Breaking the Tie and Tying the Breachee: Lexicographic Maximizers, Installment Contracts and the Substantial Impairment Requirement*

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Abstract

In an incomplete contract setting we study the effect of the "substantial impairment requirement" for cancellation of multi-trade contracts on parties' strategies. In contrast to the "perfect tender rule" for single-shot deals, US contract law grants a breachee the right to cancel multi-trade contracts upon delivery of a defective good only if the entire contract is substantially impaired. Breach remedies imply the existence of indeterminacies; we thus apply exogenous and endogenous tie-breaking rules in reference to Nalebuff-Shubik (1988) lexicographic maximization to determine parties' equilibrium strategies. We show that the substantial impairment requirement leads to a Pareto-improvement over strict compliance rules.

JEL classification: D86, K12, L14.

Keywords: Installment contracts, perfect tender rule, substantial impairment requirement, Uniform Commercial Code, incomplete contracts, lexicographic maximization, limited commitment.

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1 Introduction

Indeterminacies with one of the parties indifferent between choosing left or right at a stage of the underlying game are frequently encountered in economic models.[1] The same is true for the law and economics literature. When analyzing breach remedies we often model damage functions such that an aggrieved promisee is put in as good a position as if the promise had never been made (*reliance* and *restitution*) or as if the promisor had fully conformed to her obligations (*expectation*). In case of the latter, expectation damages for breach of a commercial contract, this implies that upon seller's (she) non-conforming delivery the buyer (he) is by law made indifferent between a perfect tender and the damage payments for breach of contract if damages are fully recoverable. In this paper we study multi-period or *installment contracts* as stipulated by U.S. contract law in the *Uniform Commercial Code (UCC)*[2], Section §2-612(1): "An 'installment contract' is one which requires or authorizes the delivery of goods in separate lots to be separately accepted [. . .]" Under the usual modeling approach we grant the aggrieved party the right to claim damages for breach of the entire contract if the promisor's delivery is non-conforming by any degree. In our analysis of a multi-period contract, however, we distinguish between breach of a single installment and breach of the entire contract. The *UCC* stipulates that upon delivery of a performance that *substantially* impairs his valuation of the *entire* contract, the buyer is given the right to cancel prior to any future deliveries and claim expectation damages not only for the non-conforming good, but also for these anticipatorily rejected non-delivered installments. By definition of full compensation expectation damages he will in the end be made indifferent between canceling the contract (damages as to non-conforming delivered installment and non-delivered future ones) or accepting delivery of future installments (damages as to a non-conforming first and any future installments to be delivered). In a simplified two-installment buyer-seller model we assume *ex-ante* uncertainty with respect to the seller's productivity. It can be shown that the seller's periodic performances are first best and continuous in her productivity over the entire type space only if the buyer always breaks his tie in favor of future period trades.

In order to identify equilibrium strategies in games with indifference it is necessary to determine how ties are broken, because the ways players do so affect other players' strategies in the game (Dewatripont, 1987; Tranæs, 1998). As to the indifference in the analysis of our two-installment, three-stage contract, we show that after observing the first installment the buyer would like the seller to believe that he breaks the tie with certainty in favor of the second period trade. If this is not the case and the seller expects the buyer to cancel with positive probability, then she will for a certain set of productivity types try to avoid the damage payments associated with cancellation. To achieve this she will deliver a first installment that does not *materially* breach the contract and thus does not give the buyer a legal option to cancel. This *substantially*

[1] We face this issue for instance in auction theory (e.g. Simon and Zame, 1990; Maskin and Riley, 2000; Jackson, Simon, Swinkels, and Zame, 2002), matching and school choice (Erdil and Ergin, 2006), models of price competition à la Hotelling, duopolistic price competition à la Bertrand, or spatial competition (e.g. Dewatripont, 1987). See Dasgupta and Maskin (1986a,b) for further applications.

[2] For text and official commentary see White and Summers (2000).

conforming performance will be *ex-post* inefficient since it is above and beyond what she would tender if the buyer did not cancel with positive probability. Therefore, if *ex-ante* the buyer cannot credibly *signal* or *commit* not to cancel *ex-post*, the parties will anticipate the seller's first period behavior and agree upon a Pareto-inferior second best installment contract. Such a contract will not induce *ex-post* efficiency over the entire type space, but will in expectations lower the parties' two-period joint surplus. Hence, since any uncertainty as to the buyer's credibility gives rise to the seller's inefficient behavior, the buyer himself has an interest in making the seller believe that there is no danger of *ex-post* cancellation and that he will break the tie in the "optimal way" (Dewatripont, 1987; p. 323).

Generally, as is emphasized by Jackson, Simon, Swinkels, and Zame (2002), tie-breaking rules may be either endogenously or exogenously given, where for the former they are determined as solution of the underlying game. In their analysis of first-price sealed-bid auctions, Maskin and Riley (2000) for instance interpret a tie-breaking rule as the outcome of an unmodeled second (intermediate) stage game. "Bribing" the tied party by means of exchanging or promising a positive monetary transfer, as is the conventional wisdom for breaking a tie in a two-party game, can be seen along these lines. We will argue, however, that due to the sequential nature of the three-stage game in our setting, if such a tie-breaking payment is assumed to be non-contractible, the seller will always have an incentive to *ex-post* defect from such an *ex-ante* promise. Without the tie-breaking payment, this approach does not yield buyer's full commitment.

As in Maskin and Riley (2000), Simon and Zame (1990) argue in favor of tie-breaking rule to be "viewed as a statistic summarizing actions taken by unseen agents whose behavior is not modeled explicitly" (p. 863). We loosely follow their assertion and refer to the concept of *lexicographic maximization* in Nalebuff and Shubik (1988). In their treatment of "emotional" considerations as part of perfectly rational behavior they argue that incorporating behavioral aspects into optimization problems is of a *lexicographic concern*. This is because agents are assumed to be fully rational up to the point where their optimal action is indeterminate due to an indifference. If rationality cannot resolve this indeterminacy, there will be room for other means of breaking the tie.

In our analysis we will assume the aggrieved buyer to be a *lexicographic maximizer*: He will maximize his payoffs up to an indifference which we assume to be broken probabilistically. This means that even if the buyer *ex-ante* would like to fully commit to the contract, i.e. break any tie in favor of the second period trade, he will *ex-post* cancel the contract with certain probability. At the outset of the game the parties have a common prior of this cancellation probability which may for instance be viewed as a Simon and Zame (1990) statistic or determined by the parties' previous business partnerships. For the remainder of this paper we will interpret this cancellation probability to be driven by the buyer's limited commitment or credibility, implying that *ex-ante* he is not able to credibly announce a cancellation with probability zero.

We analyze the effects of the substantial impairment requirement on parties' contract behavior under such commitment uncertainty. As we will discuss in more detail in the next section, the substantial impairment requirement for installment contracts relaxes the "perfect tender rule" under which the aggrieved buyer/breachee is given the right to reject the goods delivered or cancel the entire contract if the seller's/breacher's performance is non-conforming. Given such a strict compliance rule, the buyer is given the right to terminate the contract for *any* deviation by the seller. In contrast to this, the substantial impairment requirement restricts the buyer's cancellation option to deliveries that *substantially* impair his valuation of the whole contract. Thus, the law commits both parties to their deal and gives the seller some flexibility with respect to uncertainty about her production environment. The rules of contract law may therefore substitute for any tie-breaking game and mitigate the negative effects of the buyer's limited credibility or commitment. Indeed, if a tie is not with a probability of one resolved with what is optimal *ex-ante*, and if the seller's first period performance for which the buyer is indifferent between cancellation and acceptance is smaller than under strict compliance, the default rule of substantial impairment requirement serves as a commitment device and leads to a Pareto-improvement over the "perfect tender rule." As we show for a perfect judiciary with full compensation, allowing for such a leeway Pareto-improves the result even without the existence of relationship-specific investment, whose protection is usually brought forward as main motivation for the rules in place.

The rest of the paper is structured as follows: Section 2 presents the discussion of the literature on the substantial impairment requirement for installment contracts. We briefly comment on the history of the rule and provide results from the law and economics literature which is typically in favor of such a restriction of the buyer's cancellation rights. The "traditional" argument is the need for protection of the business relationship due to relationship-specific investment. In our analysis we will argue that there still is a case *pro* substantial impairment requirement even without relationship-specific investment. In Section 3 we present a basic three-stage two-installment incomplete contract model with two goods to be delivered and accepted sequentially. The modeling framework is one of complete and verifiable information and verifiable actions. We assume that relationship-specific investment is not required by efficiency, neither do we assume any inter-temporal complementarities, rendering the first best solution to be time-independent. In Section 4 we analyze the model given the buyer's limited commitment as result of the assumed lexicographic maximization and formalized by both exogenous and endogenous tie-breaking rules to obtain a second best result. In Section 5 it is established that the substantial impairment requirement leads to a Pareto-improvement over the strict compliance rule and serves as a commitment device that substitutes for buyer's credibility. Section 6 concludes and discusses two possible extensions to enrich the analysis and broaden the model's implications. Proofs of the results, the cited legal code, and a list of the cases discussed in the paper are found in the Appendix.

2 Standing relations in law

Business relationships between commercial actors are rarely one-time encounters, yet potential business partners are likely to meet and 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.[3]

In the legal literature, the discussion of the need for protection of long-term relationships has had a long tradition 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 critique stating that the legal implications of such standing relations are "still legally inarticulate." Any such tools will have to acknowledge that in "*most* [...] cases"[4] the "*commercial* (substantial) standard of performance" needs to substitute for the "*mistakenly* strict legal standard" [emphasis added] (Llewellyn, 1937; p. 378). 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 ("perfect tender rule") in multi-stage settings. 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 are in clear contradiction to what earlier scholars have 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 makes a non-conforming, defective delivery with respect to one installment this gives rise to a buyer's right to treat the whole contract as breached and to terminate.[5] 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*."[6] 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

[3]Crawford (1985) and Hart and Holmström (1987) are interesting earlier sources for dynamic contract theory while 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). See also Guriev and Kvasov (2005) for a recent literature review.

[4]This does not apply for "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.

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

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

subsequent portion, then the other party at his option may terminate all of the contract which is still executory." Later decisions, however, are more in line with Llewellyn's interpretations. In *Helgar v. Warner's Features* 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.[7]

"Standing relations" have found their way into modern law of commercial transactions via Article 2 of the *Uniform Commercial Code* (with Llewellyn one of its drafters)—at least half-way. Section §2-612 of the *UCC* governs "installment contracts" which Llewellyn (1937; p. 375) characterizes as "half-way stage toward standing relations." An installment contract under the *UCC* is "one which requires or authorizes the delivery of goods in separate lots to be separately accepted" (§2-612(1)). They go beyond single-occasion deals and thus cover more than just a one-shot contract, however, cannot necessarily be thought of as extending over the lifetime of a business relationship. In *Hubbard v. UTZ*, for instance a potato chips producer ordered 11,000 hundredweights of potatoes from a potato farmer to be delivered in five to six weekly installments of 2,000 to 4,000 hundredweights each; 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.[8] 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[9] 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 *(Midwest Mobile v. Dynamics).* For one-shot contracts, i.e. single-occasion deals, 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 than the corresponding right [...] under §2-601" (*Midwest Mobile v. Dynamics*; Vaserstein, 2004).[10] This leeway to the "perfect tender rule" is found in sections 2-612(2) and 2-612(3). 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, 2-612(3) stipulates that a buyer may cancel the whole contract

[7] *Helgar Corp. v. Warner's Features, Inc. (1918) 58 N.Y.L.J. 1780*, discussed in Recent Case Notes (1918).

[8] *Hubbard v. UTZ Quality Foods (1995) 903 F.Supp. 444*; *Midwest Mobile Diagnostic Imaging v. Dynamics Corporation of America (1997) 965 F.Supp. 1003.*

[9] Thanks to Alan Schwartz for this characterization.

[10] 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). Throughout this paper we will refer to *cancellation* as with respect to future installments, while *rejection* is concerned with goods already delivered.

only if a defect 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.[11]

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, *UCC* 2-612(3) enables 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. 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 it is the case for single-delivery 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]

A final answer to *What?* constitutes a *substantial* impairment of the buyer's value of the contract is not further given in the code, and courts have accepted this question to be a matter of fact. White and Summers (2000; §8.3) argue that the substantial impairment test be related to the determination of "material breach" known from common law.[13] The "substantial impairment requirement" (Priest, 1978; p. 994) for installment contracts also gives rise to the question of *Why?* there is need for separate handling of multi-period as compared 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 do not seem self-evident. It has in fact been suggested that the substantial impairment requirement is primarily applied to

[11]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.*

[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.

[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). Notice that the implications of this paper can be generally applied to cases with more constraining restrictions as to the buyer's right to cancel a multi-delivery deal relative to a series of single-delivery contracts, and are not necessarily restricted to US contract law.

[14]See Priest (1978), Schwartz and Scott (1991) or Hull (2005) for a discussion of the substantial impairment requirement in the context of revocation of acceptance (§2-608).

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." [emphasis added] Discussing the *ex-ante* and *ex-post* efficiency properties of performance rules (*perfect tender* vs. *substantial performance*) Schwartz and Scott (1991; pp. 230ff)[16] argue that if the law requires substantial performance rather than a perfectly conforming tender and thus allows for a leeway, the buyer is encouraged to cooperate with the seller to find out which product modifications are needed to come closest to his needs (smallest deviation in terms of value) at least cost to the seller. The argument brought forward by Whaley (1974) is similar in nature. The substantial impairment requirement exists to avoid the termination of a long-term contract "merely for technical reasons." He argues that in contracts calling for multiple deliveries, minor non-conformities are likely to occur and "it would give the buyer an unreasonable commercial advantage" if he were given the right to exit the contract for such "trivial" defects. A similar point is also brought forward by Lawrence (1994; fn. 86).

If this claimed commercial advantage merely affects the distribution of the benefits created by the contract but does not influence ex-ante investment or ex-post performance incentives, then strict compliance should not be disadvantageous from an efficiency perspective. An example can easily be constructed, however, which shows that a commercial advantage induced by a strict compliance standard will put the buyer in a bargaining position that allows for the extraction of a predominant part of the seller's rent by threatening unilateral cancellation of the contract. If the seller has relationship-specific investment at stake, she is likely to accept such a "renegotiation" offer since an *ex-post* continuation of the contract with detrimental terms of trade may be more beneficial than no a termination of the contract. Such a possible threat will then impair her incentives to invest *ex-ante*.

This argument is consistent with the findings of Goldberg and Erickson (1987; p. 388). 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." Examples for such behavior are insisting on "strict compliance with the quality standards" or "[reading] the contract literally." If the legal rules governing a contract allow for such "working to the rules", then ex-ante investment incentives may be impaired. Consequently, relaxing the quality requirements with respect to the buyer's right to cancel the contract—with damage remedies as to the defective installment unaffected—may in certain situations improve the outcome of the contract. If looked at it this way, 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 ex-ante investment incentives may be distorted.

The reasoning of Schwartz and Scott (1991, 2003) brought forward in favor of a somewhat relaxed performance rule hinges on their assumption of the existence of transactions costs. We

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

[16] Speidel (1992; pp. 139f) provides the same argument for the analogous rules in the CISG.

extend their argument and show for a two-installment, three-stage contract setting with *ex-post* renegotiation prohibitively costly and without relationship-specific investment required for efficiency that even in a setting with full compensation (perfect judiciary), the "perfect tender rule" results in an *ex-post* inefficient outcome if the buyer cannot fully commit to the second period trade. The wastefulness result for long-term contracts in Goldberg and Erickson (1987) partially accrues from a potential hold-up problem in *ex-post* renegotiations as well as distorted *ex-ante* investment incentives. A similar implication can be found in the work by Goetz and 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. A *mandatory acceptance of substantial performance* rule thus protects the seller from the buyer's demand for cure of possibly trivial defects. In our simple two-installment contract setting we rule out renegotiation of the contract terms after the first of two performances is observed to isolate our results from the standard hold-up implications.[17]Given buyer's limited commitment as to the second period trade—the buyer will with a probability of less than one reinstate the contract if he is indifferent between cancellation or reinstatement—the seller will anticipate the buyer's probabilistic cancellation and the consequential loss of payoffs if the first performance is not substantially conforming. She will then try to avoid a buyer's cancellation action by substantially conforming to the contract and therefore not giving the buyer the option to rightfully cancel. These effects can be interpreted as the buyer *tacitly* holding up the seller prior to the second period delivery.

The protection of relationship-specific investment and incentive alignment is an important but not the sole motive for contracting.[18] For instance, specific investment seem to be 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). Further reasons for contracting have also been suggested.[19] Without loss of generality for the issues of interest, we simplify the analysis by assuming that efficiency does not require the parties

[17]The perfect tender rule gives the buyer a bargaining leverage that induces a *legal* hold-up problem with seller's excessive first period effort (rather than *under-investment*) independent of buyer's commitment. As we will also argue in the concluding Section, abstracting from renegotiation is without loss of generality, given buyer's commitment the implications of this paper will hold without it.

[18]In a setting where parties cannot use long-term contracts and relationship-specific investment is required for efficiency reasons, one-period contracts lead to inefficient under-investment (Crawford, 1990; p. 562). Hart and Holmström (1987; p. 129) conclude that "a fundamental reason for long-term relationships is the existence of investments that are to some extent party-specific." Moreover, Joskow (1987) finds empirical evidence from coal contracts which shows that longer term contracts are entered as relationship-specific investments get more important. In such cases exchange relationships based on repeated bargaining are "unattractive" due to hold-up or opportunism incentives that are created after non-contracted investments are made. See also Joskow (1985) and the empirical work cited in Joskow (1987; fn. 2).

[19]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). See also Rey and Salanié (1990) for a discussion of the issue.

to engage in relationship-specific investment (self-investment or cooperative investment). For a buyer's limited commitment as to the second period trade, we obtain results that are in line both with some of the early legal literature as well as more recent law and economics studies. The substantial impairment requirement for installment contracts leads to a Pareto-improvement compared to strict compliance rules even if the parties' preferences are history-independent and the contract without memory.

3 The model

We construct a simple buyer-seller model with *ex-ante* uncertainty as to the seller' productivity. Assuming the buyer to be a lexicographic maximizer, we study the effect of the *UCC*'s default cancellation rule for installment contracts on parties' equilibrium strategies. In order to keep the analysis as simple as possible the case of two installments only is considered. Parties do not discount future periods and renegotiation of the second period installment is not possible. The motivation as to the analysis of "standing relations" is similar in kind, but our setup is quite different from the "multiple-trading-periods model" analyzed in Watson (2005). The modeling framework is one of complete and verifiable information and verifiable actions, 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) deliver a good of quantity or quality s_1 at date 1 and a good s_2 at date 2. We denote this installment 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 $C(\mathbf{s}, \theta) = C(s_1, s_2, \theta)$. Prior to the start of production of $\mathbf{s}$ she observes her *relationship-specific productivity* $\theta \in \Theta \equiv [0, 1]$, with continuous pdf $f(\theta)$ and strictly decreasing cdf $F(\theta)$, which enters $C(\mathbf{s}, \theta)$ and prevails over the lifetime of the business partnership.[20] This productivity type is observable and 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 marginal costs of s_i at $s_i = 0$ are assumed to be zero for any θ and s_j, $i \neq j = 1, 2$. Moreover, let the single-crossing property hold, i.e. given $s_i' > s_i$ and s_j, then $C(s_i', s_j, \theta) - C(s_i, s_j, \theta)$ 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 $V(\mathbf{s}) = V(s_1, s_2)$. We assume that $V(\mathbf{s}) \geq 0$ for any non-negative s_i, twice differentiable, quasi-concave, monotonically increasing in s_i for $i = 1, 2$. Moreover, marginal utility of s_i at $s_i = 0$ is infinite for any s_j, $i \neq j = 1, 2$. The buyer's overall payoff is quasi-linear and denoted by $A = V(\mathbf{s}) - Z$.

[20]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.

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 $\mathbf{s} = (s_1, s_2)$, $W(\mathbf{s}, \theta) = V(\mathbf{s}) - C(\mathbf{s}, \theta)$. 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 for $i = 1, 2$,

$$\frac{\partial V(\mathbf{s})}{\partial s_i} - \frac{\partial C(\mathbf{s}, \theta)}{\partial s_i} \stackrel{!}{=} 0. \tag{1}$$

For the sake of simplicity we assume *time-separability* of the parties' valuation and cost functions.[21] Hence, $V(\mathbf{s}) \equiv v(s_1) + v(s_2)$ and $C(\mathbf{s}, \theta) \equiv c(s_1, \theta) + c(s_2, \theta)$. As a result, the social welfare function $W(\mathbf{s}, \theta) = w(s_1, \theta) + w(s_2, \theta)$ is time-separable, too. By these assumptions, the periodic surplus functions $w(s_i, \theta)$ behave "nicely" with σ_t^* their unique maximizers, continuous and strictly increasing in θ.

The **timing** of the model is as follows. Before the seller's productivity type is observed, at $t = 0$ *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. Renegotiation of the contract is assumed to be prohibitively costly. 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 $\bar{\mathbf{s}} = (\bar{s}_1, \bar{s}_2) \in S \times S$ and the contracted price be $\bar{p} = \bar{p}_1 + \bar{p}_2$. The performance vector $\bar{\mathbf{s}}$ is chosen such that the parties' expected joint surplus is maximized, while monetary transfers $\bar{p} = \bar{p}_1 + \bar{p}_2$ split this surplus along the surplus 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 $\mathcal{I} \equiv \mathcal{I}(\bar{\mathbf{s}}, \bar{p})$. This incompleteness at the "formation" rather than the "execution" stage is assumed to result from either transaction costs and costs of writing contracts[22] 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 $t = 0.5$ the *parties observe the seller's productivity type* $\theta \in \Theta$.

$t = 1$: *The parties exchange the first installment and the agreed price, the buyer is compensated for non-conformity.* Under contract $\mathcal{I}$, it is the seller's obligation to deliver $\bar{s}_i$ for

[21] As it turns out, assuming forward inter-temporal complementarities such as for instance in Lee and Png (1990) with full compensation yields even stronger implications. The same is true for renegotiation. If parties can renegotiate the second installment, even stronger implications are obtained.

[22] 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) Notice that θ is verifiable and thus contractible; thus an enforceable contingent contract in principle possible. By assumption the model involves a *simple* contracts, but not necessarily *simple* cognitive requirements.

any realized $\bar{s}_i$ and the buyer's obligation to accept the seller's tender and pay $\bar{p}_i$ at date i. We assume $\mathcal{I}$ 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.[23] 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."[24]

For now we assume to have a frictionless judiciary at hand, i.e. going to court is costless and damages are fully compensatory. 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 $D\left(\mathbf{s}^d, \bar{\mathbf{s}}\right) = V\left(\bar{\mathbf{s}}\right) - V\left(\mathbf{s}^d\right)$, which are fully compensated by the seller. By time-separability, the periodic damages associated with each of the installments such that $D\left(\mathbf{s}^d, \bar{\mathbf{s}}\right) = d\left(s_1^d, \bar{s}_1\right) + d\left(s_2^d, \bar{s}_2\right)$ are

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

The buyer's 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 delivered good as is 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 pay partial damages rather than full. Taking the buyer's tie seriously, she can at the time of delivery give the buyer an infinitesimally small price reduction z, inducing him to accept the non-conforming tender. We can therefore assume that the buyer will never reject a good that has already been tendered.[25] Through the structure of the model environment, however, we allow for the buyer to anticipatorily reject the second installment after the delivery of the first.

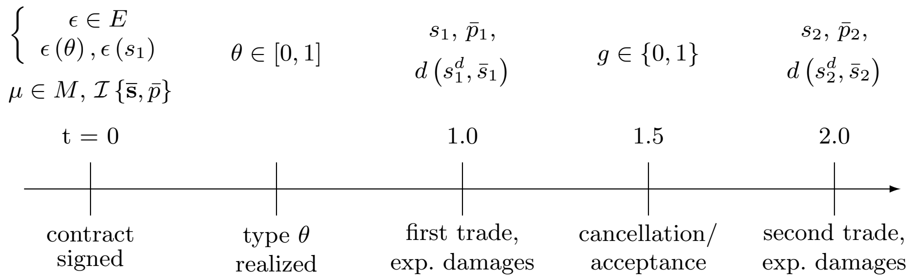
$t = 1.5$: *The buyer communicates his cancellation decision.* It is not only the buyer's contractual obligation to accept a conforming tender, but also to anticipatorily accept all future deliveries. By definition of an installment contract, delivery and acceptance of s_i are of sequential nature. In such a case the buyer can observe the seller's first installment prior to the delivery

[23] 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 Edlin and Reichelstein (1996), Schweizer (2005); Che and Chung (1999) and Schweizer (2006) for cooperative investment, or Shavell (2004) for a comprehensive literature review.

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

[25] See Jackson (1978) who discusses rejection and rescission, allowing for a third party seller. In our setup, rescission (without damages, 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 $\bar{A}_1 = v\left(\bar{s}_1\right) - \bar{p}_1$ are non-negative, he will not prefer rescission over acceptance or rejection.

Figure 1: Time structure of the model



of s_2. For simplicity, we assume the seller's production to be sequential, too. This implies that the production of the second installment does not commence before the buyer observes the first and reacts to it, and ensures that by the time the buyer makes his decision, the seller has not exerted any effort or costs as to the second delivery. To illustrate this, consider the case where a portion of the second installment is produced by the time the buyer terminates the contract. The seller may prematurely stop production and sell the remaining raw material or intermediate good for a scrap value that is likely below the initial costs. She may on the other hand finish the product and sell it on the open market for a price that is likely below the contract price $\bar{p}_2$. In order to ensure that no such issue of advanced production investment arises, sequential production is assumed.

After observing the first installment and prior to the delivery of the second the buyer decides whether to continue the contract and accept the seller's second performance at date $t = 2$, or cancel by anticipatorily rejecting s_2 before its delivery. Let this decision at date $t = 1.5$ be denoted by $g \in G \equiv \{0, 1\}$, where $g = 1$ if the buyer cancels the contract and zero otherwise.

In the previous section we examined the rules for rightful cancellation of an installment contract, stating that the *Uniform Commercial Code* allows for such anticipatory repudiation of future installments if the non-conformity of a tendered substantially impairs the buyer's valuation of the whole contract. This *substantial impairment requirement* has been argued to be closely related to the *material breach test* known from common law (White and Summers, 2000; §8.3). 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 contract if and only if this non-conformity constitutes a material breach of the contract. This simplifying assumption allows us to conduct the substantial impairment test not through how the buyer values the non-conformity but through the seller's input s_1.[26] Let the threshold of material breach and hence substantial impairment of the contract 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 materially breaches the contract. The respective

[26]Empirically, the input test has given most different results and has stipulated μ all across M. *Table to be added!*

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.[27]

Definition 2 (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 $D(\mathbf{s}^d, \bar{\mathbf{s}}) - \bar{p}_2$ with $s_2 = 0$.*

$t = 2$: *The parties exchange the second installment and the agreed price, the buyer is compensated for non-conformity.* If the buyer cancels the contract and $g = 1$, then the seller does not get a chance to perform and $s_2 = 0$. No trade takes place in the second period and the buyer's and seller's payoffs are simply given by monetary transfers from one party to the other. These payments and consequently the parties' second period payoffs will depend on the seller's first period performance s_1 and the substantial impairment parameter μ. That means, if $s_1 < \mu \bar{s}_1$ and the seller's first period delivery substantially impairs the buyer's valuation of the whole contract, the buyer is entitled to overall damage payments $D(\mathbf{s}^d, \bar{\mathbf{s}}) - \bar{p}_2$, where $d(s_1^d, \bar{s}_1)$ are associated with the first and $d(0, \bar{s}_2) - \bar{p}_2$ with the second installment. Since we rule out any windfall gains for a breaching party, the buyer's period 2 payoffs from rightful cancellation are assumed to be non-negative, $\max[\bar{A}_2, 0]$, where $\bar{A}_2 = v(\bar{s}_2) - \bar{p}_2 = d(0, \bar{s}_2) - \bar{p}_2$ the buyer's contracted share from second period trade. Analogously, the seller's second period payoffs are non-positive, $-\max[\bar{A}_2, 0]$. If buyer's cancellation is wrongful, $s_1 \geq \mu \bar{s}_1$, then the buyer is in breach and the seller is entitled to damages that put her in as good a position as if the buyer had fully conformed to the contract. Had the buyer done so and thus reinstated the contract with $g = 0$, the seller would have delivered s_2 and realized period 2 payoffs of $B(s_2, \bar{s}_2, \theta) = -c(s_2, \theta) + \bar{p}_2 - d(s_2^d, \bar{s}_2)$. Thus, the buyer's period 2 payoffs are $-\max[B(s_2, \bar{s}_2, \theta), 0]$, while the seller's amount to $\max[B(s_2, \bar{s}_2, \theta), 0]$.

By the full-compensation assumption, the buyer is indifferent between acceptance of non-tendered goods and rightful cancellation as long as $\bar{A}_2 \geq 0$, because $v(s_2) - \bar{p}_2 + d(s_2^d, \bar{s}_2) = d(0, \bar{s}_2) - \bar{p}_2$. In the case of rejection of an already tendered good, we argued that the seller would be able to "bribe" the buyer into non-rejection.. This conventional wisdom of breaking a tie for simultaneous move situations is not feasible, however, as to the decision over g. Given the sequential nature of our setting with no communication by the seller between periods $t = 1$ and $t = 2$ and personal encounters in $t = 1$ and $t = 2$, the seller would have to "bribe" the buyer with an infinitesimally small payment z in period $t = 1$ into favorably breaking the tie in $t = 1.5$. If we assume such an agreement to be non-contractible, then the seller will not have an incentive

[27]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 in the first place. Hence, we rule out the cure provision for this analysis.

to bribe, nor will the buyer be "bribable." To see this, consider two cases: (i) If the seller delivers $s_1 < \mu\bar{s}_1$, she anticipates the buyer's second period indifference and offers some positive payment z. The buyer accepts and agrees to reinstate the contract in $t = 1.5$. At his decision stage, however, the seller's upfront tie-breaking payment does not affect the buyer's decision. The buyer will keep z for any g. The seller then anticipate the buyer's possible defection and will not "bribe" him to begin with. (ii) Suppose that the seller promises the buyer a payment z in $t = 2$ if the latter favorably breaks the tie in $t = 1.5$. If the buyer does indeed choose $g = 0$ in $t = 1.5$, then the seller will have an incentive not to pay z in $t = 2$ and defect from her announcement. This is because the buyer has already communicated his reinstatement and the seller's announcement is not enforceable. Anticipating the seller's defection, the buyer will not rely on the seller's promise and the z will not affect his strategy. Again, this results in indifference at $t = 1.5$ and does not resolve the problem.

The conventional wisdom and "standard" maximization do thus not provide a tie-breaking rule for the buyer's indifference at stage $t = 1.5$. Without sacrificing rationality, Nalebuff and Shubik (1988) study how emotional considerations as an answer to indifference may extend the "modeller's toolkit." They view emotions as a "lexicographic concern, entering only when standard optimization leaves the optimal response indeterminate" (p. 10). Revenge, retaliation or pride may play a strategic role and determine how to break the indifference if sole payoff maximization does not give a definite answer. In an empirical study on business relationships, Macaulay (1963) argues in a similar way. Emotions may generally affect business parties' decisions. If for instance, a buyer is "dissatisfied" (p. 63) or if he feels that the seller's performance has made him "appear foolish or has been the victim of fraud or bad faith", cancellation may be seen as a means "to get even" (p. 66). If such an impact on decisions does not interfere with a party's payoff maximization, then Nalebuff and Shubik's (1988) requirement of "lexicographic concern" is met. For our analysis we assume the buyer to be a "lexicographic maximizer", which implies that he will maximize his payoffs up to a tie and break it along weaker than fully rational lines.

We shall more generally refer to revenge, retaliation, pride, randomization or some other reason simply as limited credibility or commitment. As will be shown, it is in the buyer's interest to make the seller believe that in case of indifference he will anticipatorily accept the second period installment with a probability of one. We assume that the seller's anticipation of the buyer's behavior is subject to the buyer's credibility, that is his capability to *ex-ante* commit to his contractual engagement. The seller's beliefs may be driven by empirical observations, by business experience or the buyer's behavior in previous encounters. As suggested by Simon and Zame (1990; p. 683), such a tie-breaking rule—as well as its anticipation—may be viewed as a "a statistic summarizing actions taken by unseen agents" who are not explicitly modeled. This means that, given indifference at some stage, if the seller has observed a tie to be broken towards cancellation, either by a third party or the buyer in a previous business relationship, then the seller's anticipation, too, may be biased towards cancellation with positive probability.

We thus assume that in case of indifference, the buyer has *perturbed commitment* and will cancel the contract with an "error" probability denoted by ϵ which is predetermined and known to both parties.

Definition 3 (Perturbed commitment)**.** *$Pr\left(g = 1 \mid s_1 < \mu\bar{s}_1, \bar{A}_2 \geq 0\right) = \epsilon$, i.e. if the buyer is indifferent with respect to his action space G, then he will cancel with constant probability $\epsilon \in E \equiv [0,1]$ $\forall\theta, s_1$ with common prior.*

The constant tie-breaking rule in Definition 3 is predetermined and prevails for all θ and s_1. As emphasized by Jackson, Simon, Swinkels, and Zame (2002), however, such rules may also be endogenously determined as part of the equilibrium solution. We will therefore also consider a *state-contingent* as well as an *endogenous* tie-breaking rule with predetermined thresholds. We assume that the buyer *ex-ante* communicates the thresholds for θ and s_1 that determine whether he will cancel or reinstate the contract. Notice that this approach slightly relaxes the aforementioned credibility restriction. We still assume that the buyer cannot commit not to cancel, but he can credibly announce thresholds θ^ϵ and s_1^ϵ.

Definition 4 (Contingent and endogenous tie-breaking)**.** *If $s_1 < \mu\bar{s}_1$ and $\bar{A}_2 \geq 0$ and the buyer indifferent with respect to his action space G he will announce*

1. *the threshold θ^ϵ such that his* state-contingent *tie-breaking rule $\epsilon(\theta)$ is equal to*

$$\epsilon(\theta) = \begin{cases} 1 & \text{if } \theta < \theta^\epsilon \\ 0 & \text{otherwise;} \end{cases} \tag{3}$$

2. *the threshold s_1^ϵ such that his* endogenous *tie-breaking rule $\epsilon(s_1)$ is equal to*

$$\epsilon(s_1) = \begin{cases} 1 & \text{if } s_1 < s_1^\epsilon \\ 0 & \text{otherwise.} \end{cases} \tag{4}$$

As becomes clear in the next section, Definitions 3 and 4 are crucial to the analysis and drive the results for this installment contract model that otherwise is based on a "perfect world." We will see that the legal default rule interacts with the buyer's perturbed commitment and in equilibrium may lead to a Pareto-improvement. Figure 1 depicts the time line of the model's structure. The *threshold of substantial conformity* μ and the *buyer's commitment type* ϵ (or thresholds θ^ϵ and s_1^ϵ) are communicated and observed by both parties. Before observing productivity type θ, they agree upon a simple fixed-price fixed-quantity contract for the first and second installment. At $t = 1$ the seller delivers s_1, which triggers the buyer's cancellation decision in $t = 1.5$. Finally, the seller decides over her second period performance s_2.

4 Buyers with perturbed commitment

Generally, the reasons for entering installment contracts may be manyfold. In this paper 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. The efficiency properties of expectation damages in one-stage models without relationship-specific investment and with discrete as well as continuous choice sets have been well analyzed in the literature[28]; so have open-quantity long-term contracts (e.g. Masten and Crocker, 1985; Goldberg and Erickson, 1987; Joskow, 1990; Crocker and Masten, 1991). Here, we look at multi-stage fixed-price, fixed-quantity contracts as we frequently observe them in business.

We solve the proposed model by backward induction to determine parties' subgame perfect equilibrium strategies in this three-stage model. Given the tie-breaking rules from Definitions 3 and 4 we study the effects of the substantial impairment requirement on parties' *ex-post* behavior and the *ex-ante* quantity and price provisions of contract $\mathcal{I}$. The model is first analyzed applying the constant "error" probability ϵ to establish the basic effects of limited commitment. Building upon these results we then argue that the proposed *contingent* and *endogenous* tie-breaking rules yield qualitatively equivalent results.

At the last stage of the game in period $t = 2$, the seller decides over her second period performance $s_2 = \sigma_2(g, \theta)$ given the buyer's cancellation decision g and her productivity θ. If the buyer decides to accept future deliveries and $g = 0$, then the seller gets the chance to perform and delivers s_2 to maximize her second period payoffs $B(s_2, \bar{s}_2, \theta) = \bar{p}_2 - c(s_2, \theta) - d\left(s_2^d, \bar{s}_2\right)$. Since $d\left(s_2^d, \bar{s}_2\right) = 0$ for any $s_2 \geq \bar{s}_2$ and the production costs increasing s_2, the seller will not deliver more—or a good of better quality—than is stipulated by the contract.

Let $\theta^*(\bar{s}_2)$ be the seller's productivity type for which delivery of $\bar{s}_2$ is first best such that $\sigma_2^*(\theta^*(\bar{s}_2)) = \bar{s}_2$. Hence, if $\bar{s}_2$ is such that there are productivity types θ for which over-performance is efficient with $\sigma_2^*(\theta) > \bar{s}_2$ and $w(\sigma_2^*(\theta), \theta) > w(\bar{s}_2, \theta)$, then the set of sellers performing inefficiently low at the top end of the type space is non-empty. We denote this set by $\overline{\Theta}(\bar{s}_2) \equiv [\theta^*(\bar{s}_2), 1] \subseteq \Theta$. Edlin (1996; p. 102) has defined a contract over as large a quantity as is efficient to trade a *Cadillac contract*. We denote such a *Cadillac* quantity or quality provision by $\bar{s}_i^{\mathcal{C}} = \sigma_i^*(1)$ for $i = 1, 2$.

The seller maximizes $B(s_2, \bar{s}_2, \theta) = \bar{p}_2 - c(s_2, \theta) - d\left(s_2^d, \bar{s}_2\right) = w(s_2, \theta) - \bar{A}_2$, which is the period 2 joint surplus $w(s_2, \theta)$ minus the buyer's contracted share, constant $\bar{A}_2 = v(\bar{s}_2) - \bar{p}_2$. If the seller does not get to perform in $t = 2$, $\sigma_2(1, \theta) = 0$. If, however, $g = 0$ then by equation (1) the seller's performance is equal $\sigma_2^*(\theta)$ for $\theta \leq \theta^*(\bar{s}_2)$ and $\bar{s}_2$ $\forall \theta > \theta^*(\bar{s}_2)$. We can thus denote her period 2 strategy as

$$\sigma_2(g, \theta) \equiv \begin{cases} 0 & \text{if } g = 1 \\ \arg\max\limits_{s_2 \leq \bar{s}_2} B(s_2, \bar{s}_2, \theta) = \begin{cases} \sigma_2^*(\theta) & \text{if } \theta \notin \overline{\Theta}(\bar{s}_2) \\ \bar{s}_2 & \text{if } \theta \in \overline{\Theta}(\bar{s}_2) \end{cases} & \text{if } g = 0. \end{cases} \tag{5}$$

Her realized second period payoffs in case of performance are then given as $\max\limits_{s_2 \leq \bar{s}_2} B(s_2, \bar{s}_2, \theta) = B(\sigma_2(g, \theta), \bar{s}_2, \theta)$. $\sigma_2(g, \theta)$ is the seller's optimal response to the buyer's cancellation decision $g \in G$ given θ.

[28]See footnote 23.

If at $t = 1.5$ the buyer rightfully cancels the contract, his period 2 payoffs are equal a non-negative transfer $\max[v(\bar{s}_2) - \bar{p}_2, 0]$ from the seller whose payoffs are thus non-positive, $-\max[v(\bar{s}_2) - \bar{p}_2, 0]$. If, however, cancellation is wrongful, then the buyer is in breach and compensates the seller for her lost profits that she would have made otherwise. The buyer's second period payoffs from performance are $-\max[B(\sigma_2(0,\theta), \bar{s}_2, \theta), 0]$ while the seller's are $\max[B(\sigma_2(0,\theta), \bar{s}_2, \theta), 0]$. The buyer observes s_1 and θ and anticipates these period 2 payoffs when deciding over $g \in G$. He chooses to cancel the contract with a probability of one if the payoffs accruing from cancellation are strictly greater than the ones he will obtain upon reinstatement with $g = 0$; and vice versa. Because the buyer is fully compensated for any non-conformity of the seller's period 1 performance for all $g \in G$, his payoffs from the first installment are constant, $\bar{A}_1 = v(\bar{s}_1) - \bar{p}_1$, and therefore determined by the contract. He then chooses g such that his period 2 payoffs are maximized. We distinguish between two cases. (i) Given $s_1 \geq \mu\bar{s}_1$, because cancellation of the contract is wrongful and triggers the seller's claim or damages, the buyer's second period payoffs from $g = 0$ and partial damage payments are strictly greater than from $g = 1$ and full damage payments for all positive θ,

$$v(\bar{s}_2) - \bar{p}_2 > -\max\left[w(\sigma_2(0,\theta), \theta) - v(\bar{s}_2) + \bar{p}_2, 0\right]. \tag{6}$$

This implies that, unless $\theta = 0$, the strict inequality in (6) holds for any s_1 or μ and the buyer will always prefer $g = 0$ over $g = 1$. This is because $w(\sigma_2(0,\theta), \theta) > 0$ for any positive θ. For $\theta = 0$ he will be indifferent if $v(\bar{s}_2) < \bar{p}_2$. Because any θ if of mass zero and $f(0) = 0$, the buyer strictly prefers continuation of the contract relationship over cancellation with a probability of one. Thus, if the the first period performance does not substantially impair the buyer's valuation of the whole contract, and no cancellation option given by law, the buyer will choose $g = 0 \; \forall\theta$.

(ii) If on the other hand $s_1 < \mu\bar{s}_1$, rendering the first installment substantially impairing, the buyer can rightfully cancel the contract. We can see that his payoffs for $g = 0$ are weakly smaller than for $g = 1$,

$$v(\bar{s}_2) - \bar{p}_2 \leq \max\left[v(\bar{s}_2) - \bar{p}_2, 0\right]. \tag{7}$$

Hence, the buyer will never strictly prefer the LHS over the RHS and thus never choose $g = 0$ with a probability of one. If $v(\bar{s}_2) < \bar{p}_2$ we see that the buyer is strictly better off by choosing $g = 1$, implying that he will never continue the contract relationship if his second period payoffs from the contract are negative. For a contract such that the buyer's valuation of the second period performance is at least as high as the price he has to pay for this installment, $v(\bar{s}_2) \geq \bar{p}_2$, he will be indifferent between cancellation and continuation of the contract. The buyer's participation constraint in the second period is thus given as

$$v(\bar{s}_2) \geq \bar{p}_2. \tag{8}$$

As we have emphasized before, if such an indifference prevails at any stage of the model, the way the tie-breaking or lexicographic rule looks like will be decisive for the equilibrium outcome. To be precise, the form of the tie-breaking rule will be part of the parties' equilibrium strategies. We assume the buyer to "suffer" from *perturbed commitment* as defined in Definition 3. This means that the seller's anticipation of the buyer's period $t = 1.5$ cancellation decision $\gamma : S \times M \times E \to \Gamma \equiv [0,1]$, $G \subseteq \Gamma$ does not only depend on the substantial impairment requirement and the seller's first period performance, but also on how she expects the buyer to be able to commit to the contract. Given μ and ϵ, $\gamma(s_1, \mu, \epsilon)$ is the buyer's best response to the seller's first period performance $s_1 = \sigma_1(\mu, \epsilon, \theta)$; his period $t = 1.5$ strategy is denoted by

$$\gamma(s_1, \mu, \epsilon) = \begin{cases} 0 & \text{if } s_1 \geq \mu \bar{s}_1 \\ \epsilon & \text{if } s_1 < \mu \bar{s}_1, \bar{A}_2 \geq 0 \\ 1 & \text{if } s_1 < \mu \bar{s}_1, \bar{A}_2 < 0, \end{cases} \tag{9}$$

This results in buyer's second period payoffs evaluated at $t = 1$ of

$$\Phi_2(s_1, \mu, \epsilon) = (1 - \gamma(s_1, \mu, \epsilon)) [v(\bar{s}_2) - \bar{p}_2] + \gamma(s_1, \mu, \epsilon) \max [v(\bar{s}_2) - \bar{p}_2, 0]. \tag{10}$$

We can see that unless $\bar{A}_2 < 0$, the buyer will always get his in-contract payoffs $\bar{A}_2 = v(\bar{s}_2) - \bar{p}_2$. Only for a negative $\bar{A}_2$ and $s_1 < \mu \bar{s}_1$ will he in equilibrium cancel the contract with probability $\gamma(s_1, \mu, \epsilon) = 1$ and receive damage payments of $\max[v(\bar{s}_2) - \bar{p}_2, 0] = 0$. Analogously, the seller's second period payoffs evaluated at $t = 1$ are

$$\Psi_2(s_1, \mu, \epsilon, \theta) = (1 - \gamma(s_1, \mu, \epsilon)) B(\sigma_2(0, \theta), \bar{s}_2, \theta) - \gamma(s_1, \mu, \epsilon) \max[v(\bar{s}_2) - \bar{p}_2, 0]. \tag{11}$$

From equation (11) we can see that even if valuation and cost functions are assumed to be time-separable, the seller's decision will still exhibit inter-temporal effects. For non-zero ϵ and μ, the expected cancellation incidence $\gamma(s_1, \mu, \epsilon)$ will be positive for some s_1. The seller's second period payoffs are therefore a function of her first period performance s_1. As a matter of fact, $\Psi_2(s_1, \mu, \epsilon, \theta)$ is constant for all s_1 but a discontinuity at $s_1 = \mu \bar{s}_1$, with a discrete increase of $\epsilon w(\sigma_2(0, \theta), \theta) > 0$ for $\bar{A}_2 \geq 0$, $\epsilon > 0$, and $B(\sigma_2(0, \theta), \bar{s}_2, \theta) = w(\sigma_2(0, \theta), \theta) - \bar{A}_2 > 0$ for $\bar{A}_2 < 0$. For $\epsilon = 0$, the seller's decision problem is time-separable and $\Psi_2(s_1, \mu, 0, \theta) = B(\sigma_2(0, \theta), \bar{s}_2, \theta)$ as long as the buyer's participation constraint in equation (8) is satisfied. Moreover, if the substantial impairment requirement is such that a non-conformity of the first performance never materially breaches the entire contract, then $\gamma(s_1, 0, \epsilon) = 0$ for all $s_1 \geq 0$, ϵ and $\bar{A}_2$. As a result, $\Psi_2(s_1, 0, \epsilon, \theta) = B(\sigma_2(0, \theta), \bar{s}_2, \theta)$ is independent of s_1.

Any positive ϵ and μ will result in the seller's first period decision to exhibit inter-temporal effects in equilibrium. Following from backward induction, at $t = 1$ the seller anticipates the effects of her first period performance on $g(s_1, \mu, \epsilon)$, $\Phi_2(s_1, \mu, \epsilon)$, and $\Psi_2(s_1, \mu, \epsilon, \theta)$ and decides over her first period performance s_1 given μ, ϵ, and θ. We assume that θ is observed upon the start of production. This means that $\bar{s}_1$ cannot be renegotiated as soon as θ is known and s_1 produced. Observe that since costs are increasing in s_1 and $d\left(s_1^d, \bar{s}_1\right) = 0$ for any $s_1 \geq \bar{s}_1$, the seller will never perform above and beyond her contractual obligation $\bar{s}_1$. She performs

$s_1 = \sigma_1(\mu, \epsilon, \theta)$ such that

$$\sigma_1(\mu, \epsilon, \theta) \equiv \arg\max_{s_1 \leq \bar{s}_1} B(s_1, \bar{s}_1, \theta) + \Psi_2(s_1, \mu, \epsilon, \theta) \tag{12}$$

where $B(s_1, \bar{s}_1, \theta) = w(s_1, \theta) - \bar{A}_1$. Recall that the first best solution for installment s_1 is characterized by the first order condition in equation (1). The first order condition of the seller's maximization problem in equation (12), however, is given as

$$\frac{\partial v(s_1)}{\partial s_1} - \frac{c(s_1, \theta)}{\partial s_1} + \frac{\partial \Psi_2(s_1, \mu, \theta)}{\partial s_1} \overset{!}{=} 0. \tag{13}$$

Since $\Psi_2(s_1, \mu, \epsilon, \theta)$ is a function of s_1 with a positive discontinuity at $s_1 = \mu\bar{s}_1$, the seller's strategy for the first performance $\sigma_1(\mu, \epsilon, \theta)$ is first best only for a subset of Θ. To see how this inter-temporal effect of s_1 on the parties' second period payoffs distorts $\sigma_1(\mu, \epsilon, \theta)$, let productivity $\theta^*(\mu\bar{s}_1)$ be the productivity type for which the delivery of $\mu\bar{s}_1$ is first best such that $\sigma_1^*(\theta^*(\mu\bar{s}_1)) = \mu\bar{s}_1$. Thus, for any type $\theta < \theta^*(\mu\bar{s}_1)$ the *ex-post* efficient performance is below the threshold of substantial conformity, $\sigma_1^*(\theta) < \mu\bar{s}_1$. A myopic seller, being ignorant of the effects of her first period performance on the buyer's behavior, will indeed deliver the first best. For a sophisticated seller, who understands the effects of her performance on the buyer's incentives, it may be worthwhile, however, to deliver $\sigma_1(\mu, \epsilon, \theta) \geq \mu\bar{s}_1$ even if a non-conforming tender $\sigma_1^*(\theta) < \mu\bar{s}_1$ is first best. This will exactly be the case if for the first installment the seller's excessive costs of substantial conformity beyond the first best are lower than the second period gains from substantial conformity.

We denote these excessive costs of substantial conformity beyond the first best by the negative difference between a type θ seller's first period payoffs for a substantially conforming performance $\mu\bar{s}_1$ and the (time-independent) first best performance $\sigma_1^*(\theta')$, $\Delta_B(\theta) \equiv -\big(B(\mu\bar{s}_1, \bar{s}_1, \theta) - B(\sigma_1^*(\theta), \bar{s}_1, \theta)\big)$. The second period gains from substantial conformity even if $\sigma_1^*(\theta) < \mu\bar{s}_1$ are defined as $\Delta_\Psi(\theta) \equiv \Psi_2(\mu\bar{s}_1, \mu, \epsilon, \theta) - \Psi_2(\sigma_1^*(\theta), \mu, \epsilon, \theta)$.

In the previous section we have assumed that the buyer will never *reject* a tendered good by allowing the seller to "bribe" the buyer into accepting a good if full compensation results in a tie. To assure this for any contract $\mathcal{I}$, we introduce the following first period participation constraint:[29]

$$v(\bar{s}_1) \geq \bar{p}_1. \tag{14}$$

As argued for the buyer's second period participation constraint in equation (7), if the buyer's in-contract payoffs $\bar{A}_1$ are negative, he will not be indifferent between rejection and acceptance but strictly prefer the former and collect damages of zero. Because $\bar{A}_1 \geq 0$ is constant, $\Delta_B(\theta)$ can be simplified to

$$\Delta_B(\theta) \equiv w(\sigma_1^*(\theta), \theta) - w(\mu\bar{s}_1, \theta), \tag{15}$$

[29] This participation constraint satisfies the upfront payment condition in Edlin (1996) for the efficiency of *Cadillac* contracts.

while

$$\Delta_\Psi(\theta,\epsilon) \equiv \begin{cases} \epsilon w(\sigma_2(0,\theta),\theta) & \text{if } \bar{A}_2 \geq 0 \\ w(\sigma_2(0,\theta),\theta) - \bar{A}_2 & \text{if otherwise.} \end{cases} \tag{16}$$

Note that in equation (16) the first line is strictly smaller than the second for all ϵ. A type θ seller will tender a $\sigma_1(\mu,\epsilon,\theta) = \mu\bar{s}_1$ as long as $\Delta_B(\theta) \leq \Delta_\Psi(\theta,\epsilon)$. 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 $s_1 = \sigma_1^*(\theta) \equiv \arg\max_{s_1 \leq \bar{s}_1} w(s_1,\theta) - \bar{A}_1$. The seller will be indifferent if the excessive costs just offset the gains from period two,

$$w(\sigma_1^*(\theta),\theta) - w(\mu\bar{s}_1,\theta) = \Delta_\Psi(\theta,\epsilon). \tag{17}$$

Given $\theta < \theta^*(\mu\bar{s}_1)$, the LHS of equation (17) is strictly positive but decreasing in θ, where by definition $w(\sigma_1^*(\theta^*(\mu\bar{s}_1)),\theta^*(\mu\bar{s}_1)) - w(\mu\bar{s}_1,\theta^*(\mu\bar{s}_1)) = 0$. The RHS is strictly positive and constant for any non-zero ϵ, as can be seen from equation (16). Hence, for a positive ϵ we can identify types $\theta < \theta^*(\mu\bar{s}_1)$ such that $\Delta_B(\theta) < \Delta_\Psi(\theta,\epsilon)$. This implies that with a positive probability a seller $\theta < \theta^*(\mu\bar{s}_1)$ will not perform first best but tender a substantially conforming, inefficient $\mu\bar{s}_1$. Let then the *threshold of substantial conformity* $\hat{\theta}(\mu\bar{s}_1,\epsilon)$ be such that $\Delta_B\left(\hat{\theta}(\mu\bar{s}_1,\epsilon)\right) = \Delta_\Psi\left(\hat{\theta}(\mu\bar{s}_1,\epsilon),\epsilon\right)$. By the above reasoning, we can then conclude that $\hat{\theta}(\mu\bar{s}_1,\epsilon) < \theta^*(\mu\bar{s}_1)$ for $\epsilon,\mu > 0$. This means that there is a non-empty set

$$\widehat{\Theta}(\mu,\epsilon,\bar{s}_1) \equiv \left[\hat{\theta}(\mu\bar{s}_1,\epsilon),\theta^*(\mu\bar{s}_1)\right) \cap \Theta \tag{18}$$

of sellers who inefficiently tender a substantially conforming $\mu\bar{s}_1$. Notice also that as $\Delta_B(\theta)$ is decreasing in θ, any low type $\theta < \hat{\theta}(\mu\bar{s}_1,\epsilon)$ will tender a first best $\sigma_1^*(\theta)$. From equation (17) we further see that sellers of productivity $\theta > \theta^*(\mu\bar{s}_1)$ will also tender a first best installment $\sigma_1^*(\theta)$ up to $\bar{s}_1$, since the LHS is positive and the RHS equal to zero for $\sigma_1^*(\theta) > \mu\bar{s}_1$ and $\Delta_\Psi(\theta,\epsilon) = 0$. Finally, from equation (12) it becomes clear that performing above and beyond $\bar{s}_1$ is not payoff maximizing for the seller. The seller's first period strategy given μ, ϵ and her productivity type θ is then given as

$$\sigma_1(\mu,\epsilon,\theta) = \begin{cases} \sigma_1^*(\theta) & \text{if } \theta < \hat{\theta}(\mu\bar{s}_1,\epsilon) \\ \mu\bar{s}_1 & \text{if } \theta \in \widehat{\Theta}(\mu,\epsilon,\bar{s}_1) \\ \sigma_1^*(\theta) & \text{if } \theta \in [\theta^*(\mu\bar{s}_1),\theta^*(\bar{s}_1)) \\ \bar{s}_1 & \text{if } \theta \in \overline{\Theta}(\bar{s}_1). \end{cases} \tag{19}$$

For a given $\epsilon > 0$ one can interpret the measure of $\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)$ as degree of inefficient behavior resulting from a seller's incentive to substantially comply with the contract. We denote this measure by $F\left(\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)\right) \equiv F\left(\theta^*(\mu\bar{s}_1)\right) - F\left(\hat{\theta}(\mu\bar{s}_1,\epsilon)\right) \leq 1$. This set is increasing in μ and $\bar{s}_1$ for positive ϵ. The effects of the substantial impairment requirement, given buyer's *perturbed commitment*, are summarized in Lemma 1.

Lemma 1. (1) *For non-zero ϵ it holds true that $\frac{\partial F\left(\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)\right)}{\partial\mu} > 0$. The measure of the set of types which induce the seller to perform inefficiently high and tender a substantially conforming* *delivery in order to deprive the buyer of his cancellation option is increasing in* $\mu \in M$*.* (2) *For non-zero* ϵ *and* μ*, it holds true that* $\frac{\partial F\left(\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)\right)}{\partial \bar{s}_1} > 0$ *for all* $\bar{A}_2$*.*

For a proof see the technical appendix. The key result from Lemma 1(1) is the observation that the easier it is for the buyer to rightfully cancel contract $\mathcal{I}$ for substantial impairment of his valuation, the more the seller's first installment s_1 will be distorted away from the first best performance $\sigma_1^*(\theta)$. If $\mu = 0$, then the buyer's strategy is never to cancel, $\gamma(s_1, \mu, \epsilon) = 0$ for all s_1, that means the seller cannot affect the buyer's cancellation decision and thus manipulate her own second period performance by a overly high first period performance. If contract law, however, grants the buyer an option to cancel the contract upon a substantially impairing first delivery, the seller has an incentive to avoid such an option by performing higher than is efficient.[30] The seller's first period decision exhibits the strongest inefficiency for a strict compliance rule with $\mu = 1$. Applying a substantial impairment requirement that is less strict on seller's quality requirements but stricter on buyer's cancellation possibilities decreases the degree of *ex-post* inefficient over-performance. Moreover, in Lemma 1(2) it is shown that the established degree of distortion of seller's incentives does not only increase with the buyer's cancellation option but also with the seller's contracted performance $\bar{s}_1$. Given $\mu > 0$, the higher $\bar{s}_1$, the more likely a seller will *over-shoot* and deliver an inefficient $\mu\bar{s}_1$.

Lemma 1 discusses the seller's *ex-post* performance incentives that directly accrue from the buyer's cancellation option which the seller is trying to avoid. Yet, this result causes the parties to agree upon a contract such that $\bar{s}_1 < \bar{s}_1^{\mathcal{C}}$. This implies that high productivity types will inefficiently *under-perform*, while intermediate types perform beyond what is efficient. To see this, notice that the parties' strategy profiles in equations (5), (9) and (19) are contingent on the parameters μ, ϵ as well the contracted installment vector $\bar{\mathbf{s}}$. The latter is negotiated by the parties at the outset of the game. A simple installment contract $\mathcal{I}$ out of the class of fixed-price, fixed quantity contracts is entered where he quantity provisions $(\bar{s}_1, \bar{s}_2)$ are chosen such that the parties' expected joint surplus $\mathbb{E}W = \mathbb{E}A + \mathbb{E}B$ is maximized. $\mathbb{E}$ is the expectation operator and from equations (10) and (11) we can see that $\mathbb{E}A \equiv \mathbb{E}_\theta\left[\bar{A}_1 + \Phi_2(\sigma_1(\mu,\epsilon,\theta), \mu, \epsilon)\right]$ and $\mathbb{E}B \equiv \mathbb{E}_\theta\left[B(\sigma_1(\mu,\epsilon,\theta), \bar{s}_1, \theta) + \Psi_2(\sigma_1(\mu,\epsilon,\theta), \mu, \epsilon, \theta)\right]$. The joint expected surplus then boils down to

$$\mathbb{E}W \equiv \mathbb{E}_\theta\left[w(\sigma_1(\mu,\epsilon,\theta), \theta) + (1 - \gamma(\sigma_1(\mu,\epsilon,\theta), \mu, \epsilon))\, w(\sigma_2(0,\theta), \theta)\right] \tag{20}$$

with $(\bar{s}_1, \bar{s}_2) \equiv \arg\max_{\bar{\mathbf{s}} \in S^2} \mathbb{E}W$. By the assumption of time-separability the first installment does not enter the decision over the optimal second period installment; both the seller's first period $\sigma_1(\mu,\epsilon,\theta)$ and the buyer's cancellation strategy $\gamma(s_1, \mu, \epsilon)$ are independent of $\bar{s}_2$ up to

[30] We encounter such *over-shooting* by agents in two or more-period settings with asymmetric information where the agent sends signals to the principal. For instance, Landers, Rebitzer, and Taylor (1996) derive and empirically show a "rat-race" equilibrium where associates in law firms work too many hours to increase their probability of promotion. Similarly, Hermalin (2005) in a recent paper on developments in corporate governance finds that CEOs whose employment contract is to be renewed and who face outside competition exert extra effort beyond their usual performance to signal a productivity type that is higher than their true type. As opposed to settings with private information, our analysis does not concern an agent's signaling to the principal, but rather sending such a message to a third party. By substantially conforming to the contract and delivering at least $\mu\bar{s}_1$, the seller signals to the court that she is entitled to protection from the buyer's limited commitment.

the buyer's participation constraint (8). Hence, the contracted optimal second installment is $\bar{s}_2 \equiv \arg\max_{\bar{s}_2 \in S} \mathbb{E}W \equiv \arg\max_{\bar{s}_2 \in S} \mathbb{E}_\theta \left[w\left(\sigma_2\left(0,\theta\right),\theta\right)\right]$ and satisfies the first order condition

$$\frac{\partial \mathbb{E}W}{\partial \bar{s}_2} = \int\limits_{\theta^*(\bar{s}_2)}^{1} \frac{\partial w\left(\bar{s}_2,\theta\right)}{\partial \bar{s}_2} dF\left(\theta\right) \overset{!}{=} 0. \tag{21}$$

$\theta^*\left(\bar{s}_2\right)$ is increasing in $\bar{s}_2$, and since $\frac{\partial w(\bar{s}_2,\theta)}{\partial \bar{s}_2} = 0$ for $\theta = \theta^*\left(\bar{s}_2\right)$ and positive for all $\theta > \theta^*\left(\bar{s}_2\right)$, the condition in equation (21) holds only for $\theta = \theta^*\left(\bar{s}_2\right) = 1$ and $\bar{s}_2 = \bar{s}_2^{\mathcal{C}}$. Hence, there is no type θ for which over-performance as to s_2 is *ex-post* efficient. We can further observe that if $\theta < \hat{\theta}\left(\mu\bar{s}_1,\epsilon\right)$, then by equation (19) we get $\sigma_1\left(\mu,\epsilon,\theta\right) < \mu\bar{s}_1$, yielding $\gamma\left(\sigma_1\left(\mu,\epsilon,\theta\right),\mu,\epsilon\right) = \hat{g}$ by equation (9), where $\hat{\gamma} = \epsilon$ if the buyer's participation constraint is satisfied, $\hat{\gamma} = 1$ otherwise. This implies, that in $t = 2$ the seller will tender $\sigma_2\left(\hat{g},\theta\right) = \sigma_2^*\left(\theta\right)$ with probability $\left(1-\hat{\gamma}\right)$. For any $\theta > \hat{\theta}\left(\mu\bar{s}_1,\epsilon\right)$, by equation (5) we get $\sigma_2\left(\epsilon,\theta\right) = \sigma_2^*\left(\theta\right)$ with a probability of one. Given the seller's period 2 strategy, and let $w_i^*\left(\theta\right) \equiv w\left(\sigma_i^*\left(\theta\right),\theta\right)$ and $W^*\left(\theta\right) \equiv W\left(\sigma_1^*\left(\theta\right),\sigma_2^*\left(\theta\right),\theta\right)$, the expected joint surplus in equation (20) reduces to

$$\begin{aligned} \mathbb{E}W \quad = \quad & \int\limits_{0}^{\hat{\theta}(\mu\bar{s}_1,\epsilon)} \left[w_1^*\left(\theta\right) + \left(1-\hat{\gamma}\right) w_2^*\left(\theta\right)\right] dF\left(\theta\right) + \int\limits_{\hat{\theta}(\mu\bar{s}_1,\epsilon)}^{\theta^*(\mu\bar{s}_1)} \left[w\left(\mu\bar{s}_1,\theta\right) + w_2^*\left(\theta\right)\right] dF\left(\theta\right) + \\ & \int\limits_{\theta^*(\mu\bar{s}_1)}^{\theta^*(\bar{s}_1)} W^*\left(\theta\right) dF\left(\theta\right) + \int\limits_{\theta^*(\bar{s}_1)}^{1} \left[w\left(\bar{s}_1,\theta\right) + w_2^*\left(\theta\right)\right] dF\left(\theta\right). \end{aligned} \tag{22}$$

At the outset of the game the parties will agree upon an equilibrium first installment $\bar{s}_1 = \bar{s}_1\left(\mu,\epsilon\right) \equiv \arg\max_{\bar{s}_1 \in S} \mathbb{E}W$ as function of μ, ϵ and a constant second installment $\bar{s}_2$. The proof of the following Lemma shows that $\bar{s}_1$ is such that it balances the *intra*-period trade-off that arises from inefficiencies for immediate and high productivity types.

Lemma 2. *If $\mu,\epsilon > 0$, then the parties will enter a simple installment contract $\mathcal{I}\left(\mu,\epsilon\right) \equiv \mathcal{I}\left(\bar{s}_1\left(\mu,\epsilon\right),\bar{s}_2,\bar{p}\right)$ with first installment $0 < \bar{s}_1\left(\mu,\epsilon\right) < \bar{s}_1^{\mathcal{C}}$, second installment $\bar{s}_2 = \bar{s}_2^{\mathcal{C}}$, and the buyer's participation constraints (8) and (14) satisfied.*

For $\mu,\epsilon > 0$ we know that $\widehat{\Theta}\left(\mu,\epsilon\right) = \widehat{\Theta}\left(\mu,\epsilon,\bar{s}_1\left(\mu,\epsilon\right)\right) \nsubseteq \emptyset$ since $\hat{\theta}\left(\mu,\epsilon\right) \equiv \hat{\theta}\left(\mu\bar{s}_1\left(\mu,\epsilon\right),\epsilon\right) < \theta^*\left(\mu\bar{s}_1\left(\mu,\epsilon\right)\right)$. At the same time, $\bar{s}_1\left(\mu,\epsilon\right) < \bar{s}_1^{\mathcal{C}}$ implies that $\overline{\Theta}\left(\mu,\epsilon\right) = \overline{\Theta}\left(\mu,\epsilon\right) \nsubseteq \emptyset$. From the seller's strategy in equation (19) it holds true that unless $\widehat{\Theta}\left(\mu,\epsilon\right) = \overline{\Theta}\left(\mu,\epsilon\right) \subseteq \emptyset$, the first period performance will be distorted. Hence, the results from Lemma 2 imply that in equilibrium the seller's first period performance will indeed be distorted for intermediate and high types, where the former exhibit excessive effort while latter perform inefficiently low. In the following Lemma we summarize the parties' equilibrium strategies given parameters μ, ϵ, θ and the second-best contract $\mathcal{I}\left(\mu,\epsilon\right)$.

Lemma 3. *Given μ, ϵ and θ, the parties' subgame perfect equilibrium strategies are*

$$\left(\begin{array}{lcl} \sigma_1^E(\mu,\epsilon,\theta) & = & \begin{cases} \sigma_1^*(\theta) & \text{if } \theta < \hat{\theta}(\mu,\epsilon) \\ \mu\bar{s}_1(\mu,\epsilon) & \text{if } \theta \in \widehat{\Theta}(\mu,\epsilon) \\ \sigma_1^*(\theta) & \text{if } \theta \in [\theta^*(\mu\bar{s}_1(\mu,\epsilon)), \theta^*(\bar{s}_1(\mu,\epsilon))) \\ \bar{s}_1(\mu,\epsilon) & \text{if } \theta \in \overline{\Theta}(\mu,\epsilon) \end{cases}, \\ \sigma_2^E(\mu,\epsilon,\theta) & = & \begin{cases} (1-\epsilon)\sigma_2^*(\theta) & \text{if } \theta < \hat{\theta}(\mu,\epsilon) \\ \sigma_2^*(\theta) & \text{if } \theta \geq \hat{\theta}(\mu,\epsilon) \end{cases} \end{array} \right) \tag{23}$$

for the seller and

$$\left(\gamma^E(\mu,\epsilon,\theta) = \begin{cases} \epsilon & \text{if } \theta < \hat{\theta}(\mu,\epsilon) \\ 0 & \text{if } \theta \geq \hat{\theta}(\mu,\epsilon) \end{cases} \right) \tag{24}$$

for the buyer.

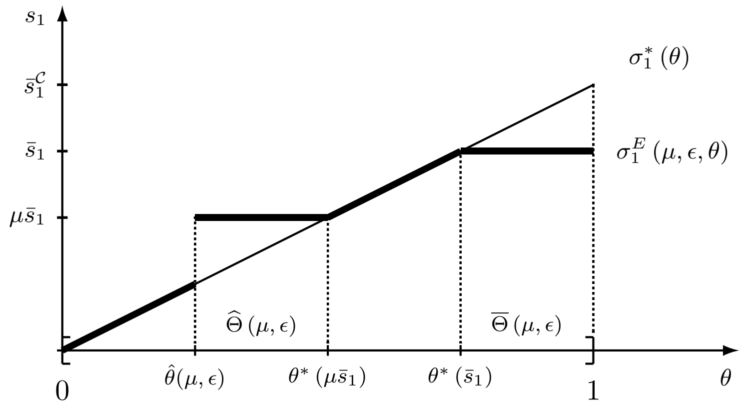
We depict $\sigma_1^E(\mu,\epsilon,\theta)$ in Figure 2. The horizontal segments of $\sigma_1^E(\mu,\epsilon,\theta)$ denote inefficient over- or underperformance, inducing the seller's first period strategy to be discontinuous at $\hat{\theta}(\mu,\epsilon)$ while the first best $\sigma_1^*(\theta)$ is continuous and strictly increasing.

When negotiating $\mathcal{I}$ parties have observed the buyer's commitment type and anticipate the effects of the the seller's period 1 strategy. As we have shown, if the buyer can credibly commit not to cancel the contract, then it is optimal to agree on a *Cadillac* contract $\bar{s}_1^{\mathcal{C}}$ that induces first best performance for all θ. If, however, the buyer's commitment is limited and $\epsilon > 0$, then too high a contract installment $\bar{s}_1$ will give some sellers an incentive to exert excessive performance effort in the first period in order for the buyer not to be able to exercise his cancellation option. This incentive is stronger for larger ϵ since in such a case the probability of second period trade is lower and consequently so are seller's second period payoffs. Lowering the first installment such that $\bar{s}_1$ is not a *Cadillac* induces distortions at the top end of the type space, $\theta \in \overline{\Theta}(\mu,\epsilon,\bar{s}_1)$, because performance above and beyond $\bar{s}_1 < \bar{s}_1^{\mathcal{C}}$ is efficient but not payoff maximizing. She will therefore deliver $\bar{s}_1$ as is her contractual obligation. At the same time, reducing installment $\bar{s}_1$ lowers the probability for the seller to find it optimal to substantially conform to the contract and to deliver an *over-shooting* $\mu\bar{s}_1$. This probability will be zero if $\bar{s}_1 = 0$.

In Lemma 2 we show that there exists no $\bar{s}_1 \in S$ such that both $\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)$ and $\overline{\Theta}(\mu,\epsilon,\bar{s}_1)$ are empty, but parties will choose a $\bar{s}_1$ such that the overall first period distortion is minimized by balancing *under*- and *over*performance to yield a second-best contract. They thus face an *intra*-period trade-off with respect to seller's first period performance since first best performance at the top comes at the cost of inefficient performance at the bottom.

Parties, however, also face an *inter*-period trade-off between first period and second period efficiency. If the seller materially breaches the contract in the first period, then the buyer will cancel the contract with probability ϵ. This loss of second period trade is the source inefficiency which fully comes at the seller's cost. The no-trade probability is minimized for $\bar{s}_1$ such that $\hat{\theta}(\mu\bar{s}_1,\epsilon) = 0$ and $\widehat{\Theta}(\mu,\epsilon,\bar{s}_1) \subseteq \emptyset$. Then $s_1 \geq \mu\bar{s}_1$ for all $\theta \in \Theta$ and probability of no second period trade is $\epsilon\int_0^{\hat{\theta}(\mu\bar{s}_1,\epsilon)} dF(\theta) = 0$. Hence, the parties' second period payoffs are maximized if

Figure 2: Seller's first period equilibrium strategy, $\mu, \epsilon > 0$



$s_2 = \sigma_2^*(\theta)$ for all θ which is true if $\bar{s}_1 = 0$ and $\bar{s}_2 = \bar{s}_2^{\mathcal{C}}$. As argued above, however, the former does not minimize the first period distortions.

Proposition 1. *Let an exogenous tie-breaking rule $\epsilon > 0$ and $\mu > 0$, then a simple installment contract $\mathcal{I}(\bar{s}_1(\mu,\epsilon), \bar{s}_2, \bar{p})$ cannot simultaneously implement the first best for both s_1 and s_2 over Θ, but will trade-off both intra- and inter-period inefficiencies.*

We are considering simple installment contracts that by definition do not exhibit any "memory." This is because the second period payment $\bar{p}_2$ does not depend on earlier outcomes, i.e. the seller's first period performance s_1 (e.g. Fellingham, Newman, and Suh, 1985). Even more, as can be seen from equation (17), the model does not exhibit any history dependence for the case of buyer's full commitment. 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, because for $\epsilon = 0$ the probability of buyer's cancellation is equal to zero, the seller does not have a first period incentive to *rat-race* and legally bind the buyer to the contract. In such a full commitment model both a multi-stage installment contract and a series of sequential one-stage contracts implement the first best for the first and the second period performance. Hence, this implies that there are no gains to a long-term contract and this repeated game can be played myopically (Fellingham, Newman, and Suh, 1985). To see this, notice that we have assumed efficiency to not require any relationship-specific investment at any stage of the game and the first best solution for the second period performance to be independent of the value of the first period performance. Then the parties will maximize the first period expected joint surplus by agreeing upon a non-type contingent *Cadillac* $\bar{s}_1(\mu, 0) = \bar{s}_1^{\mathcal{C}}$ before observing the relationship-specific productivity type θ. At stage 1 the seller will perform $s_1 = \sigma_1^E(\mu, 0, \epsilon) = \sigma_1^*(\theta)\ \forall\theta$ (Lemma 2) and, because θ is publicly observed, the parties agree upon a second period type contingent installment $\bar{s}_2 = \sigma_2^*(\theta)$ which the seller will conform to at stage 2, $s_2 = \sigma_2^E(\mu, 0, \epsilon) = \sigma_2^*(\theta)$. The optimality of the three-stage installment contract for $\epsilon = 0$ is a direct result of Lemmas 2 and 3.

A full-commitment installment contract thus reproduces the single-shot first best solution, and as found by Fellingham, Newman, and Suh (1985) such a multi-stage contract does not yield any gains over the pair of one-stage contracts and interactions among periods play no role (Ogawa, 2006). From the seller's optimal first period performance as given in equation (17) we can conclude that buyer's limited commitment as to the second period trade introduces history dependence even though by the setup the model is history-independent. A positive ϵ induces first and second period performances to exhibit inter-temporal effects that lead to a sub-optimal outcome, as is stated in Proposition 1. The fact that the buyer is not able to fully commit to the second installment does not only *ex-post* harm the seller by a positive probability of no-trade in conjunction with damage payments to the buyer, but also harms the buyer by lowering the parties' expected joint surplus. Put differently, if the seller's first period performance is substantially non-conforming, then *ex-post* the buyer is indifferent between $g = 0$ and $g = 1$ and will with probability ϵ play the latter. The seller anticipates this mixed strategy, and her over-performance from equation (17) leads to the *ex-ante* inefficient result from Proposition 1. Given a constant buyer's share α of the surplus, a smaller pie then implies that the buyer will in total get less. It should thus be in his interest to credibly commit to the contract and not give the seller an incentive to "protect" her second period payoffs by over-performing.

The same implications are also true for the contingent and endogenous tie-breaking rules in equations (3) and (4). If the buyer's credibility restriction is relaxed and he can credibly announce a threshold θ^ϵ that determines whether or not he will cancel the contract, but if at the same time he cannot commit not to cancel the contract with certainty, the seller will still exert excessive effort in the first period. To see this consider the following: A state-contingent tie-breaking rule in equation (3) and the buyer's strategy in equation (9) imply that if he is indifferent and the realized state of nature is below the announced threshold, the buyer will cancel with probability one; if it is above and the seller a "good" supplier, then he will reinstate. This means that the seller's respective threshold of substantial conformity, which determines whether or not $s_1 < \mu\bar{s}_1$, $\hat{\theta}\left(\mu\bar{s}_1, 1\right)$. Suppose $\theta^\epsilon > \hat{\theta}\left(\mu\bar{s}_1, 1\right)$ and $\widehat{\Theta}^\epsilon\left(\mu, \theta^\epsilon, \bar{s}_1\right) \equiv \left[\hat{\theta}\left(\mu\bar{s}_1, 1\right), \theta^\epsilon\right)$. Then there exists a non-empty set $\widehat{\Theta}\left(\mu, 1, \bar{s}_1\right) \cap \widehat{\Theta}^\epsilon\left(\mu, \theta^\epsilon, \bar{s}_1\right)$ of types that will inefficiently perform $s_1 = \mu\bar{s}_1$. If $\theta^\epsilon = \hat{\theta}\left(\mu\bar{s}_1, 1\right)$, then $\widehat{\Theta}^\epsilon\left(\mu, \theta^\epsilon, \bar{s}_1\right)$ is empty, as is the intersection. For such a tailored threshold θ^ϵ there is no seller that will exert excessive effort in the first period. This results in $\sigma_1\left(\mu, \theta^\epsilon, \theta\right) = \sigma_1^*\left(\theta\right)$ for all $\theta^\epsilon < \hat{\theta}\left(\mu\bar{s}_1, 1\right)$. As long as the θ^ϵ is such that the seller does not have an incentive to *over-shoot*, the first period performance will be non-distorted. Notice, however, that for $\epsilon = 1$ equation (17) reduces to $-w\left(\mu\bar{s}_1, \theta\right) = 0$. This means that for $\mu > 0$ there is no type θ such that the equality holds, and $\hat{\theta}\left(\mu\bar{s}_1, 1\right) < 0$. We can thus conclude that unless the buyer can credibly announce $\theta^\epsilon = 0$, there will be a non-empty set of sellers exerting excessive effort in the first period.

One central property of the *state-contingent* tie-breaking rule is the fact that it is independent of the seller's first period performance. The *endogenous* rule from equation (4) on the other hand is a function of the seller's first delivery. In equilibrium, the outcome will be as for $\epsilon\left(\theta\right)$. To see this, notice that if the announced threshold s_1^ϵ is such that $\theta^*\left(s_1^\epsilon\right) = \hat{\theta}\left(\mu\bar{s}_1, 1\right)$, then there is no seller of type $\theta < \theta^*(s_1^\epsilon)$ that will *over-shoot* because for types lower than the threshold of substantial conformity it is not worthwhile doing so.

We again have $\hat{\theta}(\mu\bar{s}_1, 1) < 0$, and let $\hat{\theta}(\mu\bar{s}_1, 1) < 0 \leq \theta^*(s_1^\epsilon) \leq \theta^*(\mu\bar{s}_1)$. Types lower than $\theta^*(s_1^\epsilon)$ will not *over-shoot* to $\mu\bar{s}_1$ in order to avoid the buyer's cancellation, but will deliver at the threshold s_1^ϵ. Types higher than $\theta^*(s_1^\epsilon)$ will not have an incentive to over-perform, but by the endogenous tie-breaking rule, $\sigma_1^*(\theta) > s_1^\epsilon$ ensures that the buyer will not cancel. Hence, we can conclude that the lower the buyer's announcement of s_1^ϵ, the less distorted the seller's first period performance will be. As in the cases of the constant as well as the state-contingent rule and in analogy to Proposition 1, if the buyer cannot fully commit to the second period trade and s_1^ϵ bounded away from zero, the parties will enter a second best contract $\mathcal{I}$.

Lemma 4 (Contingent and endogenous tie-breaking)**.** *Let $\mu > 0$. By Proposition 1, unless the buyer can credibly announce that he will reinstate the contract with certainty for any θ or s_1, the* state-contingent *and* endogenous *tie-breaking rules as defined in equations (3) and (4) will not induce the parties to enter a first best installment contract.*

In the next section we argue that the *substantial impairment requirement* serves as a means to mitigate the distortions presented in Propositions 1 and 4. The discussion is mainly based on the constant tie-breaking rule ϵ, but the implications are also true for $\epsilon(\theta)$ and $\epsilon(s_1)$.

5 Law-induced commitment

The default rule as to the rejection or cancellation of single-shot contracts is a strict compliance standard. If the promisor's performance is not fully conforming to the contract, then the promisee is given the right to accept any commercial unit and reject the rest, subject to the restrictions discussed in the literature section. As argued by Bohlen (1900a; p. 397f), parties in commercial contracts cannot be expected "to accept anything differing in the most minute detail from which they have contracted for." For multi-stage installment contracts the *UCC*, however, restricts the buyer's cancellation option through the substantial impairment requirement. This implies that legal institutions are such that in the given model setting for the analyzed installment contract $\mathcal{I}(\bar{\mathbf{s}}, \bar{p})$ the parameter μ, that denotes the "seriousness of damage suffered by [the aggrieved party]"[31], is strictly less than unity, unless parties explicitly state otherwise in the contract.

For the buyer's period 1.5 decision we have assumed *perturbed commitment* as to the second period trade. This limited commitment with positive cancellation probability ϵ for any $s_1 < \mu\bar{s}_1$, 0 otherwise, lowers the parties' overall surplus. Proposition 1 shows that in the given model environment, a simple fixed-price, fixed-quantity installment contract cannot implement the first best solution if the buyer cannot fully commit to his "promise" of honoring the second period trade. Any $\epsilon > 0$ will therefore impair the parties' expected joint surplus, and lower commitment parameters result in a Pareto-improvement.

[31] *Helgar v. Warner's Features*, cited in Recent Case Notes (1918; p. 698).

Recall that in this context commitment is not to be seen as the opposite of breach of contract, as put in Salanié (2005; p. 162), since by equation (6) the buyer will not breach the contract by canceling if $s_1 \geq \mu\bar{s}_1$. Nor does commitment in favor of second period trade and seller's second period payoffs relate to an altruism argument, because a positive cancellation probability does not only harm the seller, but also lowers the buyer's expected payoffs given a constant bargaining share α. Commitment benefits both parties and it is in their interest to face low cancellation probabilities. This is an immediate consequence of the seller's *ex-interim* second period payoffs $\Psi_2(s_1, \mu, \epsilon, \theta)$ that are determined by her anticipation of the buyer's cancellation decision $\gamma(s_1, \mu, \epsilon)$ in equation (9). The larger this $\gamma(s_1, \mu, \epsilon)$, the smaller $\Psi_2(s_1, \mu, \epsilon, \theta)$ and the more distorted the seller's first period performance $\sigma_1(\theta)$ given by equation (17) will be. For an exogenously given $\epsilon > 0$ we can see that $\gamma(s_1, \mu, \epsilon)$ increases with μ. This means that by relaxing the strict compliance with $\mu = 1$ (as for instance argued in the common law case *Norrington v. Wright*) and stipulating as default rule the substantial impairment requirement with $\mu < 1$ (as for instance in *Helgar v. Warner's Features*), the law provides a credible commitment device to substitute for the buyer's own lack of commitment. This *legal commitment* will improve the overall outcome of the contract as implied by the results in the previous section. We have argued before that positive μ and ϵ induce history dependence through their effect on $\gamma(s_1, \mu, \epsilon)$. A stricter cancellation option reduces this history dependence by binding the buyer to the contract and forcing him to accept delivery differing in non-minute detail from the contracted provisions. This lowers the seller's incentive to over-perform in period 1 and thus decreases the overall distortion. Hence, the substantial impairment requirement protects the seller from buyer's reckless cancellation, but foremost protects the buyer himself from his own lack of commitment. The result is summarized in the following Proposition 2. The proof follows straight from Lemmas 2 and 3 and Proposition 1 and is presented in the technical appendix.

Proposition 2 (A legal commitment device)**.** *If the buyer cannot fully commit not to exercise his cancellation option in case of seller's substantial non-conformity in the first period, then strict compliance in simple installment contracts is wasteful because it distorts seller's first period performance incentives. The substantial impairment requirement mitigates the buyer's commitment problem which leads to a Pareto-improvement.*

One of the key implications of this analysis is the observation, that the stricter the buyer's cancellation option, the better the overall outcome will be. Given a sharing rule with a constant buyer's share of α, this restriction leads to a Pareto-improvement as shown in the Proposition. This is because the buyer does not cancel the contract based on rent-seeking motives to improve his payoffs *ex-post*, but rather for "erroneous" reasons. Constraining his second period behavior by the substantial impairment requirement leaves his second period *ex-ante* and *ex-post* payoffs unaffected, but improves his first period payoffs. Analogously, the seller does not over-perform due to rent-seeking but rather "rent-protecting" reasons to "correct" the buyer's anticipated error.

The substantial impairment requirement for cancellation of the whole contract is given as "tailored" default rule (Ayres and Gertner, 1989; p. 91). As Masten (2000; pp. 33f) puts it, "[i]ndefinite contracts that use terms such as [...] 'substantial performance' to describe contractual obligations leave the parameters of acceptable performance ultimately to the courts" and "specify definite performance obligations" only "to reduce the cost or inaccuracy of [such] court ordering." Courts, however, have accepted this questions to be a matter of fact and have found a considerable range of values for the degree of non-conformity to be substantially impairing. We have assumed that parties agree upon the simplest contract specifying for each period only the quantity traded and the monetary transfers that split the expected surplus according to (α, β). Given empirical evidence, this assumption may not be implausibly strong. Macaulay (1963; p. 60) concludes in his study on relations in business that "many, if not most, exchanges reflect no planning, or only a minimal amount of it, especially concerning legal sanctions and the effect of defective performances." This observation indeed suggests that business partners often rely on the default rules given by law rather than bargain over and contract their own express terms. Restricting the class of contracts allows us to analyze whether or not such simple installment contracts implement the first best solution. We can conclude that given $\gamma(s_1, \mu, \epsilon) > 0 \ \forall s_1 < \mu \bar{s}_1$ the outcome will be second best with lower μ inducing Pareto-improvements as shown in Propositions 1 and 2. This implication grants the court as third party enforcer a somewhat strategic role. Recall that parties at $t = 0$ take the substantial impairment parameter μ as given, deduced from exogenous precedents. By *ex-ante* "setting" μ appropriately, courts or lawmakers can indeed interact and induce Pareto-improvements.

To conclude the analysis, we relax the assumption of a simple fixed price, fixed quantity contract for a moment and consider the parties' choice of μ if it were contracted.[32] Given the buyer's limited commitment $\epsilon > 0$, then $\gamma(s_1, \mu, \epsilon) > 0$ for any positive μ. From Proposition 1 we know that any positive $\gamma(s_1, \mu, \epsilon)$ will lead to the seller's first period over-performance and to an *ex-ante* inefficient $\mathcal{I}(\bar{\mathbf{s}}, \bar{p})$. If, however, $\gamma(s_1, \mu, \epsilon) = 0 \ \forall s_1$, then $\sigma_1(\mu, \epsilon, \theta) = \sigma_1^*(\theta)$ in equation (17), $\overline{\Theta}(\bar{s}_1, \mu, \epsilon)$ and $\widehat{\Theta}(\bar{s}_1, \mu, \epsilon)$ empty sets and $\mathcal{I}\left(\bar{s}_1^{\mathcal{C}}, \bar{s}_2^{\mathcal{C}}, \bar{p}\right)$ first best. Since by Lemma 2 the first period installment $\bar{s}_1$ is strictly positive for any μ, $\gamma(s_1, \mu, \epsilon) = 0$ only for $\mu = 0$. This implies that if parties can contract μ they will do so such that it induces $\mathcal{I}(\bar{\mathbf{s}}, \bar{p})$ to be first best which is obtained for $\mu^* = 0$. Notice that in the case of full commitment, any μ will do so.

Lemma 5 (Full commitment)**.** *If μ contractible, then $\bar{\mu} = \mu^* = 0$ such that there exists a simple installment contract $\mathcal{I}(\bar{\mathbf{s}}, \bar{p}, \bar{\mu})$ with $\bar{\mathbf{s}} = \left(\bar{s}_1^{\mathcal{C}}, \bar{s}_2^{\mathcal{C}}\right)$ that implements the first best solution $\left(\sigma_1^*(\theta), \sigma_2^*(\theta)\right)$ over Θ for all ϵ.*

Given the sharing rule (α, β) the parties can maximize their payoffs by minimizing the degree of history dependence. It is easy to see that under the assumptions of the model it is optimal not to enter an installment contract at all. If technology restrictions require goods s_1 and s_2 to be produced sequentially, the parties can enter an incomplete contract over $\bar{s}_1$ in period 0. We assume that the buyer does not wastefully reject a delivered good but accept and sue for expectation damages. This contract provision $\bar{s}_1$ will be equal to the first installment in $\mathcal{I}$ under

[32] As brought forward by the transaction cost argument of incomplete contract, this will be the case if the contracting costs of μ are lower than the efficiency gains from second to first best.

history independence, $\bar{s}_1 = \bar{s}_1^{\mathcal{C}}$. Hence, the seller's performance will be non-distorted. After the first delivery and realization of θ, parties can meet again and agree to trade a type-contingent $\bar{s}_2(\theta) = \sigma_2^*(\theta)$. As argued earlier, as long as $\alpha > 0$ and the buyer will agree to the trade with probability 1 as long as $\alpha > 0$ and the buyer strictly prefers the second period trade over his default option with value zero, the parties will trade with a probability of one. This implies that the overall outcome is first best over Θ for all $\alpha > 0$ as is the result for installment contracts with full commitment and $\gamma(s_1, \mu, \epsilon) = 0$.

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 to the second period trade, that means if they cannot make sellers believe that they will break the tie at period $t = 1.5$ with certainty, then the promisor will want to avoid the detrimental payoffs from buyer's cancellation 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.

It is important to acknowledge that the given model setup has its caveats and does not allow for any 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.

We have indicated before that abstracting from renegotiation is without loss of generality. While in a setup *without* renegotiation the substantial impairment requirement serves as a commitment device that binds an indifferent buyer to the second period trade, in a situation *with* renegotiation it reduces the buyer's *ex-post* bargaining leverage. This is the case because a strict compliance rule gives the buyer the chance to threat cancellation of the whole contract and *hold up* the seller in *ex-post* bargaining over the contract. A substantial impairment requirement, on the other hand, binds the buyer to the existing contract and renders his cancellation threat non-credible. This *legal hold-up* is minimized for a rule that does not allow the buyer to cancel for any non-conformities of a delivery. The effects of a setup with *ex-post* renegotiation are thus qualitatively equivalent to the results we obtain in this paper. The *legal hold-up*, however, is of rather unusual kind. In such a multi-period setup with breach remedies as to delivered and non-delivered installments (the buyer may cancel the contract upon delivery of an early installment and be compensated for the damages associated with the whole contract) the buyer's bargaining leverage does not result from seller's relationship-specific investment, which has little or no value outside the contract relationship. In the given setting, the seller is rather held up by her obligations with respect to *due* installments. This means she does not "protect" the value of her *ex-ante* investment but rather her future trade surplus.

The following two notes suggest extensions to this model and directions for broadening the underlying research program.

Note 1: Recall that the optimal substantial impairment parameter μ^* is equal to zero. An immediate extension of the present analysis is the introduction of a third party supplier (with non-correlated productivities of the two sellers). Given under-compensatory damages (either by burden-of-proof costs (e.g. Hay and Spier, 1997) or an erroneous judiciary) and renegotiation of the contract it can be shown that the optimal parameter μ^* is an interior solution strictly greater than zero. To see this, consider the following: If the buyer and first seller experience a very low productivity type, then in expectations (the project-specific productivity type is observed after a contract is entered) the alternative seller's type is likely to be higher and trade with this third party supplier efficient. From the present paper and the argument brought forward for a setting with renegotiation we know that under a strict compliance rule the seller will *over-shoot* to prevent the buyer from cancellation. The lower the parameter μ, the smaller this distortion will be. At the same time, however, the introduction of the third party supplier implies that from an efficiency point of view we indeed would like the buyer to cancel for very low initial productivity types. This gives rise to two counteracting effects and suggests the optimal μ^* to be an interior solution. Moreover, the extended setup will allow us to look at the issue of "cover" in more detail (see for instance Jackson, 1978): *UCC* §2-712 stipulates that if the buyer trades with an alternative seller, the resulting payoffs will reduce the initial seller's damage payments. There exists, however, no duty for the buyer to mitigate his damages and minimize the first seller's compensations.

Note 2: 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 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. To see how under the model assumptions of *Note 1* the substantial impairment requirement interacts with such bunching equilibria will considerably enrich the implications of the analysis and help understand the mechanics of default rules for finite multi-period "standing relations."

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A Technical Appendix

Proof of Lemma 1

We know that $\theta^*(\mu\bar{s}_1) \geq \hat{\theta}(\mu\bar{s}_1,\epsilon)$ for any μ and ϵ, where $\widehat{\Theta}(0,\epsilon,\bar{s}_1) \subseteq \emptyset$ with $\theta^*(\mu\bar{s}_1) = \hat{\theta}(\mu\bar{s}_1,\epsilon)$ for $\mu = 0$ and strictly greater for any non-zero μ, ϵ. Notice that $w(\sigma_1^*(\theta),\theta) = w(\sigma_2^*(\theta),\theta)$, hence for $\bar{A}_2 \geq 0$ equation (17) is equal to $(1-\epsilon)\,w(\sigma_1^*(\theta),\theta) - w(\mu\bar{s}_1,\theta) = 0$.

(1): To establish $\frac{\partial F\left(\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)\right)}{\partial\mu} > 0$ we need to show that $\frac{\theta^*(\mu\bar{s}_1)}{\partial\mu} > \frac{\hat{\theta}(\mu\bar{s}_1,\epsilon)}{\partial\mu}$ for any $\epsilon > 0$.

(i) Let $\bar{A}_2 \geq 0$ and $\epsilon = 0$. Then $\theta^*(\mu\bar{s}_1) = \hat{\theta}(\mu\bar{s}_1,0)$ and $\frac{\partial\theta^*(\mu\bar{s}_1)}{\partial\mu} = \frac{\partial\hat{\theta}(\mu\bar{s}_1,0)}{\partial\mu}$ as is straightforward from equation (17).

(ii) Let $\bar{A}_2 \geq 0$ and $\epsilon > 0$. Then by equation (17) we get

$$\theta^*(\mu\bar{s}_1) > \hat{\theta}(\mu\bar{s}_1,\epsilon) \tag{25}$$

for $\mu > 0$. Given $\bar{s}_1$, $\theta^*(\mu\bar{s}_1)$ is strictly increasing in μ. We know that for $\mu = 0$ the two thresholds are equal to zero, $\theta^*(\mu\bar{s}_1) = \hat{\theta}(\mu\bar{s}_1,\epsilon) = 0$. Now suppose $\frac{\theta^*(\mu\bar{s}_1)}{\partial\mu} < \frac{\hat{\theta}(\mu\bar{s}_1,\epsilon)}{\partial\mu}$, then $\theta^*(\mu\bar{s}_1) < \hat{\theta}(\mu\bar{s}_1,\epsilon)$ for any positive μ which contradicts equation (25).

(iii) Let $\bar{A}_2 < 0$. Then equation (17) implies that the threshold of substantial conformity $\hat{\theta}(\mu\bar{s}_1,1)$ such that $-w(\mu\bar{s}_1,\theta) = 0$ is negative for all positive μ and zero for $\mu = 0$. As $\theta^*(\mu\bar{s}_1)$ increases and $\hat{\theta}(\mu\bar{s}_1,1)$ decreases with μ, Lemma 1(1) is established.

For **(2)**: To establish $\frac{\partial F\left(\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)\right)}{\partial\bar{s}_1} > 0$ we need to show that $\frac{\theta^*(\mu\bar{s}_1)}{\partial\bar{s}_1} > \frac{\hat{\theta}(\mu\bar{s}_1,\epsilon)}{\partial\bar{s}_1}$ for any $\epsilon > 0$. For **(1)** we fixed $\bar{s}_1$, now we fix μ to establish the results for a change of $\bar{s}_1$. Both enter the welfare functions and thresholds by the same way, the arguments from **(1)** do thus directly apply to **(2)**.

Proof of Lemma 2

We (i) establish that a contract, such that both participation constraints hold, is feasible, i.e. the buyer will agree to such a contract; it is further argued (ii) that $\bar{s}_2 = \bar{s}_2^{\mathcal{C}}$; last, we establish (iii) an interior solution $\bar{s}_1(\mu,\epsilon)$.

(i) We first show that a contract such that the buyer's participation constraints hold is strictly better in terms of expected surplus than one with either condition (8) or (14) violated. Given that $\bar{A}_1 \geq 0$ holds true, for $\bar{A}_2 \geq 0$ to be preferred over $\bar{A}_2 < 0$ — $\bar{s}_2$ such that (8) holds—we need to establish that $\mathbb{E}W\left[\bar{A}_2 \geq 0\right] \geq \mathbb{E}W\left[\bar{A}_2 < 0\right]$ $\forall\bar{s}_1 \in S$. By the buyer's strategy in equation (9), if the inequality holds for $\epsilon = 1$ then it holds all $\epsilon \in E$. Let $\hat{\theta}^1 \equiv \hat{\theta}(\mu\bar{s}_1,1)$ for $\bar{A}_2 \geq 0$ and $\hat{\theta}^2 \equiv \hat{\theta}(\mu\bar{s}_1,1)$ for $\bar{A}_2 < 0$. By equations (16) and (17), $\hat{\theta}^1 \geq \hat{\theta}^2$. The difference between $\mathbb{E}W\left[\bar{A}_2 \geq 0\right]$ and $\mathbb{E}W\left[\bar{A}_2 < 0\right]$ is then equal to

$$\int_{\hat{\theta}^2}^{\hat{\theta}^1} w(\sigma_1^*(\theta),\theta)\,dF(\theta) - \int_{\hat{\theta}^2}^{\hat{\theta}^1} w(\mu\bar{s}_1,\theta)\,dF(\theta) \geq 0. \tag{26}$$

The first component is non-negative for any μ and $\bar{s}_1$. For $\epsilon = 1$, $\hat{\theta}^1$ is such that equation (17) holds true, yielding $w(\mu\bar{s}_1,\theta) = 0$ for $\theta = \hat{\theta}^1$ and negative for any lower θ. This renders equation (26) non-negative.

The same argument applies to participation constraint (14). $\bar{A}_1$ and $\bar{A}_2$ denote the buyer's share of the expected joint surplus; if it holds true that $\alpha \geq 0$ the buyer will agree to $(\bar{s}_1,\bar{s}_2)$ such that both participation constraints hold.

(ii) $\bar{s}_2 = \bar{s}_2^{\mathcal{C}}$ is by equation (21) and the accompanying discussion.

(iii) It remains to be shown that $0 < \bar{s}_1 < \bar{s}_1^{\mathcal{C}}$. $\bar{s}_1$ is characterized by the first order condition of equation (22), $\frac{\partial \mathbb{E}W}{\partial \bar{s}_1} \stackrel{!}{=} 0$. By Leibniz's formula for integrating into the boundaries it is given as

$$\frac{\partial \hat{\theta}\left(\mu \bar{s}_1, \epsilon\right)}{\partial \bar{s}_1}\left[\left(1-\hat{\gamma}\right) w\left(\sigma_1^*\left(\hat{\theta}\left(\mu \bar{s}_1, \epsilon\right)\right), \hat{\theta}\left(\mu \bar{s}_1, \epsilon\right)\right) - w\left(\mu \bar{s}_1, \hat{\theta}\left(\mu \bar{s}_1, \epsilon\right)\right)\right] + \int\limits_{\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)} \frac{\partial\left[w\left(\mu \bar{s}_1, \theta\right)\right]}{\partial \bar{s}_1} dF(\theta) + \int\limits_{\overline{\Theta}(\mu,\epsilon,\bar{s}_1)} \frac{\partial w\left(\bar{s}_1, \theta\right)}{\partial \bar{s}_1} dF(\theta) \stackrel{!}{=} 0.$$

Since for $\bar{A}_2 \geq 0$ by equations (16) and (17) the threshold of substantial conformity $\hat{\theta}\left(\mu \bar{s}_1, \epsilon\right)$ is such that the bracketed term equal to zero, the first order condition reduces to the two integral components to be equal to zero,

$$\int\limits_{\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)} \frac{\partial\left[w\left(\mu \bar{s}_1, \theta\right)\right]}{\partial \bar{s}_1} dF(\theta) + \int\limits_{\overline{\Theta}(\mu,\epsilon,\bar{s}_1)} \frac{\partial w\left(\bar{s}_1, \theta\right)}{\partial \bar{s}_1} dF(\theta) \stackrel{!}{=} 0. \tag{27}$$

An immediate candidate for a maximizer is the corner solution $\bar{s}_1^u$ such that $\hat{\theta}\left(\mu \bar{s}_1^u, \epsilon\right) = 1$ and $\widehat{\Theta}\left(\mu, \epsilon, \bar{s}_1\right) \subseteq \overline{\Theta}\left(\mu, \epsilon, \bar{s}_1\right) \subseteq \emptyset$. This minimizes first period inefficiencies as we can see from equation (19) where $\sigma_1\left(\mu, \epsilon, \theta\right) = \sigma_1^*\left(\theta\right)\ \forall \mu, \epsilon$. Since for any non-zero μ, ϵ we have $\hat{\theta}\left(\mu \bar{s}_1, \epsilon\right) < \theta^*\left(\mu \bar{s}_1\right)$ (with equality if either μ or ϵ equal to zero) and $\theta^*\left(\mu \bar{s}_1\right) \leq \theta^*\left(\bar{s}_1\right)$, it follows that $\bar{s}_1^u > \bar{s}_1^{\mathcal{C}}$. This means, the corner solution is *unconstrained* by practicability considerations because $\bar{s}_1^u > \sigma_1^*\left(1\right)$.

To see that the corner solution does not maximize $\mathbb{E}W$, implying first period inefficiencies to *exist* in equilibrium, we first establish an interior candidate. Suppose, the true maximizer is $\bar{s}_1 = \bar{s}_1^{\mathcal{C}}$. Then the second integral in equation (27) equals zero because $\theta^*\left(\bar{s}_1^{\mathcal{C}}\right) = 1$ and $\overline{\Theta}\left(\mu, \epsilon, \bar{s}_1\right) \subseteq \emptyset$. 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 non-zero μ and ϵ, $\widehat{\Theta}\left(\mu, \epsilon, \bar{s}_1\right)$ is non-empty, hence the first integral is negative which renders the first order condition in equation (27) strictly negative for $\bar{s}_1 = \bar{s}_1^{\mathcal{C}}$.

An installment $\bar{s}_1 < \bar{s}_1^{\mathcal{C}}$ and $\overline{\Theta}\left(\mu, \epsilon, \bar{s}_1\right)$ non-empty will increase the value of the first order condition since $\frac{\partial \theta^*\left(\bar{s}_1\right)}{\partial \bar{s}_1} > 0$ (the second integral becomes positive) and, from Lemma 1, $\frac{\partial F\left(\widehat{\Theta}\left(\mu,\epsilon,\bar{s}_1\right)\right)}{\partial \bar{s}_1} > 0$ (the first integral increases). A sufficiently low $\bar{s}_1$, balancing the counteracting effects of the two integrals in equation (27), satisfies the first order condition. To show that the optimal $\bar{s}_1$ is positive, suppose $\bar{s}_1 = 0$. Then $\widehat{\Theta}\left(\mu, \epsilon, \bar{s}_1\right)$ is empty and the first integral equal to zero. $\theta^*\left(\bar{s}_1\right) = 0$, $\frac{\partial w\left(\bar{s}_1, \theta\right)}{\partial \bar{s}_1} = 0$ for $\theta = 0$ but positive for all non-zero θ. Hence, the second integral positive, rendering the first order condition positive for $\bar{s}_1 = 0$. Once again, increasing $\bar{s}_1$ balances the effects of the two integrals. Since equation (27) is continuous and concave in $\left[0, \bar{s}_1^{\mathcal{C}}\right]$, there exists a non-zero $\bar{s}_1\left(\mu, \epsilon\right) = \bar{s}_1^*$ strictly smaller than the *Cadillac* provision $\bar{s}_1^{\mathcal{C}}$ that satisfies equation (27). Practicability considerations are not constraining at this point.

Let $\mathbb{E}W^*$ the expected joint surplus evaluated at $\bar{s}_1 = \bar{s}_1^* < \bar{s}_1^{\mathcal{C}}$ as given in equation (22) and $\mathbb{E}W^u$ the expected joint surplus evaluated at $\bar{s}_1 = \bar{s}_1^u > \bar{s}_1^{\mathcal{C}}$, which exhibits no first period distortion but second period trade with probability $\left(1-\epsilon\right)$ only (by equation (5)). Let $\Delta\mathbb{E}W$ the difference between $\mathbb{E}W^*$ and $\mathbb{E}W^u$, where

$$\Delta\mathbb{E}W = \epsilon \int\limits_{\hat{\theta}\left(\mu \bar{s}_1^*, \epsilon\right)}^{1} w\left(\sigma_2^*\left(\theta\right), \theta\right) dF(\theta) - \left[\int\limits_{\hat{\theta}\left(\mu \bar{s}_1^*, \epsilon\right)}^{\theta^*\left(\mu \bar{s}_1^*\right)} \left[w\left(\sigma_1^*\left(\theta\right), \theta\right) - w\left(\mu \bar{s}_1^*, \theta\right)\right] dF(\theta) + \int\limits_{\theta^*\left(\bar{s}_1^*\right)}^{1} \left[w\left(\sigma_1^*\left(\theta\right), \theta\right) - w\left(\bar{s}_1^*, \theta\right)\right] dF(\theta)\right] \geq 0. \tag{28}$$

To see that the inequality holds, notice that since by assumption $w\left(\sigma_1^*\left(\theta\right), \theta\right) = w\left(\sigma_2^*\left(\theta\right), \theta\right)$ and by equation (17) we have $w\left(\mu\bar{s}_1^*, \hat{\theta}\left(\mu\bar{s}_1^*, \epsilon\right)\right) = 0$ for $\epsilon = 1$. Hence, equation (28) reduces to

$$\int_{\hat{\theta}\left(\mu\bar{s}_1^*, \epsilon\right)}^{1} w\left(\mu\bar{s}_1^*, \theta\right) dF\left(\theta\right) > 0 \tag{29}$$

for $\epsilon = 1$ and $\mu > 0$. Evaluating equation (28) at some arbitrary $\bar{s}_1^* \to \bar{s}_1$ and maximizing $\Delta\mathbb{E}W$ with respect to $\bar{s}_1$ gives the first order condition

$$\int_{\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)} \frac{\partial\left[w\left(\mu\bar{s}_1, \theta\right)\right]}{\partial\bar{s}_1} dF\left(\theta\right) + \int_{\overline{\Theta}(\mu,\epsilon,\bar{s}_1)} \frac{\partial w\left(\bar{s}_1, \theta\right)}{\partial\bar{s}_1} dF\left(\theta\right) \stackrel{!}{=} 0. \tag{30}$$

Notice that equation (30) is identical to the first order condition in equation (27). By the arguments brought before, $\bar{s}_1\left(\mu, \epsilon\right) = \bar{s}_1^* < \bar{s}_1^{\mathcal{C}}$ satisfies equation (30) for all μ, ϵ. Notice that $\bar{s}_1^u = \bar{s}_1^{\mathcal{C}}$ and $\Delta\mathbb{E}W = 0$ for μ or ϵ equal to zero. Since $\bar{s}_1\left(\mu, \epsilon\right) < \bar{s}_1^{\mathcal{C}} < \bar{s}_1^u$, the equality in equation (28) is strict $\forall\epsilon, \mu > 0$ and $\bar{s}_1\left(\mu, \epsilon\right)$ unique and interior.

Proof of Lemma 3

By equations (5), (9), (19), Lemmas 1 and 2.

Proof of Proposition 1

The proof of Proposition 1 follows straight from the proof of Lemma 2.

Proof of Lemma 4

By the accompanying discussion in the text body.

Proof of Proposition 2

As the substantial impairment requirement becomes stricter on the buyer, μ decreases. By Lemma 1 we know that $\frac{\partial F\left(\widehat{\Theta}(\mu,\epsilon,\bar{s}_1)\right)}{\partial\mu} > 0$ implying that the incidence of first period inefficiency decreases for intermediate types as μ decreases. By Lemma 2 and $\frac{\partial F\left(\overline{\Theta}(\mu,\epsilon,\bar{s}_1)\right)}{\partial\mu} > 0$ the analogue is true for inefficiencies at the top. As a result, overall first period inefficiencies decrease. A lower μ further increases the probability of second period trade $\left(1 - \epsilon\int_0^{\hat{\theta}(\mu\bar{s}_1,\epsilon)} dF\left(\theta\right)\right)$. For a given (α, β) both parties will be better off for lower μ.

Proof of Lemma 5

$\sigma_2\left(\theta\right) = \sigma_2^*\left(\theta\right)$, $\forall\theta$, from the proof of Lemma 2. For $\sigma_1\left(\mu, \epsilon, \theta\right) = \sigma_1^*\left(\theta\right)$, $\forall\theta$, note that for $\bar{\mu} = 0$ buyer's cancellation from equation (9) $\gamma\left(s_1, 0, \epsilon\right) = 0$ for all s_1. This implies that the seller's second period payoffs from first period perspective Ψ_2 in equation (11) are not a function of s_1 and the seller's first period performance $\sigma_1\left(0, \epsilon, \theta\right)$ in equation (12) not distorted for intermediate types, i.e. $\sigma_1\left(0, \epsilon, \theta\right) = \sigma_1^*\left(\theta\right)$ for all $\theta \leq \theta^*\left(\bar{s}_1\right)$ and $\sigma_1\left(0, \epsilon, \theta\right) = \bar{s}_1$ for $\theta > \theta^*\left(\bar{s}_1\right)$. Note that $\Delta_\Psi = 0$ for any $\bar{A}_2$ and by equation (17) $\hat{\theta}\left(\bar{\mu}\bar{s}_1, \epsilon\right) = \theta^*\left(\bar{\mu}\bar{s}_1\right) = 0$ for all ϵ (the analogous hold for $\epsilon\left(\theta\right)$ and $\epsilon\left(s_1\right)$). Then the parties' expected joint surplus is equal to

$$\mathbb{E}W = \int_0^{\theta^*(\bar{s}_1)} \left[w\left(\sigma_1^*\left(\theta\right), \theta\right) + w\left(\sigma_2^*\left(\theta\right), \theta\right)\right] dF\left(\theta\right) + \int_{\theta^*(\bar{s}_1)}^{1} \left[w\left(\bar{s}_1, \theta\right) + w\left(\sigma_2^*\left(\theta\right), \theta\right)\right] dF\left(\theta\right) \tag{31}$$

and the first order condition for $\bar{s}_1$ is given as $\int_{\theta^*(\bar{s}_1)}^{1} \frac{\partial w(\bar{s}_1,\theta)}{\partial \bar{s}_1} dF(\theta) \overset{!}{=} 0$, which holds true for $\bar{s}_1 = \bar{s}_1^{\mathcal{C}}$ such that $\theta^*(\bar{s}_1) = 1$. This implies that there is no type $\theta > \theta^*\left(\bar{s}_1^{\mathcal{C}}\right)$ such that over-performance is efficient and $\sigma_1(0,\epsilon,\theta) = \sigma_1^*(\theta)$, $\forall\theta \in \Theta$. We can conclude that $\bar{\mu} = \mu^* = 0$, $\widehat{\Theta}(\bar{\mu},\epsilon,\bar{s}_1) = \overline{\Theta}(\bar{\mu},\epsilon,\bar{s}_1) \subseteq \emptyset$ and the equilibrium contract $\mathcal{I}\left(\left(\bar{s}_1^{\mathcal{C}}, \bar{s}_2^{\mathcal{C}}\right), \bar{p}, \bar{\mu}\right)$ induces the first best outcome.

B Legal code

B.1 United States

Restatement (Second) of Contracts: §241. Circumstances Significant in Determining Whether a Failure is Material

In determining whether a failure to render or to offer performance is material, the following circumstances significant:

(a) the extent to which the injured party will be deprived of the benefit which he reasonably expected;

(b) the extent to which the injured party can be adequately compensated for the part of that benefit of which he will be deprived;

(c) the extent to which the party failing to perform or to offer to perform will suffer forfeiture;

(d) the likelihood that the party failing to perform or to offer to perform will cure his failure, taking account of all the circumstances including any reasonable assurances;

(e) the extent to which the behavior of the party failing to perform or to offer to perform comports with standards of good faith and fair dealing.

UCC: §1-305. Remedies to be Liberally Administered.

(a) The remedies provided by [the Uniform Commercial Code] must be liberally administered to the end that the aggrieved party may be put in as good a position as if the other party had fully performed but neither consequential or special damages nor penal damages may be had except as specifically provided in [the Uniform Commercial Code] or by other rule of law.

UCC: §2-106. Definitions: "Contract"; "Agreement"; "Contract for sale"; "Sale"; "Present sale"; "Conforming" to Contract; "Termination"; "Cancellation".

(3) "Termination" occurs when either party pursuant to a power created by agreement or law puts an end to the contract otherwise than for its breach. On "termination" all obligations which are still executory on both sides are discharged but any right based on prior breach or performance survives.

(4) "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.

UCC: §2-508. Cure by Seller of Improper Tender or Delivery; Replacement.

(1) Where any tender or delivery by the seller is rejected because non-conforming and the time for performance has not yet expired, the seller may seasonably notify the buyer of his intention to cure and may then within the contract time make a conforming delivery.

(2) Where the buyer rejects a non-conforming tender which the seller had reasonable grounds to believe would be acceptable with or without money allowance the seller may if he seasonably notifies the buyer have a further reasonable time to substitute a conforming tender.

UCC: §2-601. Buyer's Rights on Improper Delivery.

Subject to the provisions of this Article on breach in installment contracts (Section 2-612) and unless otherwise agreed under the sections on contractual limitations of remedy (Sections 2-718 and 2-719), 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.

UCC: §2-608. Revocation of Acceptance in Whole or in Part.

(1) The buyer may revoke his acceptance of a lot or commercial unit whose non-conformity substantially impairs its value to him if he has accepted it

  (a) on the reasonable assumption that its non-conformity would be cured and it has not been seasonably cured; or

  (b) without discovery of such non-conformity if his acceptance was reasonably induced either by the difficulty of discovery before acceptance or by the seller's assurances.

(2) Revocation of acceptance must occur within a reasonable time after the buyer discovers or should have discovered the ground for it and before any substantial change in condition of the goods which is not caused by their own defects. It is not effective until the buyer notifies the seller of it.

(3) A buyer who so revokes has the same rights and duties with regard to the goods involved as if he had rejected them.

UCC: §2-612. "Installment contract"; Breach.

(1) An "installment contract" is one which requires or authorizes the delivery of goods in separate lots to be separately accepted, even though the contract contains a clause "each delivery is a separate contract" or its equivalent.

(2) The buyer may reject any installment which is non-conforming if the non-conformity substantially impairs the value of that installment and cannot be cured or if the non-conformity is a defect in the required documents; but if the non-conformity does not fall within subsection (3) and the seller gives adequate assurance of its cure the buyer must accept that installment.

(3) Whenever non-conformity or default with respect to one or more installments substantially impairs the value of the whole contract there is a breach of the whole. But the aggrieved party reinstates the contract if he accepts a non-conforming installment without seasonably notifying of cancellation or if he brings an action with respect only to past installments or demands performance as to future installments.

UCC: §2-712. "Cover"; Buyer's Procurement of Substitute Goods.

(1) If the seller wrongfully fails to deliver or repudiates or the buyer rightfully rejects or justifiably revokes acceptance, the buyer may "cover" by making in good faith and without unreasonable delay any reasonable purchase of or contract to purchase goods in substitution for those due from the seller.

(2) The buyer may recover from the seller as damages the difference between the cost of cover and the contract price together with any incidental or consequential damages as hereinafter defined (Section 2-715), but less expenses saved in consequence of the seller's breach.

(3) Failure of the buyer to effect cover within this section does not bar him from any other remedy.

B.2 UN: CISG

Article 73

(1) In the case of a contract for delivery of goods by instalments, if the failure of one party to perform any of his obligations in respect of any instalment constitutes a fundamental breach of contract with respect to that instalment, the other party may declare the contract avoided with respect to that instalment.

(2) If one party's failure to perform any of his obligations in respect of any instalment gives the other party good grounds to conclude that a fundamental breach of contract will occur with respect to future instalments, he may declare the contract avoided for the future, provided that he does so within a reasonable time.

(3) A buyer who declares the contract avoided in respect of any delivery may, at the same time, declare it avoided in respect of deliveries already made or of future deliveries if, by reason of their interdependence, those deliveries could not be used for the purpose contemplated by the parties at the time of the conclusion of the contract.

C Case list

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