateral monopoly setting with the parties exchanging a customized unique good, the seller's value of a delivered but rejected good is therefore sufficiently low. We impose a participation constraint for the buyer, $v(\bar{s}_1) \geq \bar{p}_1$, in order to abstract from efficiency losses that arise from potential first period rejection.

$w(\sigma_1^*(\theta), \theta) = w(\sigma_2^*(\theta), \theta)$, and $\min[\bar{a}_2, 0] = 0$ by the buyer's period 2 participation constraint. Excessive first period effort will be exerted if the LHS is larger than the RHS. From this equation (12) we can immediately conclude that the probability of such inefficiently high first period performance will be lower the higher the seller's *ex-post* bargaining power β. On the other hand, the seller's suboptimal incentives will increase the less restricted the buyer's cancellation rights are, i.e. the more likely the hold-up effect occurs. While the first best performance is continuous and strictly increasing in θ, sellers of types $\theta \in \widehat{\Theta}$ pool at $\mu\bar{s}_1$, implying a discontinuity at the lower bound of $\widehat{\Theta}$. The main results are summarized in the following proposition.

Proposition 1 (Over-shooting)**.** *Given $\bar{s}_1$, for positive μ and $\beta < 1$ the set $\widehat{\Theta}(\bar{s}_1, \mu, \beta) \subset \Theta$ of sellers over-shooting in the first period is non-empty, i.e. we observe excessive effort in the first period with strictly positive probability.*

The comparative statics of the borderline type $\hat{\theta}(\bar{s}_1, \mu, \beta)$ and probability of over-shooting $\mathcal{F}\Big(\widehat{\Theta}(\bar{s}_1, \mu, \beta)\Big) \equiv F\Big(\theta^*(\mu\bar{s}_1)\Big) - F\Big(\hat{\theta}(\bar{s}_1, \mu, \beta)\Big)$ are summarized in the following corollary.

Corollary 1.

1. *(i)* $\frac{\partial\hat{\theta}(\bar{s}_1,\mu,\beta)}{\partial\bar{s}_1} > 0$; *(ii)* $\frac{\partial\hat{\theta}(\bar{s}_1,\mu,\beta)}{\partial\mu} > 0$; *(iii)* $\frac{\partial\hat{\theta}(\bar{s}_1,\mu,\beta)}{\partial\beta} > 0$;
2. *(i)* $\frac{\partial\mathcal{F}(\widehat{\Theta}(\bar{s}_1,\mu,\beta))}{\partial\bar{s}_1} > 0$; *(ii)* $\frac{\partial\mathcal{F}(\widehat{\Theta}(\bar{s}_1,\mu,\beta))}{\partial\mu} > 0$; *(iii)* $\frac{\partial\mathcal{F}(\widehat{\Theta}(\bar{s}_1,\mu,\beta))}{\partial\beta} < 0$.

Notice that all sellers of type $\theta \in \overline{\Theta}(\bar{s}_1)$ will tender a constant $s_1 = \bar{s}_1 < \sigma_1^*(\theta)$. For those with productivity lower than $\theta^*(\bar{s}_1)$ we have seen that sellers $\theta \in \widehat{\Theta}(\bar{s}_1, \mu, \beta)$ will pool at $s_1 = \mu\bar{s}_1 \geq \sigma_1^*(\theta)$. For all other types a substantially conforming $s_1 = \mu\bar{s}_1$ does not result in an improved bargaining position relative to the first best (for $\theta > \theta^*(\mu\bar{s}_1)$) or is too costly as seen from equation (12) (for $\theta < \hat{\theta}(\bar{s}_1, \mu, \beta)$). Let's denote the set of the former efficient types by $\overline{\Theta}_1^*(\bar{s}_1, \mu) = (\theta^*(\mu\bar{s}_1), \theta^*(\bar{s}_1)]$, the one of the latter by $\widehat{\Theta}^*(\bar{s}_1, \mu, \beta) = \Big[0, \hat{\theta}(\bar{s}_1, \mu, \beta)\Big)$. The seller's first period strategy given μ, β and her productivity type θ is then given as

$$\sigma_1(\mu, \beta, \theta) = \begin{cases} \sigma_1^*(\theta) & \text{if } \theta \in \widehat{\Theta}^*(\bar{s}_1, \mu, \beta) \\ \mu\bar{s}_1 & \text{if } \theta \in \widehat{\Theta}(\bar{s}_1, \mu, \beta) \\ \sigma_1^*(\theta) & \text{if } \theta \in \overline{\Theta}_1^*(\bar{s}_1, \mu) \\ \bar{s}_1 & \text{if } \theta \in \overline{\Theta}(\bar{s}_1). \end{cases} \tag{13}$$

We have claimed that a first best $\sigma_1^*(\theta)$ cannot be a subgame perfect equilibrium strategy all sellers. Equation (13) is only true for a given $\bar{s}_1$. What remains to be shown is that in a simple installment contract there is no $\bar{s}_1 = \bar{s}_2$ such that in equilibrium it holds that $s_1 = \sigma_1^*(\theta)$ for all productivity types in Θ. We establish this result in the following proposition. The history-dependency effect, stemming from hold-up in the renegotiation of $\bar{s}_2^r$, does not only give rise to inefficient *over-performance* by intermediate productivity types in $\widehat{\Theta}(\bar{s}_1, \mu, \beta)$, but as we will see, it may also induce parties to agree upon a contract such that $\bar{s}_i < \bar{s}_i^{\mathcal{C}}$. This implies that high productivity types in $\overline{\Theta}(\bar{s}_1)$, too, will inefficiently *under-perform.*

To see this, recall that we assume a simple installment contract $\mathbb{I}$ out of the class of fixed-price, fixed quantity contracts, where the quantity provisions $(\bar{s}_1, \bar{s}_2)$ with $\bar{s}_1 = \bar{s}_2$ are chosen such that the parties' expected joint surplus $\mathbb{E}W = \mathbb{E}A + \mathbb{E}B$ is maximized. From equations (7) and (8) we can see that for the buyer $\mathbb{E}A = \mathbb{E}_\theta \left[\bar{a}_1 + \phi_2^r\left(\sigma_1\left(\mu, \beta, \theta\right), \mu, \beta, \theta\right)\right]$ and for the seller $\mathbb{E}B = \mathbb{E}_\theta \left[b\left(\sigma_1\left(\mu, \beta, \theta\right), \bar{s}_1, \theta\right) + \psi_2^r\left(\sigma_1\left(\mu, \beta, \theta\right), \mu, \beta, \theta\right)\right]$. Note that $w\left(\bar{s}_2^r\left(\theta\right), \theta\right) = w\left(\sigma_2^*\left(\theta\right), \theta\right)$. The joint expected surplus $\mathbb{E}W = \mathbb{E}_\theta \left[w\left(\sigma_1\left(\mu, \beta, \theta\right), \theta\right) + w\left(\bar{s}_2^r\left(\theta\right), \theta\right)\right]$ then boils down to

$$\begin{aligned}\mathbb{E}W \;=\; & \int\limits_{\Theta} W\left(\sigma_1^*\left(\theta\right), \sigma_2^*\left(\theta\right), \theta\right) dF\left(\theta\right) - \int\limits_{\widehat{\Theta}\left(\bar{s}_1, \mu, \beta\right)} \left[w\left(\sigma_1^*\left(\theta\right), \theta\right) - w\left(\mu \bar{s}_1, \theta\right)\right] dF\left(\theta\right) - \\ & \int\limits_{\overline{\Theta}\left(\bar{s}_1\right)} \left[w\left(\sigma_1^*\left(\theta\right), \theta\right) - w\left(\bar{s}_1, \theta\right)\right] dF\left(\theta\right) \end{aligned} \tag{14}$$

with $(\bar{s}_1, \bar{s}_2) \equiv \arg\max_{\bar{\mathbf{s}} \in \overline{S}^2} \mathbb{E}W$. The first component denotes the first best expected joint surplus, the latter two integral gives the value of distortion. The second integral denotes the expected inefficiency from the seller's over-shooting, the component on the very right gives the inefficiency from a less than *Cadillac* contract. Both depend on $\bar{s}_1$, where the former increases while the latter decreases as the level of the first installment approaches the *Cadillac* contract provision. The proof of the following proposition shows that $\bar{s}_1 = \bar{s}_2$ is such that it balances this *intra*-period trade-off that arises from inefficiencies for intermediate types in $\widehat{\Theta}$ and high productivity types in $\overline{\Theta}$.

Proposition 2. *Let the threshold of substantial impairment μ such that there exists $s_1 > 0$ for which the buyer is granted a cancellation right, $\mu > 0$, and let the seller's bargaining power be less than complete with $\beta < 1$, then the parties will enter a simple installment contract $\mathbb{I}(\mu, \beta) \equiv \mathbb{I}(\bar{\mathbf{s}}(\mu, \beta), \overline{\mathbf{p}})$ with positive contract provisions $0 < \bar{s}_i(\mu, \beta)$ and $\overline{\mathbf{p}}$ such that $\bar{a}_i \geq 0$, $i = 1, 2$. The optimal $\bar{s}_i(\mu, \beta)$ is strictly smaller than the* Cadillac *if at $\bar{s}_1(\mu, \beta) = \bar{s}_1^{\mathcal{C}}$ it holds true that*

$$\frac{\partial \hat{\theta}}{\partial \bar{s}_1} \cdot \Delta_B\left(\hat{\theta}\right) < -\int_{\widehat{\Theta}\left(\bar{s}_1, \mu, \beta\right)} \frac{\partial\left[w\left(\mu \bar{s}_1, \theta\right)\right]}{\partial \bar{s}_1} dF\left(\theta\right). \tag{15}$$

We can conclude that the results from Proposition 1 hold in equilibrium, i.e. $\widehat{\Theta}(\mu, \beta) \equiv \widehat{\Theta}\left(\bar{s}_1(\mu, \beta), \mu, \beta\right)$ is not an empty set since $\hat{\theta}(\mu, \beta) \equiv \hat{\theta}\left(\bar{s}_1(\mu, \beta), \mu, \beta\right)$ is strictly smaller then the efficient breach threshold for $\mu \bar{s}_1$, $\theta^*\left(\mu \bar{s}_1(\mu, \beta)\right)$. Moreover, if (15) holds, then $\bar{s}_1(\mu, \beta) < \bar{s}_1^{\mathcal{C}}$ implies that $\overline{\Theta}(\mu, \beta) \equiv \overline{\Theta}\left(\bar{s}_1(\mu, \beta)\right)$ will in equilibrium not be empty, either. We know that unless $\widehat{\Theta}(\mu, \epsilon) = \overline{\Theta}(\mu, \epsilon) \subseteq \emptyset$, a first best delivery $\sigma_1^*(\theta)$ cannot be a subgame perfect equilibrium strategy but will be distorted. Hence, the obtained results imply that in equilibrium intermediate and high type sellers perform *ex-post* inefficiently, where the former exhibit excessive effort while latter perform inefficiently low. By equation (13) these equilibrium strategies for μ and β are summarized as follows.

Corollary 2. *Given μ, β and θ, the seller's subgame perfect equilibrium strategy is*

$$\left(\begin{array}{lll} \sigma_1^E(\mu,\beta,\theta) & = & \left\{\begin{array}{ll} \sigma_1^*(\theta) & \text{if } \theta\in\widehat{\Theta}^*(\mu,\beta) \\ \mu\bar{s}_1(\mu,\beta) & \text{if } \theta\in\widehat{\Theta}(\mu,\beta) \\ \sigma_1^*(\theta) & \text{if } \theta\in\overline{\Theta}_1^*(\mu,\beta) \\ \bar{s}_1(\mu,\beta) & \text{if } \theta\in\overline{\Theta}(\mu,\beta) \end{array}\right. , \\ \sigma_2^E(\mu,\beta,\theta) & = & \left\{\begin{array}{ll} \sigma_2^*(\theta) & \text{if } \theta\in\overline{\Theta}_2^*(\mu,\beta) \\ \bar{s}_2(\mu,\beta) & \text{if } \theta\in\overline{\Theta}(\mu,\beta) \end{array}\right. \end{array}\right) \tag{16}$$

where $\sigma_2^E(\mu,\beta,\theta)$ is off the equilibrium path. If equation 15 holds, then $\overline{\Theta}(\mu,\beta)$ is non-empty.

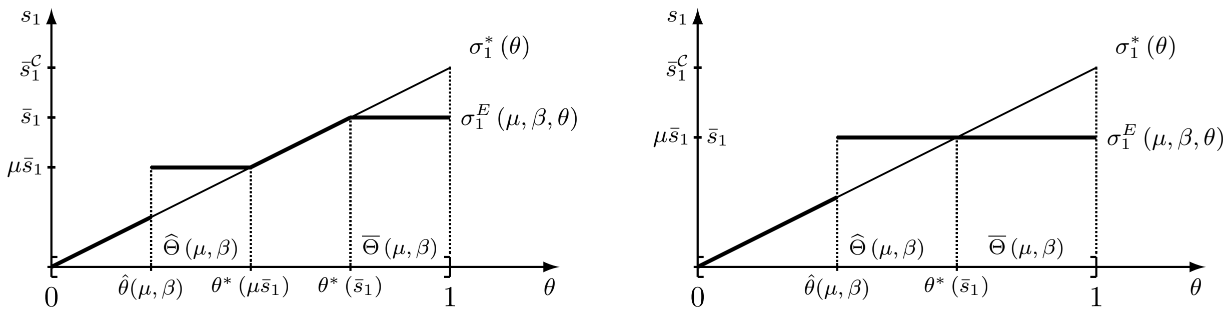
The seller's first period equilibrium performance is depicted in Figure 3. The horizontal segments of $\sigma_1^E(\mu,\beta,\theta)$ denote inefficient over- or under-performance, implying the seller's first period performance to be discontinuous at $\hat{\theta}(\mu,\beta)$ and not differentiable at $\theta^*(\bar{s}_1)$, while the first best $\sigma_1^*(\theta)$ is continuous and strictly increasing in $\theta\in\Theta$. Consider for instance the worst case scenario with $\mu=1$ and $\beta=0$, i.e. the buyer may cancel for any defect and has full bargaining power. Then all sellers with productivity higher than the threshold $\hat{\theta}$ deliver a fully conforming $\bar{s}_1$, while only the low types will efficiently breach. This scenario is depicted in the right hand panel of Figure 3. From equation (12) (see the proof of Proposition 1) it is easy to see that even for the worst case there are some sellers that will efficiently breach the contract. This is because $w(\mu\bar{s}_1,\theta)\geq 0$ will not hold for all θ unless $\bar{s}_1=0$. We thus observe a distortion at the top of the type space, that is maximal at either end of the interval $\widehat{\Theta}$, and efficient performance at the bottom.[34]

Let's further look at the results from Proposition 2 and seller's equilibrium strategy under two polar cases. (i) If the seller has full bargaining power she will recoup the entire renegotiation surplus in period $t=1.5$. The buyer cannot hold up the seller, which renders any of his cancellation threats ineffective. Since there are therefore no relative gains from second period trade $\Delta_\psi=0$ which the seller will want to protect she does not have an incentive to exert excessive effort in the first period to do so. (ii) If the law is such that the buyer is never granted the right to cancel the contract, then the buyer's cancellation threat is never credible since his disagreement point payoffs $\bar{a}_2$ for $\gamma^r=0$ are at least as high as his wrongful cancellation payoffs $-\max\left[\mathbb{E}_\theta\, w(\sigma_2(\theta),\theta)-\bar{a}_2,0\right]$ for all $\bar{a}_2$. Thus, the buyer cannot (credibly) hold up the seller in *ex-post* renegotiations of the second installment. Again, by equation (12) there are no incentives for the seller to *over-shoot* in the first period.

Lemma 3 (Polar cases)**.** *If either $\beta=1$ or $\mu=0$, then $\sigma_i^E(0,1,\theta)=\sigma_i^*(\theta)$, $i=1,2$, over Θ, hence*

[34] In the appendix we show that for time-varying productivity types we may indeed observe a distortion for the entire type space, i.e. the seller performs a constant $\mu\bar{s}_1$ for all her first period productivity types $\theta_1\in\Theta$.

Figure 3: Seller's first period equilibrium strategy



(a): $\mu > 0$ and $\beta < 1$ *(b): $\mu = 1$ and $\beta = 0$*

1. *if the seller has full bargaining power $\beta = 1$, then $\mathbb{I}(\bar{\mathbf{s}}(\mu,1), \bar{\mathbf{p}})$ with $\bar{\mathbf{s}} = (\bar{s}_1^{\mathcal{C}}, \bar{s}_2^{\mathcal{C}})$ such that $\mathbf{s} = (\sigma_1^*(\theta), \sigma_2^*(\theta))$ over Θ for all μ;*

2. *if the buyer is never granted the right to cancel and $\mu = 0$, then $\mathbb{I}(\bar{\mathbf{s}}(0,\beta), \bar{\mathbf{p}})$ with $\bar{\mathbf{s}} = (\bar{s}_1^{\mathcal{C}}, \bar{s}_2^{\mathcal{C}})$ such that $\mathbf{s} = (\sigma_1^*(\theta), \sigma_2^*(\theta))$ over Θ for all β.*

For the case of a buyer without bargaining power, any compliance rule will in equilibrium yield a first best outcome. Very strict quality standards for the seller (and therefore wide-ranging cancellation rights) only give the buyer an *ex-post* commercial advantage as pointed out by Whaley (1974) or Lawrence (1994) if he can indeed exercise it. With full bargaining power, however, the seller will recoup the entire renegotiation surplus and in equilibrium perform first best for all θ.

By the setup of the model, parties' preferences are time-separable and do not yield any inter-temporal effects that render the value and valuation of s_2 dependent on the first period performance s_1. Moreover, we assume simple installment contracts that by definition do not exhibit any "memory", i.e. the second period payment $\bar{p}_2$ does not depend on earlier outcomes. Such a contract does not yield any gains over a series of one-stage contracts that perform just as well as the multi-stage agreement (e.g. Fellingham, Newman, and Suh, 1985).[35] Lemma 3 shows that the history independence of the renegotiated installment contract holds for either of the two polar cases, from Proposition 2, however, we know that if the buyer is not fully restricted by his cancellation rights μ or his bargaining power α, then in equilibrium an installment contract will exhibit history dependence. In this case, repeated one-shot contracts will not duplicate the long-term contract result, but outperform the multi-stage deal. We have, however, emphasized before that our model is not one of contract choice but assumes a multi-stage installment

[35]Notice that this is not generally true if relationship-specific investment is required by efficiency (e.g. Townsend, 1982; Crawford, 1990; Rey and Salanié, 1990).

contract as given. This basic setup is chosen simply to isolate the effects that stem from the buyer's cancellation option.

5 Results

In Proposition 1 we show that given a non-zero contract provision $\bar{s}_1$ there is a positive probability that the seller will exert excessive effort in the first period, we thus establish the result, that given a contract $\mathbb{I}$ the first period *ex-post* performance will be inefficient if buyer's cancellation rights are not fully restricted. Proposition 2 implies that these results hold in equilibrium; a simple installment contract is such that the seller will over-shoot with positive probability. At the same time, the trade-off balance may result in a less than *Cadillac* contract (Edlin, 1996). The following lemma demonstrates the effect of the substantial impairment requirement on the parties' joint expected surplus.

Lemma 4 (Distorting cancellation)**.** *The social costs of seller's distorted first period performance, denoted by*

$$\mathbb{E}_\theta W\left(\sigma_1^*\left(\theta\right), \sigma_2^*\left(\theta\right), \theta\right) - \mathbb{E}_\theta W\left(\sigma_1^E\left(\mu, \beta, \theta\right), \bar{s}_2^r\left(\theta\right), \theta\right),$$

are strictly increasing in μ for all $\beta < 1$.

The intuition behind this result is simple and we have discussed it before. The seller is the residual claimant in both periods and bears the burden of his uncertainty. The initial contract gives her optimal performance incentives and a simple contract with *Cadillac* provisions yields a first best outcome. This will, however, only be the case if renegotiation of the contract is ruled out[36], because the buyer's cancellation threat will induce excessive first period performance in order for the seller to avoid being "robbed" by her business partner. Lemma 3 demonstrates that this effect does not arise if the buyer's renegotiation is restricted, either by his bargaining power or the degree of substantial impairment that determines the "ease" at which cancellation can be threatened. As the probability of inefficient over-shooting increases with this ease (Corollary 1) the expected surplus strictly decreases and is lowest under a perfect tender rule. Any leeway from a strict compliance quality provision will therefore improve upon the expected outcome of the contract with a first best result for $\mu = 0$.

[36] In a setting without cancellation a necessary assumption for the first best result is the buyer's full commitment. This means that the seller needs to believe that the buyer will reinstate the contract if he is indifferent between cancellation and reinstatement. Otherwise efficient first period performance will not be an equilibrium strategy. See Ganglmair (2007) for a short note on this. Given $\mu > 0$, he finds multiple equilibria depending on the buyer's commitment not to (unilaterally) cancel the contract if given the right to do so. Any equilibrium for less than full commitment yields a sub-optimal outcome.

Our results add an additional dimension to the discussion of the substantial impairment requirement for installment contracts.[37] Without the assumption of relationship-specific investment, whose protection has been considered the main motivation of the default rule[38] that is conceived of as in the need of protection, we show the existence of a distorting effect of the buyer's remedy of cancellation on the seller's performance incentives. This inefficiency stems from a hold-up effect, i.e. from the seller's response to the buyer's threat in the renegotiation game. Any restriction of the buyer's cancellation rights—any barrier to buyer's opportunism—will alleviate the seller's protectionism.

Proposition 3. *With $\mu > 0$ and $\beta < 1$ the subgame perfect equilibrium yields a second best result only. The buyer's cancellation threat induces the seller to exert excessive effort in period 1 in order to avoid rightful cancellation by the buyer. Restricting his cancellation rights, i.e. lowering the threshold of substantial impairment μ, leads to a Pareto-improvement by reducing the social costs of the hold-up effect.*

As opposed to the standard hold-up problem[39] our results do not concern seller's *ex-ante* (non-contractible) investment but relate to (contractible) first period performance, which is *ante*-renegotiation but *post*-uncertainty. Klein (1998) lists three necessary factors for a hold-up problem: incomplete contracts, hold-up is individually rational, and some specificity. Our model satisfies the first by assumption and the second by Lemmas 1 and 2. Specificity is usually in terms of *ex-ante* investment that locks in one of the contract parties. Here, we abstract from such relationship-specific investment, a lock-in effect, however, is observed through the contractual remedies for breach of contract, in particular the buyer's cancellation right. This implies that the observed hold-up effect is not of the classical definition where the result is (selfish) under-investment by the seller to minimize her *ex-post* losses. Minimization of the losses stemming from being "robbed" by the buyer in *ex-post* renegotiations is indeed the seller's objective in our model, but it results in over-performance instead. While in the standard setup of the a hold-up problem the seller anticipates the seller's hold-up as given and decides on *how much* it will be held up, in our model she can affect the buyer's behavior and decide on *whether or not* to be held up.

Our results partly stem from the fact that we consider simple contracts that are not fully renegotiated. Huberman and Kahn (1988) and Hermalin and Katz (1991) in a general setting argue that parties substitute for complex contracts by entering simple contracts that are renegotiated. A first best result may then be achieved at lower contracting costs. On the other hand, Edlin (1996) concludes that non-renegotiated (simple) *Cadillac* contracts with up-front

[37]Notice, however, that the scope of the paper's implications is limited to *Why* a substantial compliance rule is superior to a strict compliance standard in installment contracts. The model does not yield any implications on *Why* we observe a *difference* between one-shot and multi-delivery contracts.

[38]As a matter of fact, we have gone even farther by assuming time-separability of preferences and production to completely abstract from first period investment into future periods.

[39]See Bolton and Dewatripont (2005; ch. 12) or the work cited in the introductory section for a thorough discussion of the existing literature.

payments, too, lead to a first best outcome. Our setup, however, is neither fish nor fowl; the installment contract as we model it is only half-renegotiated, that means we only allow for the second installment to be adapted to the seller's type while the first is fixed. Since until now we have abstracted from relationship-specific investment and asymmetric information it is not difficult to see that there are simple contracts such that full renegotiation after the seller's type is materialized but before the first period performance decision is made yields a first best outcome in both periods. Any simple contract with rigidity as to individual installments and less than full commitment by the buyer will result in an *ex-post* inefficient outcome. Partial renegotiation at stage $t = 1.5$, however, will only give rise to the hold-up effect if (i) the buyer's cancellation threat is credible (Lemma 1), or if (ii) by equation (12) the seller's *over-shooting* induces a second period gain, $\Delta_\psi > 0$. In Lemma 3 we show that the polar cases $\mu = 0$ and $\beta = 1$, respectively, do not satisfy these conditions. With $\mu = 0$ the buyer will never credibly threaten to cancel, with seller's full bargaining power $\beta = 1$ her anticipated second period gains from *over-shooting* are equal to zero.

Both conditions give rise for possible private as well as public solutions. The polar case of $\mu = 0$ can be reached either by a respective default rule or by a privately stipulated express provision, i.e. by adding a termination clause. Thus the parties may add complexity to their contracts and *ex-ante* design their *ex-post* renegotiations. By setting $\mu = 0$ and not allowing an inefficient threat, the buyer will not be able to hold up the seller in period $t = 1.5$, thus giving her optimal performance incentives in period 1. Given a constant sharing rule (α, β), an installment contract with restricted cancellation rights indeed is a "seller's world" (Quinn, 1978; p. 2-385), however, turns out to be a buyer's world, too. To see this, consider the following lemma.

Lemma 5. *The buyer's ex-ante equilibrium payoffs*

$$\mathbb{E}_\theta\, A(\mu, \beta, \theta) = v\left(\bar{s}_1(\mu, \beta)\right) - \bar{p}_1 + \mathbb{E}_\theta\, \phi_2^r\left(\sigma_1^E(\mu, \beta, \theta), \mu, \beta, \theta\right)$$

are decreasing in μ.

Threatening cancellation and renegotiation, or rather granting the buyer the right to do so, harms both parties. While Proposition 3 gives the overall welfare effect, this lemma now establishes that the buyer's cancellation right does not have an *ex-ante* redistributive effect. As the buyer is granted the right to cancel with $\mu > 0$ he can *ex-post* reap a share of the seller's second period gains, but by the seller's evading first period performance the buyer will in expectations be worse off with the supposably *commercially advantageous* (Whaley, 1974; Lawrence, 1994) cancellation rights than without. When bargaining over μ parties do thus not face conflicting interests since both can benefit from harsher cancellation restrictions.

We see a similar inefficiency implication for instance in regulatory cases under asymmetric information where the regulator (principal, buyer) and a firm (agent, seller) agree upon a regulatory scheme. After observing the agent's first period performance the principal may not be able to resist but adapt this scheme to make use of the agent's revealed information, by either unilaterally setting a new agenda (as in e.g. Freixas, Guesnerie, and Tirole, 1985; Laffont and Tirole, 1988) or exploiting the information in *ex-post* bargaining (as in Laffont and Tirole, 1990). Such limited commitment will then reduce the agent's incentive to reveal information to begin with, leading her to shade her true type. The analogy to our model lies in the message the seller sends out when performing in the first period. While in models of asymmetric information the agent reveals her (productivity) type, in our model the seller's message concerns the buyer's right to cancel. The optimal message sent by low type agents is one of substantial non-conformity. If this information is used against her, the seller will try to shade her true "type" by *over-shooting* and finding a save haven at $\mu \bar{s}_1$. The buyer's full commitment is achieved by rendering his cancellation threat non-credible.

Moreover, the implications drawn from Comino, Nicolò, and Tedeschi (2006) are somehow related to our results. They model a partnership to set up a joint venture project and find that parties may prefer not to add any termination clauses but leave a contractual gap. This incompleteness of the contract serves as "discipline" or "commitment device" that mitigates the hold-up problem. In their setting, *no termination* is the default and including such a termination clause would allow for a partnership dissolution under pre-determined circumstances. In our model, the default is an extensive cancellation regime. By contracting around this default, setting $\mu = 0$ yields this optimal regime from Comino, Nicolò, and Tedeschi (2006). Hence, whether the absence of a termination clause denotes strategic incompleteness, as suggested by these authors, depends on the respective default rule.

Not only cancellation clauses but also damage remedies are default rules which the parties can contract around. The second condition for the hold-up effect to prevail requires the seller's anticipated second period payoffs to be a function of her first period performance. The polar case of $\beta = 1$ does not satisfy this condition since the buyer cannot exercise his hold-up threat. A different angle to tackle the problem is the buyer's remedy for breach of contract. The results in Proposition 3 are driven by the fact that the buyer is entitled to his expectation interest which gives him an *ex-post* bargaining leverage. While $\beta = 1$ prevents him from exercising these possibilities, changing the default remedy may not allow for such a leverage in the first place (and yet again render the buyer's cancellation threat non-credible). We can indeed show that *termination* in conjunction with the buyer's restitution interest (the price paid) achieves exactly this.[40] Figure 4 presents the disagreement point payoffs under the termination regime. The only difference to Figure 2 is the upper right quadrant for $q_0(1)$: If s_1 is non-substantially conforming and the buyer cancels/terminates, then he will not be able to recover his expectation interests which renders his disagreement point payoffs equal to zero.

[40] In pre-code law the buyer was required to choose her remedies and either rescind the contract and *sue off* the contract for the price paid, or cancel and *sue on* the contract for total breach damages. For details on the pre-code and code situation see Patterson (1987; section III).

Figure 4: Parties' disagreement point payoffs under restitution interest

$q_\kappa(\gamma^r)$	$s_1 \geq \mu \bar{s}_1,\ \kappa = 1$	$s_1 < \mu \bar{s}_1,\ \kappa = 0$
$\gamma^r = 1$	$q_1(1) = \big(-\max[\mathbb{E}_\theta\, b(\sigma_2(\theta), \bar{s}_2, \theta), 0],\ \max[\mathbb{E}_\theta\, b(\sigma_2(\theta), \bar{s}_2, \theta), 0]\big)$	$q_0(1) = \big(0, 0\big)$
$\gamma^r = 0$	$q_1(0) = \big(\bar{a}_2, b(\sigma_2(\theta), \bar{s}_2, \theta)\big)$	$q_0(0) = \big(\bar{a}_2, b(\sigma_2(\theta), \bar{s}_2, \theta)\big)$

Two points are crucial with respect to the termination regime. First, the buyer will always be able to recover his expectation interest for delivered goods, the restitution interest only applies to rejected non-delivered goods. Suppose that he is only entitled to his restitution interest in both cases. Then the seller will not internalize the costs of under-performance to the buyer, she will not have to pay damages and will deliver $s_i = 0$ such that her production costs are minimized. Anticipating this, the buyer will never participate and not enter such a simple installment contract. Second, in our exposition the restitution interest regime does only apply to seller's breach of contract. If the buyer wrongfully cancels/terminates, then the seller will in return be entitled to her expectation interest. It is straightforward, however, that without loss of generality we could assume two-sided restitution interest with $q_1(1) = (0, 0)$ as long as $\bar{a}_2 \geq 0$. If the buyer's participation constraint is satisfied, wrongful cancellation will remain a non-credible threat and not affect the equilibrium outcome.

Proposition 4 (Termination and the restitution interest)**.** *Let the buyer's remedy for total breach of contract upon a substantially non-conforming first installment be restricted to his restitution interest as discussed above. Then, if* $\bar{a}_2 \geq 0$*, the equilibrium contract* $\mathbb{I}(\bar{\mathbf{s}}, \bar{\mathbf{p}})$ *induces a first best outcome for any* μ *and* β*.*

From the implications of cancellation and termination we see an analogy to the discussion on the level of liability under negligence rules. Under a negligence regime a person's liability may rise discontinuously with the level of an injurer's care (see e.g. Cooter, 1982; Shavell, 1986). This is because under non-negligent care the liability is zero (damages may be positive though), a level of care lower than the negligence threshold, however, gives rise to a discontinuous jump in the level of liability. Shavell (2004; p. 253) argues that this jump in liability makes the incentive to show a non-negligent level of care "sharp", which may result in excessive care. The analogy stems from the arguments brought forward by Grady (1983) and Kahan (1989). If causation is properly applied and negligence limited, i.e. if an injurer is liable only for the damage caused in excess to the non-negligent damage, then the level of liability will rise continuously and the incentives are not "sharp."

The buyer's cancellation rights give rise to a discontinuous level of liability as in Cooter (1982) or Shavell (1986). The *damages* caused by the seller's negligent behavior, i.e. non-conforming performance, are equal to their devaluation to the buyer which decreases continuously in her level of performance. This is true for any performance both below and above the threshold of substantial conformity. Under a cancellation regime, however, the seller's *liability* exhibits a jump at this threshold. For any substantially conforming first period delivery ($s_1 \geq \mu \bar{s}_1$), the level of liability is equal to the damages. In case of a substantially impairing first period performance ($s_1 < \mu \bar{s}_1$), the buyer may cancel and recover his expectation interest, implying the seller's liability for a non-conforming first performance to be equal to the damages caused plus the buyer's bargaining leverage. This relative bargaining power is given as the difference between second period full and partial damages, i.e. compensation payments for cancellation minus payments for reinstatement. It then holds that overall liability is larger than damages,

$$d\left(s_1^d, \bar{s}_1\right) + d\left(0, \bar{s}_2\right) - d\left(s_2^d, \bar{s}_2\right) > d\left(s_1^d, \bar{s}_1\right). \tag{17}$$

Under the *cancellation* regime the seller's liability from negligent performance is not equal to the damages caused by such behavior. This is not true under a *termination* regime as shown in Proposition 4. In such a case we have $d\left(0, \bar{s}_2\right) - d\left(s_2^d, \bar{s}_2\right) = 0$ and the seller's liability is continuously decreasing in her performance and equal to the actual damages she causes (see Grady, 1983; Kahan, 1989). As the seller's incentives are not sharp, she will not exert excessive effort (or care, as in the tort terminology) in the first period. The implications from the discussion on causation in torts can therefore immediately be applied to the results of our model.

The close resemblance to the tort literature is interesting, but of secondary relevance only since this seller's decision node is off the equilibrium path. To see this we have to recall Lemma 1 and the buyer's announcement prior to renegotiations. If his cancellation threat is not credible, no hold-up effect will prevail. Credibility is given if $q_{A0}(0) \leq q_{A0}(1)$. Under a termination regime this is clearly violated because $q_{A0}(1) = 0$. As a matter of fact, as long as the buyer's cancellation damages $q_{A0}(1) < \bar{a}_2$ are under-compensatory, his cancellation threat will be non-credible, yet again violating the first condition for the hold-up effect to arise in our model. This means if the buyer pays a "cancellation tax" rendering his cancellation damages below his expectation interest (which he will be able to fully recover if he reinstates), then in equilibrium $\gamma^r = 0$ and $\Delta_\psi = 0$.[41] For completeness, off equilibrium the seller will face sharp incentives if the buyer's cancellation damages are such that $d\left(\bar{s}_2^d, \bar{s}_2\right) < q_{A0}(1) < \bar{a}_2$ and equation (17) holds.

In quite a different context, Muehlheusser (2006) obtains a related result. In a labor market setting he finds that parties may agree upon excessive, inefficient damage clauses to prevent the

[41] Litigation costs are a general example for such a tax if the burden of proof is with the plaintiff buyer and additional evidence at additional cost has to be shown for a non-conforming first performance to be substantially impairing. The Austrian (ABGB §§909–11) and German civil code (BGB §353) concept of *Reugeld* resembles an express termination penalty rather than a pre-determined consideration or fee to be paid by the aggrieved buyer in case of rightful(!) cancellation.

employee from switching firms. By setting an upper bound on these damages a regulator can induce a Pareto-improvement. In our setting this upper bound is $\bar{q} = \bar{a}_2 - \varepsilon$ for any positive ε. Any disagreement point payoffs $q_{A0}(1) \leq \bar{q}$ will not only result in a Pareto-improvement but will in equilibrium indeed induce the first best since $\gamma^r = 0$ for any s_1 and $\Delta_\psi = 0$. For this to be true the upper bound needs to be strictly smaller than expectation damages for cancellation, $d(0, \bar{s}_2) - \bar{p}_2 = \bar{a}_2$, a binding restriction that is not necessary in Muehlheusser's (2006) analysis.

The two default rules analyzed are a positive $\mu < 1$ and full compensation expectation damages if buyer rightfully cancels the contract. As we have seen, both rules resemble Ayres and Gertner's (1989) penalty rather than majoritarian defaults because it is in the interest of both parties to contract around them. Put differently, if the contract is silent on μ and the buyer's damages for cancellation, it will be enforced in a way that is detrimental to both contract partners. A majoritarian default rule calls for an even more pronounced substantial impairment requirement and a cancellation tax that mitigates the buyer's bargaining leverage against the seller in *ex-post* renegotiations. This observation, however, is not in line with the understanding that whether or not a defect materially breaches a contract is a question of fact, unless the "facts" are intentionally interpreted such that the tailored value of μ penalizes the parties for not accounting for it in the contract. The code's commentary clearly does not suggest this.

6 Conclusion

"Standing relations" (Llewellyn, 1937) or "installment contracts" in a hybrid form implemented in Section 2-612 of the *Uniform Commercial Code* are encountered every day, hence neglecting them and the peculiarities of the default rules associated with them means ignoring a considerable part of observed commercial transactions. This paper contributes to the literature by analyzing how commercial actors respond to default rules in contemporary contract law. We do not explicitly model the number of periods contracted but take an installment contract as given and look at the respective rules' effects on parties' *ex-ante* as well as *ex-post* behavior. As we have discussed, both theoretical models and empirical studies in the literature have shown that the optimal duration of contracts to a large extent depends on inter-temporal complementarities, the likelihood of contract renegotiation, or relationship-specific investment required by efficiency. Protection of a standing relation is not only optimal if relationship-specific investment incentives are to be preserved, as is usually argued in the law and economics as well as legal literature, but as we show in this paper, such protection—commitment as to the ongoing contract—is also optimal in settings *without* it. If buyers are fully compensated for any non-conformities but cannot fully commit not to hold her up during renegotiations, then the promisor will want to avoid the detrimental payoffs from buyer's cancellation threat and hence exert excessive effort. By refraining from the *perfect tender rule* and relaxing it by applying the *substantial impairment requirement*, courts can provide the buyer with a *legal* commitment device as to the second period installment. This will limit the seller's incentive to over-perform in the first period to "protect" her second period payoffs. By anticipating this, the parties will enter an installment contract with less *ex-post* distortions. Thus, the substantial impairment requirement leads to a Pareto-improvement over the strict compliance outcome and partly solves the hold-up effect observed for simple installment contracts. This effect stems from the fact that the seller's liability for a non-conformity (negligent performance) is higher than the respective damages if the defect is substantially impairing, which gives the buyer a significant bargaining leverage in *ex-post* renegotiations. We can therefore establish a link between our setting and the discussion in the tort literature led by Cooter (1982) and Shavell (1986) on the one hand and Grady (1983) and Kahan (1989) on the other.

It is important to acknowledge that the given model setup has its caveats and does not allow for far-fetching implications with respect to contract design. Concluding that business partners consistently make mistakes by entering installment contracts would go beyond the prediction power of the model. The aim of this paper is to show the Pareto-improvement of the substantial impairment requirement over a strict compliance rule *given* an installment contract rather than drawing any conclusions as to the efficiency properties of such contracts in general.

The following three notes suggest extensions to the presented model and directions for broadening the understanding of installment contracts and the respective cancellation rights.

Note 1: An obvious extension of the setting is an introduction of private information. So far we have assumed that the seller's productivity type is publicly observable and non-verifiable. By introducing private information an additional aspect enters the game. Suppose, the seller only observes her type prior to her first period performance, which is publicly observable and verifiable. Since valuation and cost functions are common knowledge, the buyer can then deduce the seller's type from this first installment. In order to protect her second period trade payoffs, the seller, however, may have an incentive to shade her true type and not perform truthfully by fully or substantially conforming to the quantity provisions of the contract. Sellers may thus bunch at such thresholds leaving the buyer with an expectation over the productivity type upon which cancellation decisions are to be based.

Note 2: In the previous section we briefly mentioned the effect of a restitution interest default for delivered and non-delivered goods on seller's performance incentives. Similar observations can be made for under-compensatory (with respect to the expectation interest) in general. If expectation damages are such that the buyer is entitled to something less than his full expectation interest, then the seller (who pays less than the buyer's full damages) will not fully internalize the costs of a defect and have inefficiently low performance incentives. From the tort literature we know that such limited liability results in too low a level care. In our analysis with full compensation we observe a seller's excessive effort, with under-compensatory damages this effect might, however, not be inefficient yet correct for the low performance levels. In such a case, some over-shooting is intended to reach a second best result; consequently the optimal μ is expected to be strictly positive. This result seems to be endorsed by the fact that courts grant buyers some cancellation rights.

Note 3: Klein (1996) posits that hold-up will only occur if a one-time gain from defection exceeds the sanctions. Our results show that this is true for the buyer, who defects by threatening to cancel the contract, only if the seller delivers a substantially non-conforming first delivery. If his cancellation rights are restricted the legal sanctions offset the gains from such rent seeking behavior. Similarly, if he is charged a cancellation tax, his threat lacks credibility and the gains from defection will be non-positive. Klein's (1996) conclusions are drawn in the context of contracting a repeated interaction setup. A possible extension of this model therefore allows for repeated installment contracts to analyze how reputational considerations affect the optimal μ by altering future matching probabilities through the destruction of trust.

All of the above do not explicitly concern the parties' *ex-ante* investment incentives but rather relate to the seller's *ex-post* performance and its inefficiencies. How these two issues interact is apparently of key interest, yet being able to draw upon this isolated performance effect will eventually enrich the analysis and allow for a broader picture.

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Appendix A: Proofs

Proof of Lemma 1

Proof. It is to show for $\kappa = 1$ that $q_{A1}(0) \geq q_{A1}(1)$ and for $\kappa = 0$ that $q_{A0}(0) \leq q_{A0}(1)$.
$\kappa = 1$: $\bar{a}_2 > -\max\left[\mathbb{E}_\theta\, w(\sigma_2(\theta), \theta) - \bar{a}_2, 0\right]$. For $\bar{a}_2 > 0$ the LHS is strictly positive while the RHS is non-positive; for $\bar{a}_2 = 0$ the LHS is zero while the RHS is strictly negative since $w(\sigma_2(\theta), \theta) > 0$ for all $\theta > 0$; for $\bar{a}_2 < 0$ we get $\bar{a}_2 > -\mathbb{E}_\theta\, w(\sigma_2(\theta), \theta) + \bar{a}_2$.
$\kappa = 0$: $\bar{a}_2 \leq \max[\bar{a}_2, 0]$. For $\bar{a}_2 \geq 0$ the buyer is indifferent, for $\bar{a}_2 < 0$ the inequality is strict. □

Proof of Lemma 2

Proof. Straightforward by equations (7) and (8). □

Proof of Proposition 1

Proof. Recall that for $\theta < \theta^*(\mu\bar{s}_1)$ the LHS of equation (12) is strictly positive but decreasing in θ, the RHS is positive for $\beta > 0$ and increasing in θ.

Let $\beta = 1$, then $LHS < RHS$ for all $\theta \neq \theta^*(\mu\bar{s}_1)$ and μ, hence the borderline type $\hat{\theta}(\bar{s}_1, \mu, \beta)$ is just the efficient type $\theta^*(\mu\bar{s}_1)$. Now suppose $\beta = 0$, then (12) is equal to $w(\mu\bar{s}_1, \theta) = 0$, and the borderline type is strictly smaller than the efficient type if $w(\mu\bar{s}_1, \theta) > 0$. Hence, a $\hat{\theta}(\bar{s}_1, \mu, \beta) < \theta^*(\mu\bar{s}_1)$ exists as long as $\mu\bar{s}_1 > 0$. We define $\widehat{\Theta}(\bar{s}_1, \mu, \beta) \equiv \left[\hat{\theta}(\bar{s}_1, \mu, \beta), \theta^*(\mu\bar{s}_1)\right)$ with $\hat{\theta}(\bar{s}_1, \mu, \beta)$ such that $\Delta_B\left(\hat{\theta}(\bar{s}_1, \mu, \beta)\right) = \Delta_\psi\left(\hat{\theta}(\bar{s}_1, \mu, \beta), \beta\right)$. Notice that for $\mu > 0$ we get that $\hat{\theta}(\bar{s}_1, \mu, \beta) = 0$ with probability zero and $\widehat{\Theta}(\bar{s}_1, \mu, \beta)$ a strict subset of Θ. This is because $\bar{s}_1$ is by assumption positive, but for $\mu\bar{s}_1 > 0$ we get $w(\mu\bar{s}_1, 0) < 0$ and $w\left(\mu\bar{s}_1, \hat{\theta}\right) = 0$ for $\hat{\theta} > 0$. Let further $\mu = 0$, then the $LHS = 0$ and not greater than the RHS for all β and θ. This implies that the borderline type $\hat{\theta}(\bar{s}_1, 0, \beta) = 0 = \theta^*(0 \cdot \bar{s}_1)$ and $\widehat{\Theta}(\bar{s}_1, 0, \beta) \subseteq \emptyset$.

The probability of such *over-shooting* is given as the measure of $\widehat{\Theta}(\bar{s}_1, \mu, \beta)$ which we denote by $\mathcal{F}\left(\widehat{\Theta}(\bar{s}_1, \mu, \beta)\right) \equiv F\left(\theta^*(\mu\bar{s}_1)\right) - F\left(\hat{\theta}(\bar{s}_1, \mu, \beta)\right) \leq 1$. By assumption, the cdf $F(\cdot)$ is strictly increasing, establishing the result. □

Proof of Corollary 1

Proof. Let by equation (12) $F \equiv w\left(\mu\bar{s}_1, \hat{\theta}\right) - \beta w\left(\sigma_1^*\left(\hat{\theta}\right), \hat{\theta}\right) = 0$.

(1.i) From the Implicit Function Theorem we know that $\frac{\partial\hat{\theta}}{\partial\bar{s}_1} = -\frac{F_{\bar{s}_1}}{F_{\hat{\theta}}}$ where $F_{\bar{s}_1} = \frac{\partial F}{\partial\bar{s}_1}$. We get $F_{\bar{s}_1} = \frac{\partial w\left(\mu\bar{s}_1, \hat{\theta}\right)}{\mu\bar{s}_1} \cdot \mu < 0$, and by the single crossing property for $\mu\bar{s}_1 > \sigma_1^*\left(\hat{\theta}\right)$ we have $F_{\hat{\theta}} = \frac{\partial w\left(\mu\bar{s}_1, \hat{\theta}\right)}{\partial\hat{\theta}} - \beta\frac{\partial w\left(\sigma_1^*\left(\hat{\theta}\right), \hat{\theta}\right)}{\partial\hat{\theta}} > 0$. This yields $\frac{\partial\hat{\theta}}{\partial\bar{s}_1} > 0$.

(1.ii) $F_\mu = \frac{\partial w\left(\mu\bar{s}_1, \hat{\theta}\right)}{\partial\mu} \cdot \bar{s}_1 < 0$ and $\frac{\partial\hat{\theta}}{\partial\mu} = -\frac{F_\mu}{F_{\hat{\theta}}} > 0$.

(1.iii) $F_\beta = -w\left(\sigma_1^*\left(\hat{\theta}\right), \hat{\theta}\right) < 0$ and $\frac{\partial\hat{\theta}}{\partial\mu} = -\frac{F_\beta}{F_{\hat{\theta}}} > 0$.

(2.i) $\mathcal{F}\left(\widehat{\Theta}(\bar{s}_1, \mu, \beta)\right)$ is increasing in $\bar{s}_1$ if $F(\cdot)$ if steeper at $\theta^*(\mu\bar{s}_1)$ than at $\hat{\theta}(\bar{s}_1, \mu, \beta)$. For a strictly increasing cdf $F(\cdot)$ this is the case if $\frac{\partial\theta^*(\mu\bar{s}_1)}{\partial\bar{s}_1} > \frac{\partial\hat{\theta}(\bar{s}_1, \mu, \beta)}{\partial\bar{s}_1}$ in $[0, \mu\bar{s}_1]$. Recall that both $\theta^*(\mu\bar{s}_1)$ and $\hat{\theta}(\bar{s}_1, \mu, \beta)$ are defined as borderline types, functions resulting from the seller's optimization, where the former is such that $w(\mu\bar{s}_1, \theta^*) - w(\sigma_1^*(\theta^*), \theta^*) = 0$ and by equation (12) the latter such that $w\left(\mu\bar{s}_1, \hat{\theta}\right) - \beta w\left(\sigma_1^*\left(\hat{\theta}\right), \hat{\theta}\right) = 0$. Hence,

$$w(\mu\bar{s}_1, \theta^*) - w(\sigma_1^*(\theta^*), \theta^*) = w\left(\mu\bar{s}_1, \hat{\theta}\right) - \beta w\left(\sigma_1^*\left(\hat{\theta}\right), \hat{\theta}\right).$$

The welfare function $w(s_1, \theta)$ is strictly increasing in both its arguments, ceteris paribus; as $\sigma_1^*(\theta)$ is strictly increasing in θ, so is $w(\sigma_1^*(\theta), \theta)$. By the definition of $\theta^*(\mu\bar{s}_1)$, $w(\mu\bar{s}_1, \theta^*(\mu\bar{s}_1))$ is strictly increasing in $\bar{s}_1$ (and μ).

Now suppose $\beta = 0$, then by the definition of $\theta^*(\mu\bar{s}_1)$ we get $w(\mu\bar{s}_1, \theta^*) - w(\sigma_1^*(\theta^*), \theta^*) = w\left(\mu\bar{s}_1, \hat{\theta}\right)$ and the borderline type $\hat{\theta}$ needs to be such that $w\left(\mu\bar{s}_1, \hat{\theta}\right) = 0$. For $\mu\bar{s}_1 = 0$ we know that $\theta^* = \hat{\theta} = 0$, for any positive $\mu\bar{s}_1$ we get a strictly positive $\hat{\theta}$. Now suppose that $\hat{\theta}$ increases at a rate equal or larger than for θ^*, $\frac{\partial\theta^*(\mu\bar{s}_1)}{\partial\bar{s}_1} \leq \frac{\partial\hat{\theta}(\bar{s}_1,\mu,\beta)}{\partial\bar{s}_1}$. Since $w(\sigma_1^*(\theta^*), \theta^*)$ strictly positive for any positive $\mu\bar{s}_1$ the equality is violated for any positive $\mu\bar{s}_1$. Hence, $\frac{\partial\theta^*(\mu\bar{s}_1)}{\partial\bar{s}_1} > \frac{\partial\hat{\theta}(\bar{s}_1,\mu,\beta)}{\partial\bar{s}_1}$. To see that this needs to be true for any $\bar{s}_1$, take some $\mu\bar{s}_1$. It needs to be true that $\frac{w(\mu\bar{s}_1,\theta^*)}{\partial\mu\bar{s}_1} > \frac{w\left(\mu\bar{s}_1,\hat{\theta}\right)}{\partial\mu\bar{s}_1}$, otherwise the equality does not hold. Put differently, if at some $\mu\bar{s}_1$, $\hat{\theta}$ increases at a faster rate than θ^*, then for some $(\mu\bar{s}_1)' > \mu\bar{s}_1$ we get $w\left((\mu\bar{s}_1)', \theta^*\right) - w(\sigma_1^*(\theta^*), \theta^*) < w\left((\mu\bar{s}_1)', \hat{\theta}\right)$ since $\frac{\partial w(\sigma^*(\theta^*),\theta^*)}{\partial\mu\bar{s}_1} > 0$.

(2.ii) The argument from (2.i) applies to both $\bar{s}_1$ and μ.

(2.iii) It is straightforward that $\frac{\partial\theta^*(\mu\bar{s}_1)}{\partial\beta} = 0$. As $\hat{\theta}$ increases with β, $\mathcal{F}\left(\widehat{\Theta}\right)$ decreases with the seller's bargaining power. □

Proof of Proposition 2

Proof. For the determination of the contract's quantity provisions we first assume that both participation constraints $\bar{a}_i \geq 0$ hold. $\bar{s}_i$ is characterized by the first order condition of equation (14), $\frac{\partial\mathbb{E}W}{\partial\bar{s}_i} \overset{!}{=} 0$. By Leibniz's formula for integrating into the boundaries, and for $\hat{\theta} = \hat{\theta}(\bar{s}_1, \mu, \beta)$ it is given as

$$\frac{\partial\hat{\theta}}{\partial\bar{s}_1}\left[w\left(\sigma_1^*\left(\hat{\theta}\right), \hat{\theta}\right) - w\left(\mu\bar{s}_1, \hat{\theta}\right)\right] + \int\limits_{\widehat{\Theta}(\bar{s}_1,\mu,\beta)} \frac{\partial\left[w(\mu\bar{s}_1, \theta)\right]}{\partial\bar{s}_1} dF(\theta) + \int\limits_{\overline{\Theta}(\bar{s}_1,\mu,\beta)} \frac{\partial w(\bar{s}_1, \theta)}{\partial\bar{s}_1} dF(\theta) \overset{!}{=} 0.$$

By Corollary 1 we have $\partial\hat{\theta}/\partial\bar{s}_1 > 0$, and by equation (12) the bracketed term positive. Suppose $\bar{s}_1 = 0$, then $\widehat{\Theta}(\bar{s}_1, \mu, \beta)$ is empty and the first integral equal to zero. $\theta^*(\bar{s}_1) = 0$, $\frac{\partial w(\bar{s}_1,\theta)}{\partial\bar{s}_1} = 0$ for $\theta = 0$ but positive for all non-zero θ. Hence, the second integral positive; the first term on the left is equal to $\frac{\partial\hat{\theta}}{\partial\bar{s}_1} w\left(\sigma_1^*\left(\hat{\theta}\right), \hat{\theta}\right)$, rendering the first order condition positive for $\bar{s}_1 = 0$.

Now suppose, the true maximizer is $\bar{s}_1 = \bar{s}_1^{\mathcal{C}}$. Then the second integral equals zero because $\theta^*\left(\bar{s}_1^{\mathcal{C}}\right) = 1$ and $\overline{\Theta}(\bar{s}_1, \mu, \beta) \subseteq \emptyset$. Note that $\frac{\partial\left[w\left(\mu\bar{s}_1^{\mathcal{C}},\theta\right)\right]}{\partial\bar{s}_1} = 0$ for $\theta = \theta^*\left(\mu\bar{s}_1^{\mathcal{C}}\right)$ and negative for all lower θ. For the given parameter assumption, $\widehat{\Theta}(\mu, \epsilon, \bar{s}_1)$ is non-empty and the first integral negative. The first order condition is negative at $\bar{s}_1 = \bar{s}_1^{\mathcal{C}}$ if $\frac{\partial\hat{\theta}}{\partial\bar{s}_1} \cdot \Delta_B\left(\hat{\theta}\right) < -\int_{\widehat{\Theta}(\bar{s}_1,\mu,\beta)} \frac{\partial[w(\mu\bar{s}_1,\theta)]}{\partial\bar{s}_1} dF(\theta)$. If this holds, then by continuity of equation (14) in $\bar{s}_1$ there exists a $\bar{s}_1^* \in \left(0, \bar{s}_1^{\mathcal{C}}\right)$ such that the first order condition is equal to zero. If the condition does not hold, then the optimal contract provision is positive and *Cadillac*, $\bar{s}_1^* = \bar{s}_1^{\mathcal{C}}$.

It is easy to see that the buyer's participation constraints need to hold. Suppose $\bar{a}_2 < 0$, then from Lemma 2 and equations (11) and (12) it follows that the seller's first period performance incentives are even more distorted, with an effect analogous to a higher μ or lower β. A stronger distortion leads to a lower expected joint surplus, given a constant sharing rule (α, β), a superior contract will be preferred by both parties. □

Proof of Lemma 3

Proof. (1) Let $\bar{a}_2 \geq 0$, then we have $\psi_2^r(s_1, \mu, 1, \bar{a}_2, \theta)\big|_{s_1 \geq \mu\bar{s}_1} = \psi_2^r(s_1, \mu, 1, \bar{a}_2, \theta)\big|_{s_1 < \mu\bar{s}_1}$ for all μ and consequently $\Delta_\psi(\theta, 1, \bar{a}_2) = 0$ (Lemma 2 and equation (11)). Equation (12) is then equal to $w(\sigma_1^*(\theta), \theta) - w(\mu\bar{s}_1, \theta) = 0$, implying by the definition of $\theta^*(\mu\bar{s}_1)$ that $\hat{\theta}(\bar{s}_1, \mu, 1, \bar{a}_2) = \theta^*(\mu\bar{s}_1)$ for

all μ. Then, $\widehat{\Theta}(\bar{s}_1, \mu, 1, \bar{a}_2) \subseteq \emptyset$ for all $\bar{s}_1$, and $\bar{s}_1$ such that $\overline{\Theta}(\bar{s}_1) \subseteq \emptyset$. From Corollary 2 we can then conclude that $\sigma_1^E(\mu, 1, \theta) = \sigma_1^*(\theta)$ for all μ. Hence, by the proof of Proposition 2, $\bar{s}_i = \bar{s}_i^{\mathcal{C}}$, $i = 1, 2$.
(2) $\kappa(s_1, 0) = 1$ $\forall s_1$, hence by Lemma 1 cancellation is not a credible threat for any s_1 or $\bar{a}_2$. Then, $\psi_2^r(s_1, 0, \beta, \bar{a}_2, \theta)\big|_{s_1 \geq \mu\bar{s}_1} = \psi_2^r(s_1, 0, \beta, \bar{a}_2, \theta)\big|_{s_1 < \mu\bar{s}_1}$ and $\Delta_\psi(\theta, \beta, \bar{a}_2) = 0$ for all β. $\bar{s}_i = \bar{s}_i^{\mathcal{C}}$ by the arguments in (i). □

Proof of Lemma 4

Proof. The proof is based on equation (15) to hold, the exposition, however, easily carries over to the case where $\overline{\Theta}(\mu, \beta) \subseteq \emptyset$. By equation (14) we get

$$\begin{aligned} \mathbb{E}_\theta W(\sigma_1^*(\theta), \sigma_2^*(\theta), \theta) - \mathbb{E}_\theta W\left(\sigma_1^E(\mu, \beta, \theta), \bar{s}_2^r(\theta), \theta\right) &= \\ \int\limits_{\widehat{\Theta}(\mu,\beta)} [w(\sigma_1^*(\theta), \theta) - w(\mu\bar{s}_1, \theta)]\, dF(\theta) + \int\limits_{\overline{\Theta}(\mu,\beta)} [w(\sigma_1^*(\theta), \theta) - w(\bar{s}_1, \theta)]\, dF(\theta) &\geq 0. \end{aligned}$$

Note that for $\mu = 0$ this is equal to zero since $\widehat{\Theta}(\mu, \beta)$ and $\overline{\Theta}(\mu, \beta)$ empty. By definition, the two integrands $[w(\sigma_1^*(\theta), \theta) - w(\mu\bar{s}_1, \theta)] > 0$ for all μ and $\theta \neq \theta^*(\mu\bar{s}_1)$. For $\mu > 0$, $\widehat{\Theta}(\mu, \beta)$ and $\overline{\Theta}(\mu, \beta)$ non-atomic and by Proposition 1 we know that $\frac{\partial \mathcal{F}(\widehat{\Theta}(\mu,\beta))}{\partial \mu} > 0$. Moreover, $\frac{\partial \mathcal{F}(\overline{\Theta}(\mu,\beta))}{\partial \mu} > 0$ since $\overline{\Theta}(\mu, \beta) \equiv [\theta^*(\bar{s}_1(\mu, \beta)), 1]$ and by Proposition 2 we have $\frac{\partial \bar{s}_1(\mu,\beta)}{\partial \mu} < 0$. □

Proof of Proposition 3

Proof. The proof is by Proposition 2 and Lemma 4 □

Proof of Lemma 5

Proof. Recall that $\bar{a}_2 \geq 0$. By the parties' joint expected surplus in equation (14) and the seller's first period performance strategy in (16) the parties' expected equilibrium payoffs are equal to

$$\mathbb{E}\, A(\mu, \beta) = V(\bar{s}_1(\mu, \beta), \bar{s}_2(\mu, \beta)) - p + \tilde{\phi}_2^r(\mu, \beta)$$

and

$$\mathbb{E}\, B(\mu, \beta) = p - V(\bar{s}_1(\mu, \beta), \bar{s}_2(\mu, \beta)) + \tilde{\psi}_2^r(\mu, \beta),$$

respectively for the buyer and seller, where

$$\begin{aligned} \tilde{\phi}_2^r(\mu, \beta) &= (1 - \beta)\left[\int_{\widehat{\Theta}} w(\sigma_2^*(\theta), \theta)\, dF(\theta) + \int_{\overline{\Theta}} [w(\sigma_2^*(\theta), \theta) - w(\bar{s}_2(\mu, \beta), \theta)]\, dF(\theta)\right] \\ \tilde{\psi}_2^r(\mu, \beta) &= \mathbb{E}_\theta W(\mu, \beta, \theta) - (1 - \beta)\left[\int_{\widehat{\Theta}} w(\sigma_2^*(\theta), \theta)\, dF(\theta) + \right. \\ &\qquad \left. \int_{\overline{\Theta}} [w(\sigma_2^*(\theta), \theta) - w(\bar{s}_2(\mu, \beta), \theta)]\, dF(\theta)\right]. \end{aligned}$$

By generalized Nash-bargaining, the price is $\bar{p} \equiv \arg\max_p [\mathbb{E}\, A(\mu, \beta)]^\alpha [\mathbb{E}\, B(\mu, \beta)]^\beta$ which yields $\bar{p} = V(\bar{s}_1(\mu, \beta), \bar{s}_2(\mu, \beta)) - \tilde{\psi}_2^r(\mu, \beta) + \beta \mathbb{E}_\theta W\left(\sigma_1^E(\mu, \beta, \theta), \bar{s}_2^r(\theta), \theta\right)$, and for the buyer's payoffs we get $\mathbb{E}_\theta A(\mu, \beta) = (1 - \beta)\mathbb{E}_\theta W\left(\sigma_1^E(\mu, \beta, \theta), \bar{s}_2^r(\theta), \theta\right)$. By Lemma 4 these payoffs are decreasing in μ. □

Proof of Proposition 4

Proof. With restitution interest the disagreement point payoff for rightful cancellation is $q_0(1) = (0, 0)$ (see Figure 4). By Lemma 1, the buyer will not credibly threaten cancellation if $\kappa = 1$. For $\kappa = 0$, the buyer will not do so if $q_{A0}(0) \geq q_{A0}(1)$, i.e. $\bar{a}_2 \geq 0$. Then $\gamma^r = 0$ for all s_1 yields $\Delta_\psi = 0$, and by Proposition 2 the contract $\mathbb{I}$ induces the first best outcome. □

Appendix B: Less-than-perfect correlation

We now consider period specific productivity types $\theta_i \in \Theta$, $i = 1, 2$, where θ_2 is realized after the renegotiation stage in $t = 1.75$. In the paper's analysis we assume $\text{cov}(\theta_1, \theta_2) = 1$. If, however, the seller's productivity type is not *project-specific* but her cost structure subject to periodic realization of a state of nature, then we see $\text{cov}(\theta_1, \theta_2) < 1$. We denote the *ex-ante* expected value of θ_2 by $\mathbb{E}^0[\theta_2]$ while the interim expected value, evaluated in $t = 1$, is given as $\mathbb{E}^1[\theta_2 | \theta_1]$. This implies that the parties cannot anticipate the seller's production costs for the second installment with certainty, implying $\bar{s}_2^r \neq \sigma_2^*(\theta_2)$. At the renegotiation stage the parties will negotiate an incomplete contract $\mathbb{I}^r(\bar{s}_2^r, \bar{p}_2^r)$ which is non-contingent on $\theta_2 \in \Theta$. Analogously to equation (3), if the renegotiated second installment $\bar{s}_2^r = \bar{s}_2^{\mathcal{C}}$ and $\overline{\Theta}(\bar{s}_2^r) \subseteq \emptyset$, then the seller's second period performance $\sigma_2^r(0, \theta) \equiv \arg\max_{s_2 \leq \bar{s}_2^r}[w(s_2, \theta_2) - \bar{a}_2^r] = \sigma_2^*(\theta_2)$ for all $\theta_2 \in \Theta$. From Figure 5 it is straightforward that the buyer's cancellation announcement γ^r is unaffected by the uncertainty over θ_2, hence Lemma 1 holds. The price $\bar{p}_{2,\kappa}^r(s_1, \mu, \gamma^r, \beta)$ in equation (5) that splits the second surplus according to (α, β) is non-contingent on θ_2 and given as

$$\arg\max_{p \in \mathbb{R}} [v(\bar{s}_2^r) - p - q_{A\kappa}(\gamma^r)]^{\alpha} \left[\mathbb{E}^1\left[w(\sigma_2^r(0, \theta_2), \theta_2) - v(\bar{s}_2^r) + p - q_{B\kappa}(\gamma^r) \,|\theta_1\right]\right]^{\beta}.$$

Figure 5: Parties' disagreement point payoffs with non-restricted $\text{cov}(\theta_1, \theta_2)$

Disagreement point payoffs	$s_1 \geq \mu\bar{s}_1,\ \kappa = 1$	$s_1 < \mu\bar{s}_1,\ \kappa = 0$
$\gamma^r = 1$	$q_1(1) =$ $\left(-\max\left[\mathbb{E}^0 b(\sigma_2(0, \theta_2), \bar{s}_2, \theta_2), 0\right], \max\left[\mathbb{E}^0 b(\sigma_2(0, \theta_2), \bar{s}_2, \theta_2), 0\right]\right)$	$q_0(1) =$ $\left(\max[\bar{a}_2, 0], -\max[\bar{a}_2, 0]\right)$
$\gamma^r = 0$	$q_1(0) =$ $\left(\bar{a}_2, \mathbb{E}^1\left[b(\sigma_2(0, \theta_2), \bar{s}_2, \theta_2) \,|\theta_1\right]\right)$	$q_0(0) =$ $\left(\bar{a}_2, \mathbb{E}^1\left[b(\sigma_2(0, \theta_2), \bar{s}_2, \theta_2) \,|\theta_1\right]\right)$

The parties' disagreement point payoffs $q_\kappa(\gamma^r)$ are given in Figure 5. The contract price associated with each κ and γ^r is then denoted by $\bar{p}_{2,\kappa}^r(s_1, \mu, \gamma^r, \beta, \theta_1) = v(\bar{s}_2^r) - (1-\beta)\mathbb{E}^1\left[w(\sigma_2^r(0, \theta_2), \theta_2) \,|\theta_1\right] + \alpha q_{B\kappa}(\gamma_r) - \beta q_{A\kappa}(\gamma^r)$. Given the payoffs in Figure 5, the parties' period two payoffs ϕ_2^r and ψ_2^r evaluated in $t = 1.5$ are equal to

$$\begin{aligned} \phi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta_1) \quad &= \quad (1 - \kappa(s_1, \mu))\left[(1-\beta)\mathbb{E}^1\left[w(\sigma_2^r(0, \theta_2), \theta_2) \,|\theta_1\right] + \max[\bar{a}_2, 0]\right] + \\ &\quad\ \kappa(s_1, \mu)\left[(1-\beta)\mathbb{E}^1\left[w(\sigma_2^r(0, \theta_2), \theta_2) - w(\sigma_2(0, \theta_2), \theta_2) \,|\theta_1\right] + \bar{a}_2\right] \end{aligned} \tag{18}$$

and

$$\begin{aligned} \psi_2^r(s_1, \mu, \beta, \bar{a}_2, \theta_1) \quad &= \quad (1 - \kappa(s_1, \mu))\left[\beta\mathbb{E}^1\left[w(\sigma_2^r(0, \theta_2), \theta_2) \,|\theta_1\right] - \max[\bar{a}_2, 0]\right] + \kappa(s_1, \mu) \cdot \\ &\quad\ \mathbb{E}^1\left[\beta(w(\sigma_2^r(0, \theta_2), \theta_2) - w(\sigma_2(0, \theta_2), \theta_2)) + b(\sigma_2(0, \theta_2), \bar{s}_2, \theta_2) \,|\theta_1\right]. \end{aligned} \tag{19}$$

As we have observed earlier in equations (7) and (8), $\phi_2^r(s_1, \mu, \beta, \bar{a}_2)$ is decreasing and $\psi_2^r(s_1, \mu, \beta, \bar{a}_2)$ increasing in $\kappa(s_1, \mu)$. This implies that the seller's gains from substantial conformity $\Delta_\psi(\beta, \bar{a}_2) = (1-\beta)\mathbb{E}^1\left[w(\sigma_2(0, \theta_2), \theta_2) \,|\theta_1\right] - \min[\bar{a}_2, 0]$ are strictly positive for any $\beta < 1$, and for all β if $\bar{a}_2 < 0$.

The seller will deliver $\mu\bar{s}_1$ as long as $\Delta_B(\theta_1) \leq \Delta_\psi(\beta, \bar{a}_2, \theta_1)$. Analogously to equation (12) we rearrange to get a borderline type $\hat{\theta}_1 = \hat{\theta}_1(\bar{s}_1, \mu, \beta)$ (for simplicity let's assume that $\bar{a}_2 \geq 0$) such that

$$w\left(\sigma_1^*\left(\hat{\theta}_1\right), \hat{\theta}_1\right) - w\left(\mu\bar{s}_1, \hat{\theta}_1\right) = (1-\beta)\mathbb{E}^1\left[w(\sigma_2(0, \theta_2), \theta_2) \,|\hat{\theta}_1\right]. \tag{20}$$

Let's consider the corner case of $\text{cov}(\theta_1, \theta_2) = 0$. Then, the right hand side is constant and positive for any $\beta < 1$, which is by a simple participation argument. If parties expected negative gains from their second period trade they would not enter the contract. Notice that this observation is independent of $\bar{a}_2$. As in the case presented in the main text of the paper, the borderline type $\hat{\theta}_1$ will be equal the efficient type $\theta_1^*(\mu\bar{s}_1)$ if $\beta = 1$. The other polar case $\mu = 0$, too, is as given in Lemma 3. As a matter of fact, for any non-polar case an *over-shooting* effect is straightforwardly seen, for the non-correlated case it is even stronger than in the perfect correlation case presented in the paper. To see this, consider the worst case with $\mu = 1$ and $\beta = 0$. Then for $\theta_1 = 0$, the LHS, $-w(\bar{s}_1, \theta_1)$ need not necessarily be larger than the RHS as it was the case for $\text{cov}(\theta_1, \theta_2) = 1$. This implies that there is a $\hat{\theta}_1 < \hat{\theta}(\bar{s}_1, 1, 0)$ such that $\Delta_B(\theta_1) \leq \Delta_\psi(0, \theta_1)$. We observe more *over-shooting* and for the worst case (or a "bad" case) may indeed observe a constant performance $\mu\bar{s}_1$ for all θ_1.

The results for a positive covariance lie in between the two corner cases (we abstract from negative type correlation). The remainder of the analysis follows from the paper.