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# How Long-Term Contracts can Mitigate Inefficient Renegotiation Arising Due to Loss Aversion \*

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## Abstract

A loss-averse buyer and seller face an uncertain environment. Should they write a long-term contract or wait until the state of the world is realized? I show that simple long-term contracts perform better than insinuated in Herweg and Schmidt (2015), even though loss aversion makes renegotiation sometimes inefficient. During renegotiation, the outcome induced by the long-term contract constitutes the reference point to which the parties compare gains and losses induced by the renegotiated transaction. Whereas Herweg and Schmidt consider that the long-term contract is always performed, it should not in “bad” states. This alters the threat point in renegotiation, making it easier to renegotiate and thus improves the performance of long-term contracts. Specific performance contracts perform better than in Herweg and Schmidt but are still problematic. Option contracts perform much better since only one party has the ex-post trade decision making it much easier to prevent the contract is inefficiently enforced due to loss aversion. My findings suggest that loss aversion alone cannot explain why parties sometimes abstain from writing beneficial long-term contracts but give important insights on how long-term contracts should be written when parties are aware they are loss averse.

*Keywords:* Incomplete Contracts, Behavioral Contract Theory, Reference points, Holdup, Renegotiation

*JEL-Classification:* D86

## 1 Introduction

A loss-averse buyer (he) and seller (she) face an uncertain environment. Being aware of their future loss aversion, they meet ex-ante to either write a long-term

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\* I would like to thank (to be added)

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contract or to wait and write a spot contract after the state of the world has realized. The long-term contract is assumed to be simple in the sense that writing a complete state-contingent contract is impossible or prohibitively expensive. Hence, performing the contract is sometimes inefficient ex-post, inducing the parties to meet and renegotiate the original contract. Apart from loss aversion, I consider a standard setting rooting back to Grossman and Hart (1986) and Hart and Moore (1988). In this strand of the literature, renegotiation always succeeds, which is certainly not what one observes in practice. Hart and Moore (2008) point out that this Coasian (1937) renegotiation perspective is problematic. When the parties always renegotiate to an efficient outcome ex-post using side payments “it is hard to see why authority, hierarchy, delegation, or indeed anything apart from asset ownership matters.”

To address this issue, Herweg and Schmidt (2015) (henceforth H&S 2015) propose a theory of inefficient renegotiation based on loss aversion in the spirit of Tversky and Kahneman (1991), assuming the reference point during renegotiation is the outcome that would obtain should renegotiation not succeed. Consider, as an example, a buyer who is reluctant to accept the renegotiated contract if he perceives the renegotiated good,  $\hat{x}$ , being of inferior quality compared to the one stipulated in the long-term contract,  $\bar{x}$ . In absence of loss aversion, the seller could offer a price,  $\hat{p}$ , below the one stipulated in the long-term contract,  $\bar{p}$ , to convince the buyer to sign the renegotiated contract. However, if the buyer’s feelings of losses are substantial, and losses in the value dimension are evaluated separately from gains in the monetary dimension, inducing both parties to sign the renegotiated contract may be impossible. Put differently, the parties’ utility functions satisfy decomposability as defined by Tversky and Kahneman (1991), being a common assumption in the literature on reference points, see also Kőszegi and Rabin (2006, 2007). Hence, the long-term contract in conjunction with loss aversion creates an endowment effect/status-quo bias, making renegotiation inefficient.<sup>1</sup> H&S (2015) point out their theory is backed by solid experimental evidence: Bartling and Schmidt (2015) conducted an interesting experiment, in which a buyer and a seller either negotiate from scratch or are in an otherwise identical situation and renegotiate an existing contract. As predicted by the model of H&S (2015), the contract caused prices to be sticky and insufficiently adapted to the realization of the state as compared to the situation without an initial contract.

I consider a model similar to H&S (2015), but the reference point during renegotiation is sometimes different. H&S (2015) write the reference point is the outcome that would obtain if renegotiation failed. However, when considering a specific performance contract, H&S (2015) assume the disagreement outcome is the one prescribed by the contract, i.e., the contract is enforced should renegotiation not succeed. However, even a specific performance contract only gives each party the *right* but not the *obligation* to enforce performance. Hence, in some states, it may be best for both parties not to enforce specific performance, even

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<sup>1</sup>The endowment effect and status-quo bias are well-known results in behavioral economics, see (Thaler, 1980; Kahneman et al., 1990) for further reading on the former effect and Samuelson and Zeckhauser (1988) for the latter.

when they are loss averse. It is worth recalling H&S's (2015) comparison between a long-term specific performance contract and a spot contract negotiated after the parties learn the state. When considering the latter, H&S (2015) assume the reference point during spot contracting is that the parties trade a generic good on the market. Doing so should plausibly also be the reference point during renegotiation under a specific performance contract when trading the contracted good is undesirable for both parties. But does this imply the reference point during (re)negotiation is the same under both contracts, given the disagreement outcome is that the parties trade with a third party on the market? After all, under both contracts, the parties incur the same feelings of losses during (re)negotiation, for example, the buyer when he perceives the (re)negotiated good to be of lower quality than the generic good he could purchase on the market. However, only when renegotiating a long-term contract, the parties also *avoid* incurring future feelings of losses, making it more likely renegotiation succeeds. These feelings would arise should the parties fail to reach an agreement during renegotiation and trade the generic good instead of the one specified in the long-term contract. To illustrate the point, let us consider the following example:

### An example

(i) Bob the buyer and Susan the seller meet to negotiate a *spot contract* on a custom-tailored piece of art  $\hat{x}$  costing Susan  $\hat{c} = 1000$  to produce. Bob values Susan's work  $\hat{v} = 1500$  in the current (already realized) state of the world. Should Bob and Susan not reach an agreement, Susan crafts a generic piece of art costing her  $c^{out} = 200$  and sells it on the market for  $p^{out} = 300$ . Also, Bob's outside option is to trade on the market. He purchases a generic piece of art he values  $v^{out} = 400$  at the market price  $p^{out} = 300$ . When Bob and Susan are not loss averse, they manage to negotiate a spot contract on  $\hat{x}$  since their joint utility  $\hat{v} - \hat{c} = 500$  exceeds the sum of their individual utilities when taking their outside options,  $v^{out} - p^{out} + p^{out} - c^{out} = 200$ . In contrast to before suppose Susan is loss averse. Then her total (perceived) cost of producing for Bob is  $-1000 - \lambda[1000 - 200]$ , where  $\lambda$  is her degree of loss aversion and the last term are her feelings of losses because the custom-tailored piece of art is more costly to produce than the generic one.<sup>2</sup> When Susan's degree of loss aversion is sufficiently large, say  $\lambda = 0.5$ , spot contracting cannot succeed, even when Bob is not loss averse. Bob and Susan's joint agreement utility is just  $\hat{v} - \hat{c} - 0.5[\hat{c} - c^{out}] = 100$ , whereas the sum of their outside-option utilities is  $v^{out} - p^{out} + p^{out} - c^{out} = 200$ .<sup>3</sup>

(ii) Now consider Bob and Susan wrote a long-term *specific performance con-*

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<sup>2</sup>It may be implausible to assume Susan evaluates the price and her cost of production separately if both are purely monetary. Hence, let us assume the difference in cost of production is due to Susan having to put in extra effort to custom tailor the art for Bob.

<sup>3</sup>As in H&S 2015 Susan does not feel any losses when trading on the market because doing so is her reference point. It is also worth mentioning Susan may feel additional losses in the monetary dimension when trading with Bob, occurring when the spot price  $\hat{p}$  is lower than  $p^{out} = 300$ . Of course, Susan would never agree on such a low price.

*tract* specifying a custom-tailored piece of art  $\bar{x}$  for a price of  $\bar{p} = 600$ . Unfortunately, in the realized state Bob only values the art  $\bar{v} = 400$ , but Susan's cost of production are  $\bar{c} = 800$ . They thus meet, trying to replace the original contract with a spot contract on a different piece of art  $\hat{x}$ , again costing Susan  $\hat{c} = 1000$  and valued  $\hat{v} = 1500$  by Bob. Bob and Susan anticipate the outcome that would obtain should they fail to reach an agreement: Neither Bob nor Susan would enforce the original specific performance contract. Bob would purchase a generic piece of art on the market since  $v^{out} - p^{out} > \bar{v} - \bar{p}$  or equivalently  $100 > -200$ . Since the specific performance contract looms prominently on Susan's mind, she would incur feelings of losses when trading on the market. Even so, it is best for her not to enforce specific performance since  $\bar{p} - \bar{c} < p^{out} - \lambda[\bar{p} - p^{out}] - c^{out}$  or equivalently  $600 - 800 < 300 - 0.5[600 - 300] - 200 \Leftrightarrow -200 < -50$ . The term  $-0.5[600 - 300]$  are Susan's feelings of losses arising because the market price  $p^{out}$  is lower than the price  $\bar{p}$  promised to her in the original specific performance contract. The parties joint utility when renegotiation succeeds is the same as in case (i), but Susan is worse off when renegotiation fails due to the fact she also incurs feelings of losses when it does,  $\lambda[\bar{p} - p^{out}] = 0.5[600 - 300] = 150$ . This makes it easier to reach an agreement when renegotiating the long-term contract compared to negotiating a new spot contract from scratch.

## Main results

The example highlights it is important to take into account that long-term contracts are not always performed, not even a specific performance contract. However, the long-term contract shapes the reference point during renegotiation also when it is not performed. This is advantageous also in the general case – by reaching an agreement during renegotiation, the parties not only internalize feelings of losses but also avoid future feelings of losses. Even when renegotiation does break down, the long-term contracts perform better than in H&S (2015). Simply because sometimes it is optimal for the parties not to carry it out, but to take their outside options instead. When comparing the performances of a long-term and a spot contract also the parties' degrees of loss aversion play a role. In H&S (2015), the parties suffer from higher loss aversion when renegotiating a long-term specific performance contract. The rationale being that they spent time negotiating it and are hence emotionally attached to the promised outcome. However, when the disagreement outcome is that the parties trade on the market, it seems plausible that their degrees of loss aversion are the same under a long-term and a spot contract. After all, the disagreement outcome is materially the same. All of the reasons explained above contribute to a specific performance contract performing better than in H&S (2015), but whether it outperforms a spot contract depends on fine details of the considered parameter constellation.

In the present paper, the price stipulated in the long-term contract  $\bar{p}$  plays a more important role as in H&S (2015), where it just defines a wealth position. After all, it influences the likelihood the parties enforce the contract ex-post, which in turn is relevant during renegotiation. However, in some states renegotiation fails and the contract is inefficiently enforced independently of the price  $\bar{p}$ . Does the

less than optimal performance of the specific performance contract explain why parties often (?) abstain from writing (any type of) long-term contracts as argued by H&S (2015)? To address this question, I consider long-term option contracts, a type of contract that is frequently observed in practice. I find as my main result that a simple option contract outperforms both a specific performance and a spot contract. An option contract gives one of the parties the option to purchase  $\bar{x}$  for price  $\bar{p}$  ex-post. Because only one of the loss-averse parties has the trade decision ex-post, it is less likely the contract is inefficiently carried out. This gives the parties a higher degree of freedom to use the price as a strategic instrument to increase the likelihood future renegotiation succeeds.

Consider again our example but suppose Susan’s degree of loss aversion is  $\lambda = 2$ . It is easy to show Susan enforces specific performance to avoid substantial feelings of losses that would occur when she does not. These arise because the price she can obtain on the market,  $p^{out} = 300$ , is much lower than the one promised in the long-term contract,  $\bar{p} = 600$ . Anticipating this disagreement outcome during renegotiation, Bob and Susan fail to reach an agreement. The rationale is that Susan would feel a loss of  $\hat{c} - \bar{c} + 2[\hat{c} - \bar{c}] = 600$  because producing the renegotiated good  $\hat{x}$  is expensive relative to the one stipulated in the long-term contract  $\bar{x}$ . To avoid this problem, Bob and Susan could write an option contract stipulating a sufficiently high price  $\bar{p}$  and giving the option to Bob. In contrast, stipulating a high price in a specific performance contract does not work because the higher the price the more likely it becomes Susan enforces the contract. This in turn makes it unlikely that renegotiation succeeds, as explained in the example. In Section 3.2, I show that the materially efficient good can be reached by renegotiation under an option contract unless one of the parties has all the bargaining power. Finally, in Section 4, I consider the standard hold-up problem in which the buyer makes a (selfish) ex-ante relationship-specific investment. Considering the same setting as H&S (2015), I find that an option contract outperforms a contract allocating ownership rights. As shown by H&S (2015), loss aversion affects asset ownership in two ways. First, it reduces the price adjustment, decreasing the hold up. But second, loss aversion in itself increases the hold up. These effects cancel each other out and we obtain the well-known result that the buyer underinvests due to not internalizing the full benefit of his investment. His investment increases the expected renegotiation surplus which the buyer must share with the seller. Option contracts are well known to protect (selfish) relationship-specific investment, recall for example Nöldeke and Schmidt (1995). However, the option contract inducing first-best investment is typically not the one minimizing the likelihood renegotiation fails, so there is a tradeoff.

## Relationship to the literature

As explained, the present paper is most closely related to H&S (2015). Back in 1991, Tversky and Kahnemann postulated contracts shape reference points in bargaining and that “[...] in the bargaining context the aversion to losses takes the form of an aversion to concessions.” The first paper to formally model contracts as reference points is Hart and Moore (2008). In their model, the parties feel entitled

to the best outcome possible under the contract. A party's performance ex-post then depends on whether he or she receives what he or she feels entitled to in comparison with the actual outcome of the contract. A party feeling shortchanged shades on performance, which is assumed to be a costless way of punishment. The more flexible the initial contract, the easier it is to adjust after learning the state but the higher are feelings of entitlement and consequently inefficient shading. This tradeoff then gives rise to the optimal (intermediate) degree of flexibility. Hart (2009) is situated in the same strand of the literature and shows contracts allocating asset ownership and indexing contracts can reduce incentives to engage in the hold-up. His result is driven by payoff uncertainty and not by the classical hold-up problem. Also Hart and Holmström (2010) and Hart (2013) consider shading models. The former investigates the boundaries of the firm and the latter considers a seller making a non-contractible investment and assumes the seller can make take-it-or-leave-it offers to the buyer. When shading is possible, the contract optimally limits the seller's possible offers, however, this may give rise to inefficiencies ex-post. In Halonen-Akatwijuka and Hart's (2013) shading model, reference points are also shaped by contracts, and their main result is that an incomplete contract may be strictly superior to a contingent contract. An important difference between the shading literature and the present paper is that the former does not focus on inefficient renegotiation under loss aversion and how it can be mitigated.

Also relevant is Watson (2007), who considers a canonical incomplete-contracting model between two risk-neutral parties. The long-term contract considered by H&S (2015) is what Watson (2007) calls a "forcing contract". Watson (2007) shows that forcing contracts may severely shrink the set of implementable outcomes compared to contracts that allow the parties to not enforce the contract ex-post. Hence, it is no surprise H&S's (2015) specific performance contract performs poorly and I conjecture Watson's (2007) result also holds when the parties are loss averse. Another well-known result within the literature on incomplete contracts is that option contracts perform well in protecting relationship-specific investment. For instance, Nöldeke and Schmidt (1995) analyze a hold-up model akin to Hart and Moore (1988), with the assumption that delivery of the good can be verified. Their main result is that simple option contracts giving the seller the option, and specifying payments depending on whether the seller exercises her option or not, induce an efficient investment decision and efficient trade. Other articles showing the desirability of different types of option contracts in settings varying in fine details such as the timing of the model and the nature of investment(s) include Lyon and Rasmusen (2004), Buzard and Watson (2012), and Göller (2019). Yet, these articles do not consider loss-averse parties, and renegotiation is assumed to always succeed.

In the present paper and H&S (2015), the reference point during (re)negotiation is the outcome that would obtain should the parties not reach an agreement. Köszegi and Rabin (2006), consider a different type of loss aversion, so called expectation-based loss aversion, in a general model applied to consumer behavior and labor-supply decisions. Their reference point is formed before the state of

the world becomes known. In their own words, a party’s reference point is “her rational expectations held in the recent past about outcomes, which are determined in a personal equilibrium by the requirement that they must be consistent with optimal behavior given expectations.” Herweg et al. (2018) consider an incomplete-contracting model in which only the buyer is expectation-based loss averse. Their main result is that if the parties anticipate renegotiation to occur after learning the state, the seller will opportunistically exploit the buyer’s loss aversion, giving rise to a new type of hold-up problem.

The rest of the paper is organized as follows. Section 2 begins with the presentation of the model, which I subsequently solve by backward induction. In Section 2.1, I analyze whether the parties enforce the long-term contract on date 3. Section 2.2 considers the renegotiation problem on date 2 during which the parties anticipate their trade decisions on trade 2, which become relevant when renegotiation fails. Section 2.3 defines the social surplus of a long-term contract compared to the one of a spot contract. This helps me to compare the performance of these contracts in Section 3, where I first compare a spot contract to a long-term specific performance contract, and subsequently, to a long-term option contract. In Section 4, I allow the buyer to make a selfish investment and explain why an option contract often outperforms a contract allocating ownership rights, and Section 5 concludes.

## 2 The Model

Two loss-averse and risk-neutral agents, 1 (the buyer, he) and 2 (the seller, she), are engaged in a contractual relationship with a non-durable action opportunity and external enforcement. The seller can produce different specifications  $x \in X$ , where  $X$  is a compact and multi-dimensional space. It includes details such as quantity, quality, and the location of delivery etc. Henceforth, I simply refer to  $x$  as “the good”.

On date 0, the parties may write a long-term contract governing trade on date 3. I focus on two types of contracts, specific performance, and option contracts. A specific performance contract stipulates that the seller produces and delivers good  $\bar{x} \in X$  for price  $\bar{p}$  to the buyer on date 3, meaning both parties have the right to enforce the contract. An option contract is different in that only one party has the trade decision, i.e., the option, ex post. On date 1, a state of the world  $\theta$  is randomly drawn from a compact set of possible states  $\Theta$  according to a commonly known distribution function  $F(\theta)$  and becomes known to both parties, yet not to the external enforcer. The state determines the buyer’s valuation  $v = v(x, \theta)$  and the seller’s cost  $c = c(x, \theta)$  for any good  $x \in X$ , and the set  $X$  is assumed to be state independent. The external enforcer can observe payments and which good  $x$  is delivered, but not cost  $c$  and valuation  $v$ . The *materially* efficient good depends on the state and is assumed to be unique:

$$x^*(\theta) = \arg \max_{x \in X} \{v(x, \theta) - c(x, \theta)\}, \quad (1)$$



and I denote the seller's cost and the buyer's valuation of trading it by  $c^* = c(x^*, \theta)$  and  $v^* = v(x^*, \theta)$ , respectively. Let us solve the model by backwards induction, first considering date 3.

## 2.1 Date 3: Actions, Production, and Trade

If the parties signed a spot contract on date 2, replacing the original long-term contract if there was any, then it is simply performed on date 3. I describe precisely how (re)negotiation on date 2 works in Section 2.2. Otherwise, whether the parties perform the long-term contract or trade on the market depends on the *actions* they take on date 3. These actions are verifiable but irreversible, meaning I consider a model with a non-durable trading opportunity. To formalize the idea, the parties choose actions  $a = (a_1, a_2) \in A_1 \times A_2$  on date 3, where  $a_1$  is the buyer's action and  $a_2$  is the seller's action. The feasible actions depend on the contract but not on the realized state  $\theta$ . I assume the seller chooses his action first, but my results continue to hold when the buyer does so. Considering a specific performance contract,  $a_i = 1, i \in \{1, 2\}$ , means party  $i$  enforces performance and  $a_i = 0$  implies he or she does not. Only when both parties agree,  $a_1 = a_2 = 0$ , do they take their outside options, i.e., trade the generic good  $x^{out}$  on the market. Under an option contract, party  $i$  has the trade decision, meaning the parties trade with one another when  $a_i = 1$  and trade on the market when  $a_i = 0$ .

Let us now consider the parties' ex-post *material* utilities, ignoring loss aversion. There are three possible outcomes: (i) The parties perform the long-term contract, meaning the buyer pays the price  $\bar{p}$  and receives the contracted good  $\bar{x}$ , which he values  $\bar{v} = v(\bar{x}, \theta)$ . Consequently, his ex-post material utility is  $\bar{v} - \bar{p}$ . The seller receives the price  $\bar{p}$  but incurs production cost  $\bar{c} = c(\bar{x}, \theta)$ , so her material utility is  $\bar{p} - \bar{c}$ . Alternatively (ii), the parties trade some good  $\hat{x}(\theta) \in X$  for price  $\hat{p}$  they previously agreed upon during (re)negotiation on date 2. In this instance, the parties' material utilities are  $v(\hat{v}, \theta) - \hat{p} = \hat{v} - \hat{p}$  and  $\hat{p} - c(\hat{c}, \theta) = \hat{p} - \hat{c}$ , respectively. Or (iii), the buyer and the seller each trade a generic good  $x^{out}$  for price  $p^{out}$  on the market. Then, the buyer's material utility is  $v(x^{out}, \theta) - p^{out} = v^{out} - p^{out}$  and the seller's is  $p^{out} - c(x^{out}, \theta) = p^{out} - c^{out}$ .<sup>4</sup> This case can arise when the parties decide not to perform the long-term contract or when they did not sign a contract at all.

Having discussed the material utilities on date 3, it is time to take the parties' loss aversion into account. Should the parties replace the long-term contract with a spot contract on date 2, and subsequently perform it on date 3, this potentially causes feelings of losses. This case is being discussed extensively in H&S (2015), and I summarize the main insights in Section 2.2. Before doing so, let us suppose the long-term contract has not been renegotiated on date 2, and the parties decide whether to perform it on date 3. Since the buyer and the seller are loss averse, the long-term contract creates a reference point, causing feelings of losses when

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<sup>4</sup>For simplicity and to facilitate an easy comparison of our results, I follow H&S (2015) by assuming the parties trade the same type of generic good  $x^{out}$ . Moreover, like H&S (2015), I assume  $v^{out} \geq p^{out} \geq c^{out}$ , implying I do not need to consider a fourth case in which the parties do not trade at all.

the contract is not performed and the parties trade on the market instead. More precisely, the buyer feels a loss when the generic good is more expensive than the contracted good,  $p^{out} > \bar{p}$ , or when he prefers the seller's good,  $v^{out} < \bar{v}$ . In a similar fashion, the seller feels a loss when the contracted price is higher than the market price,  $p^{out} < \bar{p}$ , or when the generic good costs more to produce,  $c^{out} > \bar{c}$ . Lemma 1 summarizes the parties' complete utilities, including loss aversion:

**Lemma 1** *Suppose the buyer and the seller did not (re)negotiate on date 2. Then, their utilities on date 3 are*

$$U^{B1} = \bar{v} - \bar{p} \text{ and } U^{S1} = \bar{p} - \bar{c}, \text{ or} \quad (2)$$

$$U^{B-1} = v^{out} - p^{out} \text{ and } U^{S-1} = p^{out} - c^{out}, \text{ or} \quad (3)$$

$$U^{B0} = v^{out} - p^{out} - \lambda[\bar{v} - v^{out}]^+ - \lambda[p^{out} - \bar{p}]^+ \text{ and} \quad (4)$$

$$U^{S0} = p^{out} - c^{out} - \lambda[c^{out} - \bar{c}]^+ - \lambda[\bar{p} - p^{out}]^+, \quad (5)$$

where  $U^{Bi}$ ,  $i \in \{-1, 0, 1\}$ , is the buyer's utility,  $U^{Si}$  is the seller's utility,  $\lambda > 0$  measures the parties' degree of loss aversion, and  $[z]^+ \equiv \max[z, 0]$ .<sup>5</sup>

In Lemma 1  $U^{B1}$  and  $U^{S1}$  are the parties' date 3 utilities should they perform the long-term contract. Moreover, if the buyer and the seller did not sign a long-term contract on date 0 or a spot contract on date 2, they can only trade  $x^{out}$  on the market, and their utilities are denoted  $U^{B-1}$  and  $U^{S-1}$ , respectively. The perhaps most interesting case arises when the parties did write a long-term contract, but decide not to perform it, meaning they trade the generic good  $x^{out}$  on the market instead. Their utility functions denoted  $U^{B0}$  and  $U^{S0}$  then consist of two additively separable components: Considering the buyer, the term  $v^{out} - p^{out}$  represents material outcome-based utility and  $-\lambda[\bar{v} - v^{out}]^+ - \lambda[p^{out} - \bar{p}]^+$  is gain-loss utility, see also Köszegi and Rabin (2006, 2007) for an in-depth discussion of reference-dependent preferences. Monetary losses arising due to differences between the prices are evaluated separately from losses arising due to differences in cost and valuations, and thus the utility functions satisfy decomposability as defined by Tversky and Kahneman (1991).<sup>6</sup> Let us now derive conditions for when the parties perform the long-term contract, first considering a specific performance contract.

### Specific performance

It is worth recalling both parties have the right to enforce the contract and the seller chooses his action first. Whenever a party is indifferent between enforcing the contract,  $a_i = 1$ , and not doing so,  $a_i = 0$ , I simply assume he or she chooses the former ( $a_i = 1$ ).

<sup>5</sup>For my results to be easily comparable with H&S (2015), I also do not consider buyer- and seller-specific values of  $\lambda$ .

<sup>6</sup>As pointed out by H&S (2015), this common assumption is necessary for loss aversion to explain well-known deviations from standard theory such as the endowment effect (Thaler, 1980; Kahneman et al. 1990) or the status quo bias (Samuelson and Zeckhauser, 1988), see also their Footnotes 4 and 5.

**Lemma 2** *The specific performance contract is carried out when*

$$(1 + \lambda_{v+})(\bar{v} - v^{out}) \geq (1 + \lambda_{p+})(\bar{p} - p^{out}) \quad (6)$$

and/or

$$(1 + \lambda_{p-})(\bar{p} - p^{out}) \geq (1 + \lambda_{c+})(\bar{c} - c^{out}), \quad (7)$$

where

$$\lambda_{v+} = \begin{cases} \lambda, & \text{if } \bar{v} - v^{out} \geq 0 \\ 0, & \text{otherwise} \end{cases}, \lambda_{c+} = \begin{cases} \lambda, & \text{if } \bar{c} - c^{out} \leq 0 \\ 0, & \text{otherwise} \end{cases},$$

$$\lambda_{p+} = \begin{cases} \lambda, & \text{if } \bar{p} - p^{out} \leq 0 \\ 0, & \text{otherwise} \end{cases}, \lambda_{p-} = \begin{cases} \lambda, & \text{if } \bar{p} - p^{out} \geq 0 \\ 0, & \text{otherwise} \end{cases}.$$

**Proof.**

Given the seller remains silent,  $a_2 = 0$ , the buyer asks for specific performance,  $a_1 = 1$ , when  $U^{B1} \geq U^{B0}$  or equivalently  $(1 + \lambda_{v+})(\bar{v} - v^{out}) \geq (1 + \lambda_{p+})(\bar{p} - p^{out})$ . Should the seller enforce performance,  $a_2 = 1$ , the buyer's decision does not matter. Anticipating the buyer's decision, the seller enforces performance,  $a_2 = 1$ , when  $U^{S1} \geq U^{S0}$  or equivalently  $(1 + \lambda_{p-})(\bar{p} - p^{out}) \geq (1 + \lambda_{c+})(\bar{c} - c^{out})$ . The parties' date 3 utilities are taken from Lemma 1. ■

In absence of loss aversion, the buyer would enforce performance when  $\bar{v} - \bar{p} \geq v^{out} - p^{out}$ . However, because the parties are loss averse, the original contract is sticky. For instance, the buyer may enforce the contract even though it would be materially better for him not to do so. More precisely, he enforces performance when  $(1 + \lambda_{v+})(\bar{v} - v^{out}) \geq (1 + \lambda_{p+})(\bar{p} - p^{out})$ , where the variable  $\lambda_{v+}$  is equal to  $\lambda$  when he prefers the contracted good,  $\bar{v} - v^{out} \geq 0$ . Moreover,  $\lambda_{p+} = \lambda$  when the generic good is more expensive than the contracted good, or  $\bar{p} - p^{out} \leq 0$ . Consequently, when  $\lambda$  is sufficiently large and either  $\bar{v} > v^{out}$  or  $\bar{p} < p^{out}$ , the buyer may enforce specific performance even when he would be materially better off not doing so. In a similar fashion, the seller may "inefficiently" enforce performance. Namely, when the contracted price is higher than the market price,  $\bar{p} > p^{out}$ , or when the generic good is costly to produce,  $c^{out} > \bar{c}$ . However, it is possible neither party enforces the contract, a case occurring when the conditions (6) and (7) do not hold.

## Option Contracts

Also, an option contract creates a reference point, inducing feelings of losses when the option is not exercised on date 3. However, it seems plausible that the parties' degree of loss aversion, denoted  $\lambda^{opt}$ , is smaller than under a specific performance contract,  $0 \leq \lambda^{opt} \leq \lambda$ . After all, the buyer and the seller are aware on date 0 that the option is just that – an option. I can directly establish the following lemma:

**Lemma 3** *Under a buyer-option contract, the buyer exercises his option,  $a_1 = 1$ , when  $U^{B1} \geq U^{B0}$  evaluated at  $\lambda = \lambda^{opt}$ , or equivalently*

$$(1 + \lambda_{v+})(\bar{v} - v^{out}) \geq (1 + \lambda_{p+})(\bar{p} - p^{out}), \quad (8)$$

where

$$\lambda_{v+} = \begin{cases} \lambda^{opt}, & \text{if } \bar{v} - v^{out} \geq 0 \\ 0, & \text{otherwise} \end{cases} \quad \text{and}$$

$$\lambda_{p+} = \begin{cases} \lambda^{opt}, & \text{if } \bar{p} - p^{out} \leq 0 \\ 0, & \text{otherwise} \end{cases}.$$

*Under a seller-option contract, the seller exercises her option,  $a_2 = 1$ , when  $U^{S1} \geq U^{S0}$  evaluated at  $\lambda = \lambda^{opt}$ , or equivalently*

$$(1 + \lambda_{p-})(\bar{p} - p^{out}) \geq (1 + \lambda_{c+})(\bar{c} - c^{out}), \quad (9)$$

where

$$\lambda_{c+} = \begin{cases} \lambda, & \text{if } \bar{c} - c^{out} \leq 0 \\ 0, & \text{otherwise} \end{cases} \quad \text{and}$$

$$\lambda_{p-} = \begin{cases} \lambda^{opt}, & \text{if } \bar{p} - p^{out} \geq 0 \\ 0, & \text{otherwise} \end{cases}.$$

The conditions in Lemma 3 are, apart from a different degree of loss aversion, the same as in Lemma 2. However, only one of them is relevant, depending on which party has the option. Consequently, it is less likely the contract is performed when it would be materially better for the parties to take their outside options.

## 2.2 Date 2: Renegotiation and Spot Contracts

After having learned the state  $\theta$  on date 1, the parties meet to (re)negotiate on date 2 should they anticipate the date 3 outcome to be inefficient. Provided they reach an agreement, the parties write a spot contract on some good  $\hat{x}$  to be traded on date 3 for price  $\hat{p}$ . This contract replaces any long-term contract they may have signed on date 0. In absence of distortions renegotiation would be materially efficient, i.e.,  $\hat{x} = x^*(\theta)$ . As shown by H&S (2015), loss aversion makes the original contract sticky, meaning the parties may renegotiate to a good that is materially inefficient or they may not renegotiate at all. The rationale is that the parties may incur feelings of losses when (re)negotiation succeeds, for example, the seller when the renegotiated good is more costly to produce compared to the one stipulated in the long-term contract. In contrast to H&S (2015), loss aversion plays a role on date 2 *and* date 3. On date 3, when the parties trade the generic good instead of the contracted good, and on date 2 during (re)negotiation. The reference point

on date 2 is the outcome that would arise on date 3 should renegotiation not succeed. There are three possible reference points: (i) The parties signed a long-term contract on date 0 and perform it on date 3, (ii) the parties do not perform the long-term contract, but trade on the market, or (iii) the parties trade on the market because they did not write a long-term contract. Case (ii) is particularly interesting – by reaching an agreement on date 2 the parties may incur feelings of losses, but also avoid incurring future feelings of losses on date 3. Due to this trade-off, long-term contracts are not as sticky as in H&S (2015). I proceed as follows: First, I derive the renegotiation sets, consisting of all goods  $\hat{x}$  for which there exists a price  $\bar{p}$  so that reaching an agreement is better for both parties compared to receiving their disagreement outcomes. Second, I define the actual outcome of renegotiation as the spot contract maximizing the generalized Nash product of the parties' utilities when renegotiation succeeds minus their disagreement utilities. Third, I derive the renegotiated price  $\hat{p}$  for a given renegotiated good to gain a better understanding of how loss aversion affects the price adjustment during (re)negotiation.

### The reference point is that the long-term contract is performed

Let us first consider case (i), in which the disagreement outcome is that the parties trade the contracted good  $\bar{x}$  for price  $\bar{p}$ . The renegotiation set consists of any renegotiated good  $\hat{x}$  for which there exists a price  $\hat{p}$ , making both parties (weakly) better off compared to when the long-term contract is performed. Case (i) is covered extensively in Section 3.1 of H&S (2015), hence I just provide a short recap. The buyer prefers a new spot contract on  $(\hat{x}, \hat{p})$  to the initial long-term contract when

$$\hat{U}^{B1} = \hat{v} - \hat{p} - \lambda[\bar{v} - \hat{v}]^+ - \lambda[\hat{p} - \bar{p}]^+ \geq \bar{v} - \bar{p}, \quad (10)$$

and the seller does so when

$$\hat{U}^{S1} = \hat{p} - \hat{c} - \lambda[\hat{c} - \bar{c}]^+ - \lambda[\bar{p} - \hat{p}]^+ \geq \bar{p} - \bar{c}, \quad (11)$$

where the left-hand side consists of the parties' utilities under the spot contract and the right-hand side gives their utilities in case the long-term contract is performed on date 3. Loss aversion works like in the previous section: The buyer feels a loss when the renegotiated price exceeds the contracted price,  $\hat{p} > \bar{p}$ , or when he prefers the contracted good,  $\hat{v} < \bar{v}$ . In a similar fashion, the seller feels a loss when  $\hat{p} < \bar{p}$ , or when the renegotiated good is more costly to produce than the contracted one,  $\hat{c} > \bar{c}$ . It seems plausible the parties' degree of loss aversion is the same as on date 3. In both cases, they compare the good they are emotionally attached to,  $\bar{x}$ , to an alternative ( $x^{out}$  on date 3 and  $\hat{x}$  on date 2). To keep the notation simple, I just write  $\lambda$ , however, it is useful to keep in mind  $\lambda$  must be replaced with  $\lambda^{opt}$  whenever we consider an option contract specifically. Spot contracts  $(\hat{x}, \hat{p})$  satisfying conditions (10) and (11) are called individually rational. Specifically, the renegotiation set  $X_1$  consists of all goods  $\hat{x}$  for which there

exists a price  $\hat{p}$  so that  $(\hat{x}, \hat{p})$  is individually rational. The following proposition characterizes the set:

**Proposition 1** *Suppose the parties meet on date 2, state  $\theta \in \Theta$  is realized, and the disagreement outcome is that the long-term contract is performed on date 3. The renegotiation set  $X^1$  consists of any good  $\hat{x} \in X$  for which there exists a price  $\hat{p}$  so that  $\hat{U}^{B1} \geq U^{B1}$  and  $\hat{U}^{S1} \geq U^{S1}$  or equivalently*

- (a)  $\hat{v} \geq \bar{v}$  and  $\bar{c} \geq \hat{c}$ , or
- (b)  $\hat{v} > \bar{v}$ ,  $\bar{c} < \hat{c}$  and

$$\hat{v} - \bar{v} \geq (1 + \lambda)^2[\hat{c} - \bar{c}], \quad (12)$$

or

- (c)  $\hat{v} < \bar{v}$ ,  $\bar{c} > \hat{c}$  and

$$\bar{c} - \hat{c} \geq (1 + \lambda)^2[\bar{v} - \hat{v}]. \quad (13)$$

I omit the proof and refer the reader to the proof of Proposition 1 in H&S (2015). To understand the proposition, it is worth recalling the buyer's,  $U^{B1} = \bar{v} - \bar{p}$ , and the seller's,  $U^{S1} = \bar{p} - \bar{c}$ , disagreement outcomes. When (a)  $\hat{v} \geq \bar{v}$  and  $\bar{c} \geq \hat{c}$ , leaving the price unchanged,  $\hat{p} = \bar{p}$ , ensures signing a spot contract on  $\hat{x}$  is individually rational for both parties. In case (b), accepting the spot contract is individually rational for the seller when she is compensated for her higher production costs by receiving a sufficiently high price  $\hat{p} > \bar{p}$ . More precisely, the price increase must be at least  $\hat{p} - \bar{p} = (1 + \lambda)[\hat{c} - \bar{c}]$ , i.e., it must compensate for the seller's material loss,  $\hat{c} - \bar{c}$ , plus her additional feelings of losses,  $\lambda[\hat{c} - \bar{c}]$ . Considering the buyer, the price increase decreases his utility by  $(1 + \lambda)[\hat{p} - \bar{p}]$ . Consequently, signing the spot contract is individually rational for him when this term does not exceed his increase in utility,  $\hat{v} - \bar{v}$ . That is when  $(1 + \lambda)[\hat{p} - \bar{p}] \leq \hat{v} - \bar{v}$ . The intuition behind case (c) is very similar and thus omitted. It is noteworthy the size of the renegotiation set  $X^1$  is decreasing in the degree of loss aversion  $\lambda$  but does not depend on the initial price  $\bar{p}$ .

**The reference point is that the parties trade  $x^{out}$  for  $p^{out}$  on the market**

Trading on the market is the reference point during (re)negotiation either when (ii) the parties did sign a long-term contract but anticipate they will not perform it, or (iii) when they did not sign a long-term contract. Before I derive conditions for when it is individually rational for the parties to sign a spot contract on  $(\hat{p}, \hat{x})$ , it is worth recalling their disagreement utilities when (re)negotiation does not succeed. These are given by  $U^{B0}$  and  $U^{S0}$  in case (ii), and by  $U^{B-1}$  and  $U^{S-1}$  in case (iii), see Lemma 1. As explained, case (ii) is particularly interesting because by signing the spot contract the parties incur feelings of losses yet may also prevent future feelings of losses. But how are these evaluated exactly? To see the issue, suppose

the generic good is more expensive than the contracted good,  $p^{out} > \bar{p}$ . Does the buyer feel a loss when the renegotiated price  $\hat{p}$  exceeds the one of the generic good,  $\hat{p} > p^{out}$ , or when

$$\hat{p} > p^{out} + \lambda[p^{out} - \bar{p}] ? \quad (14)$$

This would entail he compares the renegotiated price  $\hat{p}$  to the price he would pay for the generic good plus feelings of losses he would incur on date 3 due to trading the generic good  $x^{out}$  instead of the contracted one  $\bar{x}$ . This seems unreasonable in many situations. Consider for example that  $\lambda = 1$ ,  $\hat{p} = 3$ ,  $p^{out} = 2$ , and  $\bar{p} = 1$ . Inserting these numbers into inequality (14) reveals both sides are equal to 3, and consequently, the buyer does not feel any losses even though the renegotiated good is more expensive than the generic good,  $\hat{p} = 3 > 2 = p^{out}$ . Thus, it seems plausible to assume the buyer simply feels a loss when  $\hat{p} > p^{out}$ , in which case his feelings of losses are  $\lambda[\hat{p} - p^{out}]$ . I can now state the condition for when it is individually rational for the buyer to sign the spot contract:

$$\begin{aligned} \hat{U}^{B0} &= \hat{v} - \hat{p} - \lambda^{out}[v^{out} - \hat{v}]^+ - \lambda^{out}[\hat{p} - p^{out}]^+ \\ &\geq v^{out} - p^{out} - \{\lambda[\bar{v} - v^{out}]^+ + \lambda[p^{out} - \bar{p}]^+\} = U^{B0}, \end{aligned} \quad (15)$$

where  $\lambda^{out}$  is the parties' degree of loss aversion on date 2 when the disagreement outcome is that they trade the generic good  $x^{out}$ . I assume  $\lambda^{out} \leq \lambda$ , since the parties are presumably less emotionally attached to the generic good  $x^{out}$  compared to the contracted good  $\bar{x}$ . The terms inside the curly bracket are the buyer's feelings of losses when his disagreement outcome is realized, i.e., when he trades on the market because the long-term contract is not performed. Avoiding these feelings of losses mitigates the feelings of losses arising when renegotiation succeeds and thus makes it more likely the parties can reach an agreement. Signing the spot contract is individually rational for the seller when

$$\begin{aligned} \hat{U}^{S0} &= \hat{p} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ - \lambda^{out}[p^{out} - \hat{p}]^+ \\ &\geq p^{out} - c^{out} - \{\lambda[c^{out} - \bar{c}]^+ + \lambda[\bar{p} - p^{out}]^+\} U^{S0}. \end{aligned} \quad (16)$$

From H&S (2015) (case (i) in the present paper) we know that when the buyer prefers the renegotiated good,  $\hat{v} > \bar{v}$ , but it is more costly to produce for the seller,  $\hat{c} > \bar{c}$ , the renegotiated price must be higher than the contracted price to compensate the seller,  $\hat{p} > \bar{p}$ . The present case (ii) is not so straightforward. To derive the direction of the price adjustment, we check which party, if any, is worse off if the price is unchanged,  $\hat{p} = p^{out}$ . The buyer is worse off when

$$\hat{v} - v^{out} - \lambda^{out}[v^{out} - \hat{v}]^+ + \{\lambda[\bar{v} - v^{out}]^+ + \lambda[p^{out} - \bar{p}]^+\} < 0 \quad (17)$$

and the seller is when

$$c^{out} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ + \{\lambda[c^{out} - \bar{c}]^+ + \lambda[\bar{p} - p^{out}]^+\} < 0, \quad (18)$$

see (15) and (16). When the left-hand side of (17) is smaller than zero, signing the spot contract is not individually rational for the buyer unless he is compensated by a sufficiently low price,  $\hat{p} < p^{out}$ . Similarly, the seller needs to be compensated by a higher price,  $\hat{p} > p^{out}$ , when the left-hand side of 18 is negative. The following proposition characterizes the renegotiation set denoted  $X^0$ .

**Proposition 2** *Suppose the parties meet on date 2, state  $\theta \in \Theta$  is realized, and the disagreement outcome is that the long-term contract is not performed on date 3. The renegotiation set  $X^0$  consists of any  $\hat{x} \in X$  for which there exists a price  $\hat{p}$  so that  $\hat{U}^{B0} \geq U^{B0}$  and  $\hat{U}^{S0} \geq U^{S0}$  or equivalently*

- (a)  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ \geq 0$  and  $\Delta_c + \lambda[\bar{p} - p^{out}]^+ \geq 0$ , or  
(b)  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ > 0$ ,  $\Delta_c + \lambda[\bar{p} - p^{out}]^+ < 0$ , and

$$\Delta_v + (1 + \lambda^{out})\Delta_c \geq -\lambda\{[p^{out} - \bar{p}]^+ + (1 + \lambda^{out})[\bar{p} - p^{out}]^+\}, \quad (19)$$

or

- (c)  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ < 0$ ,  $\Delta_c + \lambda[\bar{p} - p^{out}]^+ > 0$ , and

$$(1 + \lambda^{out})\Delta_v + \Delta_c \geq -\lambda\{(1 + \lambda^{out})[p^{out} - \bar{p}]^+ + [\bar{p} - p^{out}]^+\}, \quad (20)$$

where

$$\begin{aligned} \Delta_v &= \hat{v} - v^{out} - \lambda^{out}[v^{out} - \hat{v}]^+ + \lambda[\bar{v} - v^{out}]^+ \text{ and} \\ \Delta_c &= c^{out} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ + \lambda[c^{out} - \bar{c}]^+. \end{aligned}$$

In case (a), signing the renegotiated spot contract is individually rational for both parties, for example when the spot price is equal to the price of the generic good,  $\hat{p} = p^{out}$ , see (15) and (16). Recalling case (a) from Proposition 1, the intuition behind why leaving the price unchanged ( $\hat{p} = \bar{p}$ ) worked was that both parties preferred trading the renegotiated good,  $\hat{v} \geq \bar{v}$  and  $\hat{c} \leq \bar{c}$ . In Proposition 2, and when  $\hat{p} = p^{out}$ , signing the spot contract is individually rational for the buyer when  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ \geq 0$ , where  $\Delta_v$  collects all valuation terms. Here,  $\lambda[p^{out} - \bar{p}]^+$  are the buyer's (weakly positive) feelings of losses occurring when renegotiation does not succeed and the parties trade on the market instead. The buyer prefers trading the renegotiated good  $\hat{x}$  to trading the generic good  $x^{out}$  when  $\hat{v} - \lambda^{out}[v^{out} - \hat{v}]^+ > v^{out} - \lambda[\bar{v} - v^{out}]^+$ . In both cases, he may incur feelings of losses: When renegotiation succeeds when he prefers the generic good,  $v^{out} > \hat{v}$ , and otherwise when he prefers the good stipulated in the long-term contract to the generic good,  $\bar{v} > v^{out}$ .<sup>7</sup>

In case (c), the buyer would be worse off when the price remained unchanged and consequently needs to be compensated by a lower price so that  $\hat{p} - p^{out} < \Delta_v + \lambda[p^{out} - \bar{p}]^+$ , where the terms on the right-hand side have been explained in case (i). The seller is only willing to accept the lower price when  $(1 + \lambda^{out})[p^{out} - \hat{p}] < \Delta_c + \lambda[\bar{p} - p^{out}]^+$  or equivalently when his utility loss induced by the lower price is offset by his gain from signing the spot contract. This gain consists of avoiding future feelings of losses,  $\lambda[\bar{p} - p^{out}]^+$ , occurring when the market price  $p^{out}$  is lower

<sup>7</sup>In extreme cases the buyer may actually prefer trading the renegotiated good even when he materially prefers the renegotiated good,  $v^{out} > \hat{v}$ . This somewhat paradoxical case may occur when the seller has the option and the parties anticipate he is not going to execute it, and when the buyer strongly prefers the contracted good over the generic good, or more precisely when  $\lambda[\bar{v} - v^{out}]$  is sufficiently large. By agreeing to the spot contract, he avoids these feelings of losses. Consequently, the set  $X_0$  may even be larger than under the absence of loss aversion.



than the contracted price  $\bar{p}$ . In addition, signing the spot contract may be better from a cost perspective. The term  $\Delta_c$  contains the material cost difference  $\hat{c} - c^{out}$  plus the seller's feelings of losses occurring when she does sign the spot contract,  $(-\lambda^{out}[\hat{c} - c^{out}]^+)$ , or when she does not,  $\lambda[c^{out} - \bar{c}]^+$ . The intuition behind case (b) is very similar and thus omitted. An interesting insight is that, in contrast to H&S (2015), the price stipulated in the long-term contract,  $\bar{p}$ , matters for the size of the renegotiation set:

**Proposition 3** *The renegotiation set  $X^0$  is increasing in the price difference  $|\bar{p} - p^{out}|$ . Moreover, any good  $\hat{x}$  for which it holds  $\hat{v} > v^{out}$  can be reached by renegotiation when  $\bar{p} - p^{out}$  is sufficiently large. Likewise, any good  $\hat{x}$  with  $\hat{c} < c^{out}$  can be reached by renegotiation when  $\bar{p} - p^{out}$  is sufficiently large in a negative sense.*

Proposition 3 implies any good that is superior from a material perspective ( $\hat{v} - \hat{c} > v^{out} - c^{out}$ ) can be reached by renegotiation. In other words, loss aversion does not shrink the renegotiation set in the considered situation. In other words, the parties do not experience a breakdown of renegotiation *given* the disagreement outcome is that the long-term contract is not performed. The caveat is, of course, that the disagreement outcome is not fixed. For instance, under a specific performance contract, the larger the price difference  $|\bar{p} - p^{out}|$ , the more attractive it is for one of the parties to enforce performance on date 3. Finally, let us briefly consider the parties did not write a long-term contract on date 0, but meet to negotiate a spot contract from scratch.

**Proposition 4** *Suppose the parties meet on date 2, state  $\theta \in \Theta$  is realized, and the disagreement outcome is that the parties trade the generic good  $x^{out}$  on the market. The renegotiation set  $X^{-1}$  consists of any good  $\hat{x} \in X$  for which there exists a price  $\hat{p}$  so that  $\hat{U}^{B0} \geq U^{B-1}$  and  $\hat{U}^{S0} \geq U^{S-1}$  or equivalently*

- (a)  $\hat{v} \geq v^{out}$  and  $c^{out} \geq \hat{c}$ , or
- (b)  $\hat{v} > v^{out}$ ,  $c^{out} < \hat{c}$  and

$$\hat{v} - v^{out} \geq (1 + \lambda^{out})^2[\hat{c} - c^{out}], \quad (21)$$

or

- (c)  $\hat{v} < v^{out}$ ,  $c^{out} > \hat{c}$  and

$$c^{out} - \hat{c} \geq (1 + \lambda^{out})^2[v^{out} - \hat{v}]. \quad (22)$$

The conditions in Proposition 4 are very similar to those in Proposition 1 and I hence omit the proof. Comparing Propositions 4 and 2 shows the renegotiation set is larger when the parties wrote a long-term contract compared to when they did not, even though the material disagreement outcome is exactly the same, namely that the parties trade  $x^{out}$  on the market. As explained, this roots back to the fact that the disagreement outcome is worse in Proposition 2.

## The renegotiation outcome

After having characterized the renegotiation sets, let us consider the actual outcome of renegotiation. Like in H&S (2015), this outcome is the spot contract maximizing the following Generalized Nash Product (GNP):

$$(\hat{x}_i(\theta), \hat{p}_i(\theta)) \equiv \arg \max_{x,p} (\hat{U}^{Bi}(x, p|\theta) - U^{Bi})^\alpha \cdot (\hat{U}^{Si}(x, p|\theta) - U^{Si})^{1-\alpha}, \quad (23)$$

where  $i \in \{-1, 0, 1\}$  indicates the date 3 outcome should renegotiation not succeed and  $\alpha \in [0, 1]$  can be interpreted as the buyer's bargaining power. For instance,  $\hat{U}^{B1}$  and  $\hat{U}^{S1}$  are the parties' utilities under the renegotiated spot contract and  $U^{B1}$  and  $U^{S1}$  are their disagreement utilities, when the long-term contract is performed. To state the exact renegotiation outcome requires additional assumptions on the renegotiation problem. These will be imposed when comparing the performance of the different contracts in the following sections. However, even without added assumptions, it is possible to derive the renegotiated price for a *given* renegotiated good. Let us first consider that the reference point during renegotiation is that the long-term contract is performed ( $i = 1$ ). H&S (2015) derive the renegotiated price  $\hat{p}(\theta)$  for a given renegotiated good  $\hat{x}(\theta)$  in their Proposition 2,<sup>8</sup> which I replicate below:

**Proposition 5 (Herweg and Schmidt)** *Suppose  $(\hat{x}(\theta), \hat{p}(\theta))$  maximize the GNP given in (23) when  $i = 1$ . For a given good  $\hat{x}(\theta)$ , the renegotiated price  $\hat{p}(\theta)$  is given by:*

$$\hat{p}(\theta) = \begin{cases} \bar{p} + (1 - \alpha) \frac{1 + \lambda_{v+}}{1 + \lambda} (\hat{v} - \bar{v}) + \alpha (1 + \lambda_{c+}) (\hat{c} - \bar{c}) \equiv \bar{p} + \Delta_{p+}^1, & \text{if } \Delta_{p+}^1 \geq 0 \\ \bar{p}, & \text{otherwise} \\ \bar{p} + (1 - \alpha) (1 - \lambda_{v+}) (\hat{v} - \bar{v}) + \alpha \frac{1 + \lambda_{c+}}{1 + \lambda} (\hat{c} - \bar{c}) \equiv \bar{p} + \Delta_{p-}^1, & \text{if } \Delta_{p-}^1 \leq 0 \end{cases} \quad (24)$$

$$\text{with } \lambda_{v+} = \begin{cases} \lambda, & \text{if } \bar{v} - \hat{v} \geq 0 \\ 0, & \text{otherwise} \end{cases}, \text{ and } \lambda_{c+} = \begin{cases} \lambda, & \text{if } \bar{c} - \hat{c} \leq 0 \\ 0, & \text{otherwise} \end{cases}.$$

To understand the intuition behind Proposition 5 it is useful recalling the parties cannot transfer utility one-to-one due to loss aversion. Let us consider that the buyer prefers the renegotiated good, but it is also more costly to produce,  $\hat{v} > \bar{v}$  and  $\hat{c} > \bar{c}$ . For  $\hat{x}$  to be part of the renegotiation set  $X^1$  condition 12 must be satisfied. In the considered situation, the price must be increased to compensate the seller for her higher cost of production. Proposition 5 reveals that the renegotiated price is increased to

$$\hat{p} = \bar{p} + (1 - \alpha) \frac{1}{1 + \lambda} (\hat{v} - \bar{v}) + \alpha (1 + \lambda) (\hat{c} - \bar{c}) > \bar{p}.$$

<sup>8</sup>To keep the notation simple, I drop the subscript  $i$  and just write  $\hat{p}$  whenever it is clear which case I am referring to.

If the buyer has all the bargaining power,  $\alpha = 1$ , the seller is compensated exactly for his perceived loss,  $\hat{p} = \bar{p} + (1 + \lambda)(\hat{c} - \bar{c})$ . And when the buyer has zero bargaining power, the renegotiated price simplifies to  $\hat{p} = \bar{p} + \frac{1}{1+\lambda}(\hat{v} - \bar{v})$ , meaning the seller appropriates the buyer's utility increase originating from receiving a better product.<sup>9</sup> Now suppose both parties prefer the renegotiated good,  $\hat{v} > \bar{v}$  and  $\hat{c} < \bar{c}$ . In this case, the price change can go in any direction, or the price is not adjusted at all. Specifically, the price is not adjusted when  $\Delta_{p+}^1 < 0 < \Delta_{p-}^1$  or equivalently

$$(1 - \alpha) \frac{1}{1 + \lambda} (\hat{v} - \bar{v}) + \alpha (\hat{c} - \bar{c}) < 0 < (1 - \alpha) (\hat{v} - \bar{v}) + \alpha \frac{1}{1 + \lambda} (\hat{c} - \bar{c}). \quad (25)$$

Consequently, the price is not adjusted when both parties have some bargaining power and  $|\bar{v} - \hat{v}|$  and  $|\hat{c} - \bar{c}|$  are close together.<sup>10</sup>

**The reference point is that the parties trade  $x^{out}$  for  $p^{out}$  on the market**

When the disagreement outcome is that the long-term contract is not performed, the renegotiated price is given by the following proposition:

**Proposition 6** *Suppose  $(\hat{x}(\theta), \hat{p}(\theta))$  maximize the GNP given in (23) when  $i = 0$ . For a given good  $\hat{x}(\theta)$ , the renegotiated price  $\hat{p}(\theta)$  is given by:*

$$\hat{p}(\theta) = \begin{cases} p^{out} + \frac{1-\alpha}{1+\lambda^{out}} [\Delta_v + \lambda[p^{out} - \bar{p}]^+] - \alpha [\Delta_c + \lambda[\bar{p} - p^{out}]^+] \equiv p^{out} + \Delta_{p+}^0, & \text{if } \Delta_{p+}^0 \geq 0 \\ p^{out}, & \text{otherwise} \\ p^{out} + (1 - \alpha) [\Delta_v + \lambda[p^{out} - \bar{p}]^+] - \frac{\alpha}{1+\lambda^{out}} [\Delta_c + \lambda[\bar{p} - p^{out}]^+] \equiv p^{out} + \Delta_{p-}^0, & \text{if } \Delta_{p-}^0 \leq 0 \end{cases} \quad (26)$$

with  $\Delta_v = \hat{v} - v^{out} - \lambda^{out}[v^{out} - \hat{v}]^+ + \lambda[\bar{v} - v^{out}]^+$  and  $\Delta_c = c^{out} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ + \lambda[c^{out} - \bar{c}]^+$ .

As in Proposition 24, the price must be adjusted if no adjustment would mean one party is worse off (and the other is better off) compared to the disagreement outcome. Suppose it is the buyer who is better off, implying he either prefers the renegotiated good,  $\hat{v} > v^{out}$  and/or would incur substantial feelings of losses should renegotiation fail, i.e.,  $\lambda[\bar{v} - v^{out}]^+ + \lambda[p^{out} - \bar{p}]^+$  is sufficiently large, recall (17). The seller is worse off when her higher cost of production is not offset by the fact she avoids incurring feelings of losses when renegotiation succeeds, or equivalently

$$c^{out} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ + (\lambda[c^{out} - \bar{c}]^+ + \lambda[\bar{p} - p^{out}]^+) < 0.$$

<sup>9</sup>To see this, recall the buyer's utility is  $\hat{U}^{B1} = \hat{v} - \hat{p} - \lambda[\hat{p} - \bar{p}]^+$ . After substituting for  $\hat{p}$ , this expression simplifies to  $\hat{U}^{B1} = \bar{v} - \bar{p}$ , which is exactly the buyer's disagreement utility.

<sup>10</sup>H&S (2015) write that the parties do not adjust the price when the absolute values  $|\bar{v} - \hat{v}|$  and  $|\hat{c} - \bar{c}|$  are small and both parties have bargaining power. This is not entirely correct. To see the point, suppose  $\alpha = 0.5$  and  $\lambda = 1$ . From the inequalities in (25) we know that the price is not adjusted when  $-0.5(\hat{c} - \bar{c}) < \bar{v} - \hat{v} < -2(\hat{c} - \bar{c})$ . This reveals  $|\bar{v} - \hat{v}|$  and  $|\hat{c} - \bar{c}|$  can be arbitrarily large or small but must be sufficiently close together. The more equal the bargaining powers and the larger the degree of loss aversion, the less sense it makes to adjust the price. For example, when  $\hat{v} - \bar{v} = \bar{c} - \hat{c} > 0$  and  $\alpha = 0.5$ , any price change causes feelings of losses and hence cannot maximize the GNP given  $\hat{x}$  is held constant.

To compensate the seller, the renegotiated price is increased to

$$\hat{p} = p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}} [\Delta_v + \lambda[p^{out} - \bar{p}]^+] - \alpha[\Delta_c + \lambda[\bar{p} - p^{out}]^+] > p^{out},$$

where  $\Delta_v = \hat{v} - v^{out} - \lambda^{out}[v^{out} - \hat{v}]^+ + \lambda[\bar{v} - v^{out}]^+$  collects all valuation terms and  $\Delta_c = c^{out} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ + \lambda[c^{out} - \bar{c}]^+$  collects all cost terms. When the buyer has all the bargaining power ( $\alpha = 1$ ), the price increase compensates the seller for his utility loss which explains  $-[\Delta_c + \lambda[\bar{p} - p^{out}]^+]$ . Her utility loss is increasing in the cost of the renegotiated good, but is decreasing in  $\lambda[c^{out} - \bar{c}]^+$  and  $\lambda[\bar{p} - p^{out}]^+$ , which are the feelings of losses the seller avoids incurring on date 3. If the seller has all the bargaining power,  $\alpha = 0$ , the price is increased so that the buyer is made indifferent between trading the generic good  $x^{out}$  and trading  $\hat{x}$  with the seller or equivalently  $(1 + \lambda^{out})(\hat{p} - p^{out}) = \Delta_v + \lambda[p^{out} - \bar{p}]^+$ , see (15). Interestingly, as long as  $\bar{p} < p^{out}$ , the lower the price stipulated in the long-term contract  $\bar{p}$ , the higher is the price adjustment. This roots back to the fact the buyer's disagreement utility  $U^{B0}$  is increasing in  $\bar{p}$  and consequently reaching an agreement with the seller becomes more important for the buyer the lower  $\bar{p}$ .

When  $\hat{p} = p^{out}$  would mean the buyer is worse off compared to receiving her disagreement outcome, the price is reduced,  $\hat{p} < p^{out}$ , to compensate the buyer. Finally, the price change can go in any direction when both parties would be better off trading  $\hat{x}$  for  $\hat{p} = p^{out}$  compared to trading on the market. As I discussed under Proposition 5, the higher the degree of loss aversion  $\lambda^{out}$  and the more equal the parties' bargaining powers, the less likely it is the price is adjusted. A high degree of loss aversion  $\lambda^{out}$  means the parties incur substantial feelings of losses when the price is adjusted, reducing the GNP. The role of  $\lambda$  is ambiguous. To see this, suppose  $\Delta_{p+}^0$  is positive, meaning the price is adjusted upwards,  $\hat{p} > p^{out}$ . As  $\lambda$  increases, the parties' feelings of losses should the disagreement outcome materialize also increase. The price adjustment is increasing in the buyer's feelings of losses,  $\lambda[p^{out} - \bar{p}]^+ + \lambda[\bar{v} - v^{out}]^+$ , but decreasing in the seller's,  $\lambda[\bar{p} - p^{out}]^+ + \lambda[c^{out} - \bar{c}]^+$ .

Let us briefly consider the parties did not write a long-term contract on date 0. Then, the disagreement outcome is still that they trade  $x^{out}$  on the market. However, they do not incur feelings of losses when the disagreement outcome is realized since the reference point, the long-term contract, is missing. Consequently, the renegotiated price is given by Proposition 5 after substituting  $c^{out}$ ,  $v^{out}$ ,  $p^{out}$ , and  $\lambda^{out}$  for  $\bar{c}$ ,  $\bar{v}$ ,  $\bar{p}$ , and  $\lambda$ , respectively.

### 2.3 The social surplus of a long-term contract compared to a spot contract

Let us briefly consider the social surplus generated by writing a long-term contract from an ex-ante perspective. From an ex-post perspective, renegotiation ensures that the outcome is efficient in utility terms. However, due to loss aversion, the parties may not be willing to renegotiate at all, and if they do they maximize the GNP (23) and not the material social surplus  $S(x, \theta) = v(x, \theta) - c(x, \theta)$ . In

addition, they incur feeling of losses, all of which is inefficient from an ex-ante perspective. The ex-post social surplus of a long-term contract that is renegotiated to  $(\hat{x}, \hat{p})$  depends on disagreement outcome should renegotiation not succeed. When the disagreement outcome is that the long-term contract is performed it is given by

$$S(\theta|\bar{x}, \bar{p}, \lambda) = \hat{v} - \hat{c} - \{\lambda[\bar{v} - \hat{v}]^+ + \lambda[\bar{c} - c^{out}]^+ + \lambda|\hat{p} - \bar{p}|\}. \quad (27)$$

Otherwise, the ex-post social surplus is

$$S(\theta|\bar{x}, \bar{p}, \lambda) = \hat{v} - \hat{c} - \{\lambda^{out}[v^{out} - \hat{v}]^+ + \lambda^{out}[\hat{c} - c^{out}]^+ + \lambda^{out}|\hat{p} - p^{out}|\}. \quad (28)$$

see also (10), (11), (15), and (16) for the parties' ex-post utilities. It is worth recalling the renegotiated prices  $\hat{p}$  are not the same as they depend on the disagreement outcome during renegotiation, which is different. From an ex-ante perspective, the efficiency loss induced by a long-term contract with renegotiation is the expectation of materially efficient surplus,  $S^*(\theta) = \max_x v(x, \theta) - c(x, \theta)$ , minus the expected surplus the parties reach through renegotiation:

$$L(\lambda, \bar{x}, \bar{p}, \alpha) = E_\theta[S^*(\theta) - S(\theta|\bar{x}, \bar{p}, \lambda)]. \quad (29)$$

H&S (2015) explain the efficiency loss is increasing in the parties' degree of loss aversion  $\lambda$ . After all, the renegotiated good may not be the efficient good and the disutility from the parties' feeling of losses is increasing in their degree of loss aversion.<sup>11</sup> But in contrast to H&S (2015), the efficiency loss of the long-term contract depends on the contracted price  $\bar{p}$ . As explained,  $\bar{p}$  influences the likelihood the contract is performed on date 3, and consequently the renegotiation outcome on date 2, recall the discussion below Proposition (2).

### 3 Long-term contracts vs spot contracts

In this section, I revisit the question of whether the parties are better off writing a long-term contract on date 0 compared to writing a spot contract after the state has been realized on date 2. As discussed, and in contrast to H&S (2015), the price  $\bar{p}$  stipulated in the long-term contract matters for efficiency. This raises the question of whether the parties suffer from loss aversion on date 0 when writing the long-term contract. If not, they can choose the price  $\bar{p}$  that maximizes the expected joint utility and divide the expected surplus by transferring money

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<sup>11</sup>This is typically correct. In extreme cases, however, the efficiency loss may be decreasing in  $\lambda$ . Consider for example there is just one possible renegotiated good with  $\hat{v} > \bar{v}$  and  $\hat{c} < \bar{c}$ , meaning the parties only suffer feelings of losses due to the price adjustment  $\lambda|\hat{p} - \bar{p}|$ . Since the price adjustment is decreasing in  $\lambda$ , a higher degree of loss aversion may decrease the efficiency loss. It is useful recalling inequalities (25). Everything else constant, these inequalities hold for a sufficiently high  $\lambda$ , meaning the price is only adjusted when  $\lambda$  is low. For example, when  $\hat{v} = 20 > 10 = \bar{v}$ ,  $\hat{c} = 5 < \bar{c} = 10$ , and  $\alpha = 0.5$ , the price is not adjusted when  $\lambda > 1$ .

from one party to another on date 0. H&S (2015) argue loss aversion on date 0 is of second-order importance since it is natural that it is easier to find alternative trading partners on date 0 compared to ex-post. These trading partners may be willing to enter into a similar contractual arrangement and hence the feelings of losses on date 0 are small. However, it is unclear to which degree loss-averse parties can use  $\bar{p}$  as a strategic instrument. Consequently, I first consider that the parties simply set the price equal to the one of the generic good  $\bar{p} = p^{out}$  and subsequently how they can improve upon that.

### 3.1 Specific performance compared to spot contracting

I adopt the following simple setting from H&S (2015). There exist  $n \geq 2$  states of the world  $\{\theta_1, \dots, \theta_n\} \equiv \Theta$  and specifications  $\{x_1, \dots, x_n\} \equiv X$ . Good  $x_i$  is materially efficient only in state  $\theta_i$ , that is  $x^*(\theta_i) = x_i$ . The probability that state  $i$  arises is denoted  $\pi_i$  with  $\sum_{i=1}^n \pi_i = 1$  and  $\pi_i \leq \pi_1$  for all  $i \geq 2$ . When the parties trade good  $i$  with one another in state  $\theta_i$  their material utilities are

$$U^B = v^* - p \text{ and } U^S = p - c^*, \text{ respectively,} \quad (30)$$

and if they trade some good  $j \neq i$ , the material utilities are given by

$$U^B = \underline{v} - p \text{ and } U^S = p - \underline{c}, \quad (31)$$

with  $v^* - c^* > \underline{v} - \underline{c} > 0$  and  $v^* - c^* > v^{out} - c^{out} > 0$ . It is worth recalling that the parties' reference point during (re)negotiation on date 2 is the outcome that obtains on date 3 should renegotiation not succeed. It is straightforward which good the parties stipulate in case of a specific performance contract:

**Lemma 4** *The optimal specific performance contract specifies  $\bar{x} = x_1$ . In state  $\theta_1$ , the parties enforce specific performance on date 3 independent of the price  $\bar{p}$  stipulated in contract and the contract is not renegotiated on date 2.*

The intuition behind Lemma 4 is that there are only two configurations of cost and benefit, and state  $\theta_1$  occurs with the highest probability. As a consequence, the specific performance contract optimally stipulates  $\bar{x} = x_1$ . We know from Lemma 2 that the contract is enforced on date 3 in state  $\theta_1$ . Since  $x_1$  is materially efficient, the parties do not renegotiate the contract on date 2. What happens in a “bad” state  $\theta_i \neq \theta_1$  depends on the parameter constellation.

$$v^* > v^{out} > \underline{v} \text{ and } c^* > \underline{c} > c^{out}$$

In this interesting case the parties prefer the generic good,  $x^{out}$ , to the contracted one,  $\bar{x}$ , in the bad states but not in the good state. Whether the specific performance contract is enforced in a bad state  $\theta_i \neq \theta_1$  depends on the price  $\bar{p}$  stipulated in contract. However, let us first consider the parties did not write a long-term contract, but meet on date 2 to negotiate a spot contract. From Proposition 4 we

know the parties manage to agree on a spot contract on the materially efficient good  $x^*(\theta_i)$  when

$$v^* - v^{out} \geq (1 + \lambda^{out})^2 [c^* - c^{out}] \Leftrightarrow \lambda^{out} \leq \sqrt{\frac{v^* - v^{out}}{c^* - c^{out}}} - 1 \equiv \bar{\lambda}^{out},$$

where  $\lambda^{out} \leq \lambda$  is the parties' degree of loss aversion under a spot contract. The negotiated price  $\hat{p}$  is given by

$$\hat{p} = p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}} (v^* - v^{out}) + \alpha(1 + \lambda^{out})(c^* - c^{out}),$$

see Proposition (5) after replacing  $\bar{v}$  with  $v^{out}$  etc. If the parties' degree of loss aversion is high,  $\lambda^{out} > \bar{\lambda}^{out}$ , the negotiations, on date 2, do not succeed and they trade the generic good,  $x^{out}$ , on the market. From an ex-ante perspective, the surplus under a spot contract is

$$S^{SC} = \begin{cases} v^* - c^* - \lambda^{out} \left\{ \frac{1 - \alpha}{1 + \lambda^{out}} (v^* - v^{out}) + [1 + \alpha(1 + \lambda^{out})] (c^* - c^{out}) \right\}, & \text{if } \lambda^{out} \leq \bar{\lambda}^{out} \\ v^{out} - c^{out}, & \text{if } \lambda^{out} > \bar{\lambda}^{out}. \end{cases} \quad (32)$$

The first line summarizes the parties' joint surplus when their degree of loss aversion,  $\lambda^{out}$ , is low and spot contracting succeeds. Note that  $-\lambda^{out}$  times the large term inside the curly brackets is equal to  $-\lambda^{out} \{c^* - \bar{c} + \hat{p} - p^{out}\}$ . It thus consists of the seller's feeling of losses arising because the renegotiated good is more costly to produce than the generic good, plus the buyer's feeling of losses due to the negotiated price being higher than the price of the generic good. The second line gives the parties' joint surplus when spot contracting fails in which case they simply trade the generic good on date 3.

Now let us consider the specific performance contract. Simply setting the contracted price equal to the one of the generic good,  $\bar{p} = p^{out}$ , ensures the contract is enforced in the good state only. According to Proposition 2 (case ii), the parties manage to renegotiate to the materially efficient good  $x^*(\theta_i)$  in a bad state when

$$v^* - v^{out} \geq (1 + \lambda^{out})^2 [c^* - c^{out}] \Leftrightarrow \lambda^{out} \leq \sqrt{\frac{v^* - v^{out}}{c^* - v^{out}}} - 1 \equiv \bar{\lambda}^{out},$$

which is the same condition as under a spot contract. From Proposition 6, we know that the renegotiated price is given by

$$\hat{p} = p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}} (v^* - v^{out}) + \alpha(1 + \lambda^{out})(c^* - c^{out}),$$

which is also equal to the one under the spot contract. Consequently, the ex-ante surplus of the specific performance contract is

$$S^{SP} = \begin{cases} v^* - c^* - (1 - \pi_1) \lambda^{out} \left\{ \frac{1 - \alpha}{1 + \lambda^{out}} (v^* - v^{out}) + [1 + \alpha(1 + \lambda^{out})] (c^* - c^{out}) \right\}, & \text{if } \lambda^{out} \leq \bar{\lambda}^{out} \\ \pi_1 (v^* - c^*) + (1 - \pi_1) (v^{out} - c^{out}), & \text{if } \lambda^{out} > \bar{\lambda}^{out}. \end{cases} \quad (33)$$

I can directly establish the following result that stands in stark contrast to H&S (2015):

**Proposition 7** *Suppose  $v^* > v^{out} > \underline{v}$  and  $c^* > \underline{c} > c^{out}$ . A specific performance contract stipulating  $\bar{x} = x_1$  and  $\bar{p} = p^{out}$  outperforms a spot contract.*

In the good state  $\theta_1$ , the parties enforce specific performance on date 3 and trade the materially efficient good without incurring feelings of losses. In contrast, spot contracting on date 2 fails when the parties' degree of loss aversion  $\lambda^{out}$  is high. Even when it does not, the parties incur feelings of losses. In the bad states  $\theta_i \neq \theta_1$ , the parties (re)negotiate on date 2 under both contracts. Since the disagreement outcome is exactly the same, the outcome of the (re)negotiations is also the same. As a consequence, the specific performance contract performs better in the good state  $\theta_1$  and equal to the spot contract in the bad states.

### Other cases.

In H&S (2015), the specific performance contract also performs well in the good state,  $\theta_1$ , for the reasons explained above. In the bad states, the disadvantage of the specific performance contract is twofold. First, should renegotiation not succeed, the parties trade the contracted good  $\bar{x}$ , which they may perceive inferior to the generic good  $x^{out}$ . Second, the fact they are emotionally more attached to the contracted good  $\bar{x}$ , compared to the generic good, makes renegotiation difficult, recall  $\lambda \geq \lambda^{out}$ . As a consequence, H&S (2015) find the spot contract performs better when the probability of the good state  $\pi_1$  occurring is low and/or the differences in the degrees of loss aversion is large,  $\lambda \gg \lambda^{out}$ . Moreover, H&S (2015) consider the parameter constellation,  $v^* > v^{out} > \underline{v}$  and  $c^* > c^{out} > \underline{c}$ .<sup>12</sup> What happens when we allow the parties to take the performance decision themselves in H&S (2015) constellation? When  $\bar{p} \geq p^{out}$ , the seller always enforces the contract on date 3 since the contracted good is cheaper to produce than the generic good,  $\underline{c} < c^{out}$ . Otherwise, we know from Lemma 2 the contract is not enforced when

$$\frac{v^{out} - \underline{v}}{1 + \lambda} > p^{out} - \bar{p} > (1 + \lambda)(c^{out} - \underline{c}).$$

This interval is empty when

$$\lambda > \sqrt{\frac{v^{out} - \underline{v}}{c^{out} - \underline{c}}} - 1 \equiv \tilde{\lambda},$$

meaning the contract is always enforced, on date 3, when  $\lambda$  is high and H&S (2015) results continue to hold. In contrast when  $\lambda$  is small there exist prices so that the contract is not enforced. As a consequence, the relevant degree of

<sup>12</sup> More precisely, H&S (2015) assume  $c^{out} = \beta c^* + (1 - \beta)\underline{c}$  and  $v^{out} = \beta v^* + (1 - \beta)\underline{v}$ , where  $\beta \in [0, 1]$  measures the specificity of the generic good.



loss aversion during renegotiation is  $\lambda^{out} \leq \lambda$ , implying the specific performance contract performs better than established by H&S (2015).

It is impossible to state more generally which of the two types of contracts performs better. For instance, considering  $v^* > v^{out}$  and  $c^* < c^{out}$  the parties do not suffer from loss aversion during spot contracting on date 2. Hence, writing a spot contract is optimal. Likewise, when  $v^* > \underline{v}$  and  $c^* < \underline{c}$ , a specific performance contract stipulating  $\bar{p} = p^{out}$  is optimal. The parties enforce the contract in the good state and renegotiate to the materially efficient good in the bad states. When the parties prefer the contracted good  $\bar{x}$  to the generic good in the bad states, i.e., when  $\underline{v} \geq v^{out}$  and  $\underline{c} \leq c^{out}$ , they always enforce specific performance on date 3. Consequently, the advantage of the specific performance contract is that the parties trade the contracted good  $\bar{x}$  instead of the generic good  $x^{out}$  when renegotiation fails.

### 3.2 A simple option contract

To facilitate an easy comparison, let us consider the constellation we focused on previously,  $v^* > v^{out} > \underline{v}$  and  $c^* > \underline{c} > c^{out}$ . It is straightforward the option contract specifies good  $\bar{x} = x_1$  and gives one of the parties the right to exercise the option on date 3. From Proposition 3, we know the materially efficient good can be reached by renegotiation when the disagreement outcome is that the parties trade the generic good  $x^{out}$  and the price difference  $|\bar{p} - p^{out}|$  is sufficiently large.<sup>13</sup> More intricately, the price adjustment during renegotiation also depends on the price stipulated in the long-term contract  $\bar{p}$ , meaning  $\bar{p}$  can be used as a strategic instrument to reduce the parties' feelings of losses during renegotiation. The problem with a specific performance contract is that a large price difference also ensures one of the parties enforces the contract in the bad states  $\theta_i \neq \theta_1$ . As shown by H&S (2015), this reference point makes the original long-term contract sticky and renegotiation may not succeed. Consequently, it is difficult to use the price  $\bar{p}$  as a strategic instrument under a specific performance contract. This is less of a problem under an option contract, given the correct party has the trade decision on date 3.

**Lemma 5** *The optimal option contract specifies the buyer should have the option on date 3.*

The seller should not have the option because the contracted good is more costly to produce in the good state  $\theta_1$  than in a bad state  $\theta_i \neq \theta_1$ . Hence if the seller exercises the option in the good state, she also does so in the bad state, which is inefficient.<sup>14</sup> When the buyer has the option and the price difference  $|\bar{p} - p^{out}|$  is not too large,

<sup>13</sup>Recall that setting  $\bar{p} > p^{out}$  or  $\bar{p} < p^{out}$  makes renegotiation easier since one of the parties incurs feelings of losses on date 3 when the long-term contract is not performed. By reaching an agreement on date 2, the parties avoid these feelings of losses, making it more likely an agreement is reached.

<sup>14</sup>Recall that it is optimal when the option is exercised in the good state only. This allows the parties to reach the materially efficient good without renegotiation in the good state and makes renegotiation easier in the bad states.

the option is exercised in the good state  $\theta_1$  only, which is exactly what we want. In all but extreme cases it is better to specify a high price in contract, meaning  $\bar{p} > p^{out}$  is preferable to  $\bar{p} < p^{out}$ .<sup>15</sup> Let us focus on  $\bar{p} > p^{out}$ : By increasing  $\bar{p}$ , the parties reduce the price adjustment the seller requests during renegotiation as compensation for his higher cost,  $c^* > c^{out}$ . If  $\bar{p}$  is sufficiently large, the materially efficient good can be reached by renegotiation, recall Proposition 3. However, when  $v^* - \bar{p} < v^{out} - p^{out} - \lambda^{opt}[v^* - v^{out}]$  or equivalently  $\bar{p} > (1 + \lambda^{opt})[v^* - v^{out}] + p^{out}$ , the buyer does not exercise his option in any state. This is unproblematic when the probability of the good state  $\pi_1$  occurring is small, but undesirable otherwise.

## Renegotiation always succeeds and $\bar{p}$ is set such that $\hat{p} = p^{out}$

Let us now derive the price  $\bar{p}$  ensuring the seller does not demand any price adjustment during renegotiation in the bad states  $\theta_i \neq \theta_1$ . It is worth recalling the renegotiated price is given by (26), where  $\Delta_v$  collects all valuation and  $\Delta_c$  collects all cost terms. In the considered parameter constellation, they simplify to  $\Delta_v = v^* - v^{out} > 0$  and  $\Delta_c = (1 + \lambda^{out})(c^{out} - c^*) < 0$ , respectively. Hence, we consider the first line of (26), which is equal to  $p^{out}$  when

$$\frac{1 - \alpha}{1 + \lambda^{out}}[\Delta_v + \lambda^{opt}[p^{out} - \bar{p}]^+] - \alpha[\Delta_c + \lambda^{opt}[\bar{p} - p^{out}]^+] = 0 \Leftrightarrow \quad (34)$$

$$\bar{p}^* = p^{out} + \frac{1 - \alpha}{\alpha\lambda^{opt}(1 + \lambda^{out})}\Delta_v - \frac{1}{\lambda^{opt}}\Delta_c \geq p^{out}. \quad (35)$$

Note that  $\bar{p}^*$  is decreasing in the buyer's bargaining power  $\alpha$ . To understand why, recall that when  $\bar{p} = p^{out}$  the seller is worse off when the price is unchanged,  $\hat{p} = p^{out}$ , and consequently requests a price increase. The larger the seller's bargaining power  $1 - \alpha$ , the larger is her requested price increase. Increasing the price in the long-term contract to  $\bar{p}^*$  makes the seller equally well off as would a price increase from  $p^{out}$  to  $\hat{p}$ . This is because she avoids incurring a loss of  $\lambda^{opt}[\bar{p}^* - p^{out}]$  only when renegotiation succeeds. Conversely, when the seller has all the bargaining power,  $\alpha = 0$ , there does not exist a price  $\bar{p}$  mitigating the need for a price adjustment. In that case, the renegotiated price  $\hat{p}$  obtains that simply makes the buyer indifferent between trading  $x^*$  and trading the generic good  $x^{out}$ . Since  $\bar{p}$  does not matter for the buyer's decision, it cannot be used to reduce the price adjustment  $\hat{p} - p^{out}$ .<sup>16</sup> It is also worth noticing that the stronger the parties' loss aversion,  $\lambda^{opt}$ , is on date 3, the smaller is  $\bar{p}^*$ . The effect of the parties' degree of loss aversion on date 2,  $\lambda^{out}$ , can steer  $\bar{p}^*$  in both directions.

<sup>15</sup>When  $\bar{p}$  is too large, the buyer does not exercise his option in the good state  $\theta_1$ , which is inefficient. And when it is too low, he exercises it in the bad states  $\theta_i \neq \theta_1$ , which is typically even more inefficient for the same reasons as why a specific performance contract is problematic in H&S (2015). Moreover, Proposition 2 reveals it is easier for the parties to reach an agreement when  $\bar{p} > p^{out}$ . Considering case (b),  $-\lambda^{opt}[p^{out} - \bar{p}]$  is larger than  $-\lambda^{opt}(1 + \lambda^{out})[\bar{p} - p^{out}]$ , making it more likely the condition holds for a given price difference  $|\bar{p} - p^{out}|$ .

<sup>16</sup>We are considering  $\bar{p} > p^{out}$ , meaning the buyer does not incur any feelings of losses in the price dimension when renegotiations fail and the parties trade the generic good instead of the contracted good.

**Lemma 6** Consider an option contract on  $(x_1, \bar{p}^*)$  and that the buyer has the option on date 3. In the bad states  $\theta_i \neq \theta_1$ , the buyer does not exercise his option and the parties manage to renegotiate to the materially efficient good  $x^*(\theta_i)$ .

**Proof.** On date 3, the buyer does not exercise his option in the bad states because  $v^{out} > \underline{v}$  and  $\bar{p}^* > p^{out}$ . On date 2, the parties manage to renegotiate to the materially efficient good  $x^*(\theta_i)$  because the conditions in case (i) in Proposition 2 hold. Here,  $\Delta_v + \lambda^{opt}[p^{out} - \bar{p}]^+$  simplifies to  $v^* - v^{out} > 0$ . The second condition  $\Delta_c + \lambda^{opt}[\bar{p}^* - p^{out}]^+ \geq 0$  can be rewritten as  $\bar{p}^* \geq p^{out} - \frac{\Delta_c}{\lambda^{opt}}$ . The expression on the left-hand-side is equal to  $\bar{p}^*$  when the buyer has all the bargaining power,  $\alpha = 1$ , and is smaller otherwise. ■

Recalling that during renegotiation the price is unchanged,  $\hat{p} = p^{out}$ , we now have all the ingredients to state the ex-ante expected surplus of the option contract:

**Proposition 8** Consider an option contract on  $(x_1, \bar{p}^*)$  and that the buyer has the option on date 3. When  $\bar{p}^* \leq (1 + \lambda^{opt})[v^* - v^{out}] + p^{out}$ , the buyer exercises his option in state  $\theta_1$  only. The ex-ante surplus of the option contract is given by:

$$S^{opt1} = \pi_1(v^* - c^*) + (1 - \pi_1)[(v^* - c^*) - \lambda^{out}(c^* - c^{out})].$$

When  $\bar{p}^* > (1 + \lambda^{opt})[v^* - v^{out}] + p^{out}$ , the buyer never enforces the contract on date 3. The ex-ante surplus of the option contract is given by:

$$S^{opt2} = v^* - c^* - \lambda^{out}[c^* - c^{out}].$$

Let us consider the ex-ante joint surplus  $S^{opt1}$ . In the good state  $\theta_1$ , the buyer exercises his option and the parties trade the materially efficient good  $x^*(\theta_1)$  without incurring feelings of losses. In the bad states, occurring with probability  $1 - \pi_1$ , the buyer does not exercise her option on date 3 and the parties renegotiate to the materially efficient good on date 2. The seller incurs feelings of losses because the materially efficient good is more expensive than the generic good. The buyer, however, does not incur any feelings of losses because the price is not adjusted during renegotiation. Note that  $S^{opt1}$  is (weakly) larger and in many cases much larger than the social surplus arising under a specific performance or a spot contract, compare (32) and (33). When  $\bar{p}^*$  is so large that the buyer does not exercise his option in the good state, the parties always renegotiate to the materially efficient good  $x^*(\theta_i)$ . It is easy to see  $S^{opt2}$  is larger than the ex-ante expected surplus under a spot contract, and also larger than the one under the optimal specific performance contract unless the probability of the good state occurring  $\pi_1$  is very high. Does this imply a specific performance contract potentially outperforms an option contract when  $\bar{p}^* > (1 + \lambda^{opt})[v^* - v^{out}] + p^{out}$  and  $\pi_1$  is large? This is of course not so. In that case, the optimal price  $\bar{p}$  is just a bit smaller than  $(1 + \lambda^{opt})(v^* - v^{out}) + p^{out}$ . This ensures the buyer exercises his option in the good state  $\theta_1$  and mitigates his feelings of losses occurring because the price is adjusted upwards from  $p^{out}$  to  $\hat{p}$ , albeit not completely.

## 4 Asset ownership, long-term contracts, and the hold up problem

The literature on incomplete contracts typically considers a situation where a buyer and/or a seller make an ex-ante investment prior to learning the state. As time passes, and the parties do learn the state, they renegotiate the contract in a Coasian fashion towards an ex-post efficient outcome. The problem here is that the investing party shares the benefit of her investment with the other party during renegotiation. Consequently, the investing party underinvests, the classical hold-up problem. There are two strands of the literature dealing with how to mitigate the hold-up problem. The property rights approach going back to Grossman and Hart (1986) and Hart and Moore (1990) focuses on contracts allocating ownership rights. Typically, the party owning the asset has the better outside option and hence also a better bargaining position. Hence, she has stronger investment incentives ex-ante and it should therefore be the investing party that owns the asset, but two-sided investment problems may be problematic. The second strand of the literature began blooming with Hart and Moore (1988) and considers how long-term contracts can mitigate the hold-up problem. However, when investment is non-contractible and contracts cannot be state-contingent this is difficult. The first best is typically easier to achieve when investment is selfish (Aghion et al., 1994; Nöldeke and Schmidt, 1995; Edlin and Reichelstein, 1996) than when it is cooperative (Che and Hausch, 1999; Segal, 1999), and two-sided cooperative investment is more problematic compared to one-sided investment (Buzard and Watson, 2012).<sup>17</sup>

When the parties are loss averse, the optimal contract must mitigate two problems simultaneously, the holdup problem and inefficient renegotiation. Recalling the two strands of the literature discussed above, it is an interesting question whether the parties should write a contract on trade and/or one that allocates ownership rights. In the latter case, the parties allocate who owns asset  $A$  on date 0 and write a spot contract on trade on date 2 after the state has realized. Let us, like H&S (2015), consider that the buyer makes a selfish investment  $I \in \mathbb{R}_+^+$  at cost  $(1/2)I^2$  on date 1/2. H&S (2015) find that a contract allocating ownership rights outperforms a specific performance contract (that is always enforced)

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<sup>17</sup>My summary of the literature is not very precise since the models differ in fine details and these details matter. One important detail are the informational assumptions employed. As an example, recall Edlin and Reichelstein's (1996) comparison of a specific performance contract to a contract governed by the standard breach remedy expectation damages. Whereas specific performance contracts may be problematic since promised performance is often impossible, expectation damages only work when the court is indeed able to assess the damages. This typically means that the court can observe cost  $c$  and quality/benefit  $v$ , and hence indirectly investment, which makes it questionable investment is non-contractible ex-ante. Another important detail is when exactly the parties renegotiate. In Che and Hausch (1999), the parties make their trade decision and renegotiate any inefficient decisions afterward. In contrast, in H&S (2015) the present paper and many others, the parties renegotiate when they anticipate the future trade decision to be inefficient, a case called interim renegotiation by Watson (2007). In such a setting, the first best is easier to achieve, and indeed G'oller (2019) proposes an augmented option contract that performs well even under two-sided cooperative investment.

when the probability of being in the good state  $\pi_1$  is low compared to the degree of asset specificity they denote  $\beta$ . As explained, the performance of the specific performance contract may improve when one does not consider it as a forcing contract, but leave the ex-post trade decision to the parties. However even then, specific performance contracts are problematic, typically performing worse than option contracts. Let us consider the following setting: When the parties trade with one another in state  $\theta_i$ , the buyer's material utility on date 3 is given by

$$U^B = \begin{cases} v^* + I - p - \frac{1}{2}I^2, & \text{if } x = x_i \\ \underline{v} - p - I^2, & \text{if } x \neq x_i \end{cases},$$

with  $v^* > \underline{v}$ . Note the cost of investment,  $I^2$ , is sunk, the parties incurred it on date 1/2 already. The seller's material utility is just

$$U^S = \begin{cases} p - c^*, & \text{if } x = x_i \\ p - \underline{c}, & \text{if } x \neq x_i \end{cases},$$

with  $c^* > \underline{c}$ , and  $v^* - c^* > \underline{v} - \underline{c}$ . These utilities do not depend on the contract under consideration. I consider the same setting as H&S (2015) but have to take a stand on what happens when the long-term contract is not performed on date 3. In H&S (2015) this question is of no concern since writing a specific performance contract and allocating ownership rights is *mutually exclusive*. As they put it, ownership of an asset  $A$  only improves the bargaining position of the owner when he or she can threaten to take the asset and trade with someone else. This argument makes sense when the threat point during renegotiation is that the long-term contract is enforced. However, when the threat point is that the contract is not enforced, on date 3, asset ownership matters also under a long-term contract. Even when the parties do not specify asset ownership in contract, one of the parties does own the asset  $A$  by default and benefits from it when he or she trades with a third party, i.e., when the option is not exercised (or neither party enforces specific performance). This implies the parties' material outside option utilities on date 3 are the same under a long-term contract and asset ownership, in case the long-term contract is not performed. Suppose the buyer's material utility on date 3, should the parties take their outside options instead of trading with one another, is

$$U^B = \begin{cases} v^* + \beta I - p^{out} - \frac{1}{2}I^2, & \text{if the buyer owns } A \\ v^* - p^{out} - I^2, & \text{if the seller owns } A \end{cases},$$

where  $\beta \in [0, 1]$  measures the specificity of the buyer's investment. The seller's date 3 material utility is

$$U^S = p^{out} - c^*$$

independent of who owns the asset. Note that the buyer's investment incentives are increasing in  $\beta$ , and it should hence be the buyer who owns the asset. In the

benchmark case without frictions caused by the contract and loss aversion, the parties trade good  $x_i$  in state  $\theta_i$  and invest

$$I^* = \arg \max_I \{v^* - c^* + I - \frac{1}{2}I^2\} = 1. \quad (36)$$

## Contract that allocates ownership rights

Because both parties prefer trading with one another compared to trading with an outsider, they always agree on a spot contract on  $(x^*(\theta), \hat{p})$  on date 2. The negotiated price  $\hat{p}$  is given by

$$\hat{p} = p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}}(v^* + I - v^* - \beta I) + \alpha(1 + \lambda^{out})(c^* - c^*) = p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}}(1 - \beta)I$$

compare Proposition (5) after replacing  $v^*$  with  $v^* + I$  and  $\bar{v}$  with  $v^* + \beta I$  etc. The buyer's ex-post utility is

$$\begin{aligned} \hat{U}^{B-1} &= v^* + I - \hat{p} - \lambda^{out}[\hat{p} - p^{out}] - \frac{1}{2}I^2 \\ &= v^* + I - p^{out} - (1 - \alpha)(1 - \beta)I - \frac{1}{2}I^2 \\ &= v^* + \{1 - (1 - \alpha)(1 - \beta)\}I - p^{out} - \frac{1}{2}I^2. \end{aligned}$$

This utility expression does not depend on  $\lambda^{out}$  since loss aversion causes two effects canceling each other out. First, it reduces the price adjustment  $\hat{p} - p^{out}$ , reducing the hold up. Second, it creates feelings of losses thus increasing the hold up. The seller does not feel any losses and hence her ex-post utility is simply

$$\begin{aligned} \hat{U}^{S-1} &= \hat{p} - c^* \\ &= p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}}(1 - \beta)I - c^*. \end{aligned}$$

H&S (2015) establish the following result:

**Lemma 7** *If the parties rely on asset ownership, they optimally allocate the ownership of the asset to the buyer. In equilibrium, the parties always agree to trade with one another on date 2. The buyer's investment is given by*

$$I^A = 1 - (1 - \alpha)(1 - \beta) < 1$$

and the surplus generated by giving asset ownership to the buyer is

$$S^A = v^* - c^* + I^A - \frac{1}{2}(I^A)^2 - \frac{\lambda^{out}}{1 + \lambda^{out}}(1 - \alpha)(1 - \beta)I^A.$$

A contract that allocates ownership rights gives rise to two sources of inefficiency. First, the buyer generally underinvests unless he has all the bargaining power ( $\alpha = 1$ ) or the investment is unspecific,  $\beta = 1$ . Second, the buyer incurs feelings of losses because  $\hat{p} \geq p^{out}$ . The price adjustment during negotiations on date 2 is decreasing in  $\alpha$ ,  $\beta$  and the degree of loss aversion  $\lambda^{out}$ .

## Option contract

Let us consider an option contract on  $(\bar{p}, x_1)$ , the buyer has the option, and owns the asset. As discussed, one may either take the price stipulated in the long-term contract as exogenously given or allow the parties to use it as a strategic instrument. Let us first consider the simple case in which the contracted price is just equal to the market price,  $\bar{p} = p^{out}$ . As it will turn out, even this “naive” option contract outperforms a contract allocating just ownership rights.

**Lemma 8** *Consider an option contract on  $(x_1, p^{out})$ , the buyer owns the asset and also has the option on date 3. Independent of investment  $I$ , the buyer exercises his option in state  $\theta_1$  only.*

The reasoning is straightforward. We know from Lemma 3 that in the good state  $\theta_1$  the buyer exercises his option when  $\bar{p} \leq p^{out} + (1 + \lambda^{opt})(\bar{v} - v^{out})$ , which simplifies to  $0 \leq (1 + \lambda^{opt})(1 - \beta)I$  here. The right-hand side is (weakly) larger than zero and hence the buyer exercises the option. In the bad states  $\theta_i \neq \theta_1$ , the buyer does not exercise his option due to the fact  $\bar{v} - \bar{p} < v^* + \beta I - p^{out}$  for any  $I$ . In the good state  $\theta_1$  there is no scope for renegotiation on date 2. In the bad states  $\theta_i \neq \theta_1$ , renegotiation always succeeds because the buyer prefers the materially efficient good  $v^* + I$  over trading with an outsider. This yields him  $v^* + \beta I$ , whereas the seller is indifferent because she incurs costs of  $c^*$  in either case. From (26) we know that the renegotiated price is given by

$$\hat{p}(\theta) = p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}}(1 - \beta)I. \quad (37)$$

It is easy to see this price is larger than  $p^{out}$ , meaning the buyer shares some of his increased utility with the seller through the price increase. The magnitude of the price increase depends on the buyer’s bargaining power  $\alpha$ , the degree of loss aversion on date 2,  $\lambda^{out}$ , and the investment taken on date 1/2,  $I$ . The buyer’s ex-ante expected utility is

$$U_0^B = \pi_1[v^* + I - \frac{1}{2}I^2 - \bar{p}] + (1 - \pi_1)\{v^* + [1 - (1 - \alpha)(1 - \beta)]I - p^{out} - \frac{1}{2}I^2\}, \quad (38)$$

where the term inside the curly brackets is the buyer’s utility in the bad states  $\theta_i \neq \theta_1$ , which is exactly the same as under the contract allocating ownership rights. As before, the buyer’s optimal investment  $I^{opt}$  does not depend on the parties’ degree of loss aversion  $\lambda^{opt}$ . It is given by

$$I^{opt} = \arg \max_I \{I - (1 - \pi_1)(1 - \alpha)(1 - \beta)I - \frac{1/2^2}{I}\} = 1 - (1 - \pi_1)(1 - \alpha)(1 - \beta).$$

I can directly establish the following result:

**Proposition 9** *Consider an option contract on  $(x_1, p^{out})$ , the buyer owns the asset and has the option on date 3. The expected surplus generated by this contract is*

$$S^{opt} = v^* - c^* + I^{opt} - \frac{1}{2}(I^{opt})^2 - (1 - \pi_1)\frac{\lambda^{out}}{1 + \lambda^{out}}(1 - \alpha)(1 - \beta)I^{opt},$$

where  $I^{opt} = 1 - (1 - \pi_1)(1 - \alpha)(1 - \beta) \geq I^A$ . Consequently, the option contract outperforms the contract that allocates ownership rights.

The intuition is straightforward. In the bad states  $\theta_i \neq \theta_1$ , the option contract induces exactly the same outcome as the contract allocating ownership rights. In both cases, the threat point during (re)negotiation is that the parties trade with an outsider. The outcome of (re)negotiation is that the parties agree on trading the materially efficient good  $x^*(\theta_i)$  and the price is adjusted to  $\hat{p} = p^{out} + \frac{1-\alpha}{1+\lambda^{out}}(1-\beta)I$ , see (37). In the good state  $\theta_1$ , and in contrast to the contract allocating ownership rights, the parties trade  $x^*(\theta_1)$  without the need for renegotiation. A second advantage of the option contract is that it induces higher investment incentives, compared to the contract allocating ownership rights,  $I^* = 1 \geq I^{opt} \geq I^A$ . This roots back to the fact the latter contract relies on negotiation in all states, which reduces investment incentives because the renegotiated price is increasing in the buyer's investment, see (37). Consequently, the option contract outperforms the contract allocating ownership rights unless the buyer has all the bargaining power,  $\alpha = 1$  or the investment is perfectly unspecific,  $\beta = 1$ .

The option contract we considered is simple but not optimal. Let me briefly sketch why specifying a price  $\bar{p} \neq p^{out}$  is advantageous. First, and like in the setting without investment, a positive wedge between  $\bar{p}$  and  $p^{out}$  makes renegotiation easier: By reaching an agreement on date 2, one of the parties avoids feeling losses on date 3. This, in turn, increases the renegotiation surplus and leads to a lower price adjustment. Second, the strike price  $\bar{p}$  can be used as an instrument to increase investment incentives. Which party should have the option depends on the parameter constellation. As discussed, in absence of investment it is best that the buyer has the option. However, to induce optimal selfish investment ( $I^{opt} = I^*$ ), the non-investing party should have the option. This is well known in the literature (cf. Nöldeke and Schmidt, 1995; Lyon and Rasmusen 2004; Buzard and Watson 2012). Consequently, there is a tradeoff.<sup>18</sup>

## 5 Conclusions

This article considers the model of H&S (2015), but without the assumption that long-term contracts are always enforced when renegotiation does not succeed. The results highlight the fact that specific performance contracts perform poorly when the parties are loss averse does not mean long-term contracts do so in general. In fact, we already know since Watson (2007) that assuming a contract is always enforced ex-post reduces the set of implementable outcomes and thus negatively impacts efficiency. A contract that is naturally not always enforced is an option contract. Indeed, under this contract, the parties often manage to adjust to the materially efficient specification even when their degree of loss aversion is high. Hence, it seems a bit far-fetched to conclude that the type of loss aversion considered in the present paper and in H&S (2015) explains why parties often (do they?)

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<sup>18</sup>As it turns out, the optimal option contract is very sensitive to the considered parameter constellation and its derivation is long and tedious. The calculations are available upon request.



abstain from writing (beneficial) long-term contracts. Even enriching the model by considering relationship-specific investment does not challenge the desirability of option contracts, which frequently outperform contracts allocating ownership rights.

Depending on the parameter constellation, the optimal price  $\bar{p}^*$  under an option contract is sometimes extreme. When, as assumed in the present paper and in H&S (2015), the parties are loss averse after the state of the world has been realized but not ex-ante when writing the contract, this is unproblematic. However, should they also be loss-averse ex-ante, would they sign a contract stipulating an extreme price? If the parties use an ex-ante side payment to ensure that they do so, it may be reasonable to assume that this side payment causes additional feelings of losses when the contract is not performed ex-post.

Like in Herweg and Schmidt (2015), the buyer and the seller are sophisticated in that they are perfectly aware of any future loss aversion. This allows them to use the specified price as an instrument to steer in which states of the world the contract will be performed and/or to mitigate feelings of losses arising during renegotiation. When it cannot be substantiated loss aversion is the sole reason why parties sometimes abstain from writing beneficial long-term contracts in reality, does it make sense to consider “naive” parties that fail to anticipate their future loss aversion? Naive parties would for sure write inefficient long-term contracts, and it may indeed be best for them to wait until the state of the world is realized and just write a spot contract. However, I conjecture that naive parties would often prefer a long-term contract over a spot contract, simply because they are naive and do not fully understand the consequences. I thus find it doubtful a model with naive parties would justify why parties sometimes do not write beneficial long-term contracts in reality. It may be interesting to consider in future research that one or both parties are expectation-based loss-averse, like the buyer in Herweg et al. (2018). Is the fact contracts are not always performed, on date 3, as crucial as in the present setting?

## 6 Appendix

### 6.1 Proof of Proposition 2

**Proof.**

Recall that the disagreement outcome is that the parties choose their outside options on date 3. Their disagreement utilities are given by  $U^{B0}$  and  $U^{S0}$ , respectively, see Lemma 1. Considering (a), setting the price equal to the price of the generic good,  $\hat{p} = p^{out}$ , ensures (15) and (16) hold, i.e., that signing the renegotiated spot contract is individually rational for both parties. In case (b), the seller would be worse off when  $\hat{p} = p^{out}$ , see (18). Hence, she needs be compensated by a higher price,  $\hat{p} > p^{out}$ . Applying  $\hat{p} > p^{out}$  in (15) reveals signing the spot contract is individually rational for the buyer when

$$\hat{p} \leq p^{out} + \frac{\Delta_v + \lambda[p^{out} - \bar{p}]^+}{1 + \lambda^{out}},$$

where  $\Delta_v = \hat{v} - v^{out} - \lambda^{out}[v^{out} - \hat{v}]^+ + \lambda[\bar{v} - v^{out}]^+$ . Applying  $\hat{p} > p^{out}$  in (16) yields that the seller is better off signing the spot contract when

$$\hat{p} \geq p^{out} - \Delta_c - \lambda[\bar{p} - p^{out}]^+.$$

where  $\Delta_c = c^{out} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ + \lambda[c^{out} - \bar{c}]^+$ . Hence, the renegotiated spot contract is individually rational for both parties when

$$\Delta_v + (1 + \lambda^{out})\Delta_c \geq -\lambda([p^{out} - \bar{p}]^+ + \lambda(1 + \lambda^{out})[\bar{p} - p^{out}]^+),$$

which is the condition stated in the proposition. In case (c), it is the buyer who is worse off when  $\hat{p} = p^{out}$  and hence requests a lower price. The condition stated in the proposition can be derived in a similar fashion. ■

### 6.2 Proof of Proposition 3

**Proof.**

The set  $X^0$  consists of any  $\hat{x} \in X$  for which there exists a price  $\hat{p}$  so that  $\hat{U}^{B0} \geq U^{B0}$  and  $\hat{U}^{S0} \geq U^{S0}$ . This is the case when the conditions stated in (i), (ii), or (iii) in Proposition 2 hold. Let me first show that if some  $\hat{x}$  belongs to the set  $X^0$  for a given difference  $|\bar{p} - p^{out}|$  it still belongs to the set  $X^0$  for any larger difference.

(i) The left-hand sides of the inequalities  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ \geq 0$  and  $\Delta_c + \lambda[\bar{p} - p^{out}]^+ \geq 0$  are (weakly) increasing in  $|\bar{p} - p^{out}|$ . Hence, if some good  $\hat{x}$  (together with some price  $\hat{p}$ ) fulfills both conditions for a given price difference it also does so for any larger difference. It is thus still an element of the set  $X^0$ .

In case (ii), the right-hand side of the condition

$$\Delta_v + (1 + \lambda^{out})\Delta_c \geq -\lambda([p^{out} - \bar{p}]^+ + (1 + \lambda^{out})[\bar{p} - p^{out}]^+)$$

is (weakly) decreasing in  $|\bar{p} - p^{out}|$ , but the left-hand sides of  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ > 0$  and  $\Delta_c + \lambda[\bar{p} - p^{out}]^+ < 0$  are (weakly) increasing in  $|\bar{p} - p^{out}|$ . However, if the latter condition becomes violated as the price difference grows larger,  $\hat{x}$  must meet the conditions from case (i). Consequently it is still an element of the set  $X^0$ .

In case (iii) the right-hand side of the condition

$$(1 + \lambda^{out})\Delta_v + \Delta_c \geq -\lambda((1 + \lambda^{out})[p^{out} - \bar{p}]^+ + [\bar{p} - p^{out}]^+).$$

is also (weakly) decreasing in  $|\bar{p} - p^{out}|$ , but the left-hand side of  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ < 0$  is (weakly) increasing in  $|\bar{p} - p^{out}|$ . If this condition becomes violated after an increase of the price difference,  $\hat{x}$  must also meet the conditions in case (i). Consequently it is still an element of the set  $X^0$ .

Let us now consider some good  $\hat{x}$  not fulfilling the conditions in (i), (ii), and (iii) for a given price difference  $|\bar{p} - p^{out}|$ . Consequently,  $\hat{x}$  is not an element of the set  $X^0$ . As the price difference increases,  $\hat{x}$  becomes part of the set  $X^0$  when the conditions in (i), (ii), or (iii) hold. Note that one of the conditions in case (i) becomes slacker as the price difference increases. Specifically, consider some good  $\hat{x}$  not an element of the set  $X^0$  for which  $\hat{v} > v^{out}$  holds, implying the first condition

$$\Delta_v + \lambda[p^{out} - \bar{p}]^+ = \hat{v} - v^{out} + \lambda[\bar{v} - v^{out}]^+ \lambda[p^{out} - \bar{p}]^+ \geq 0$$

holds. The left-hand side of the other condition,  $\Delta_c + \lambda[\bar{p} - p^{out}]^+ \geq 0$ , is strictly increasing in  $|\bar{p} - p^{out}|$  and consequently the condition must hold when this price difference becomes sufficiently large. A similar argument works when  $\hat{c} < c^{out}$ , in which case both conditions in (i) hold once  $p^{out} - \bar{p}$  becomes sufficiently large. The argument shows  $X^0$  is increasing in  $|\bar{p} - p^{out}|$  and any good  $\hat{x}$  for which it holds  $\hat{v} > v^{out}$  and/or  $\hat{c} < c^{out}$  can be reached by renegotiation, *given* the disagreement outcome is that the long-term contract is not performed on date 3. ■

### 6.3 Proof of Proposition 6

**Proof.**

Using the utility expressions in (15) and (16), the GNP can be written as

$$GNP(p) = (\hat{v} - p - \lambda^{out}[v^{out} - \hat{v}]^+ - \lambda_1[p - p^{out}] - \{v^{out} - p^{out} - \lambda[\bar{v} - v^{out}]^+ - \lambda[p^{out} - \bar{p}]^+\})^\alpha \times (p - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ - \lambda_2[p^{out} - p]^+ - \{p^{out} - c^{out} - \lambda[c^{out} - \bar{c}]^+ - \lambda[\bar{p} - p^{out}]^+\})^{1-\alpha},$$

$$\text{where } \lambda_1 = \begin{cases} \lambda^{out}, & \text{if } p - p^{out} \geq 0 \\ 0, & \text{otherwise} \end{cases} \text{ and } \lambda_2 = \begin{cases} \lambda^{out}, & \text{if } p - p^{out} \leq 0 \\ 0, & \text{otherwise} \end{cases}.$$

The GNP is strictly concave and differentiable in  $p$  for any  $p \neq p^{out}$ . We consider the three cases summarized in Proposition 2: (i) Both parties are (weakly) better off when the price is unchanged, (ii) the buyer is better off but the seller is worse

off, and (iii) the seller is better off but the buyer is worse off. In case (ii) it must hold that  $p > p^{out}$  to compensate the seller and in case (iii) we must have  $p < p^{out}$  to compensate the buyer. Hence, the GNP is differentiable in the relevant range. Let us differentiate the GNP with respect to  $p$ , yielding the following first order condition:

$$\begin{aligned} \frac{\partial GNP(p)}{\partial p} = 0 &\Leftrightarrow \\ (1 - \alpha)(1 + \lambda_2)[\hat{U}^{S0}(\hat{x}, p|\theta) - U^{S0}]^{-\alpha}[\hat{U}^{B0}(\hat{x}, p|\theta) - U^{B0}]^\alpha \\ -(1 + \lambda_1)\alpha[\hat{U}^{B0}(\hat{x}, p|\theta) - U^{B0}]^{\alpha-1}[\hat{U}^{S0}(\hat{x}, p|\theta) - U^{S0}]^{1-\alpha} &= 0. \end{aligned}$$

This can be rewritten as

$$\begin{aligned} (1 - \alpha)(1 + \lambda_2)[\hat{U}^{B0}(\hat{x}, p|\theta) - U^{B0}] &= (1 + \lambda_1)\alpha[\hat{U}^{S0}(\hat{x}, p|\theta) - U^{S0}] \Leftrightarrow \\ (1 - \alpha)(1 + \lambda_2)[\hat{v} - p - \lambda^{out}[v^{out} - \hat{v}]^+ - \lambda_1[p - p^{out}] - \{v^{out} - p^{out} - \lambda[\bar{v} - v^{out}]^+ - \lambda[p^{out} - \bar{p}]^+\}] \\ &= (1 + \lambda_1)\alpha[p - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ - \lambda_2[p^{out} - p]^+ - \{p^{out} - c^{out} - \lambda[c^{out} - \bar{c}]^+ - \lambda[\bar{p} - p^{out}]^+\}]. \end{aligned} \quad (39)$$

Let us first consider case (ii), in which the seller is worse off when the price is unchanged. Here, we only need to consider prices satisfying  $p > p^{out}$  or else the seller is not willing to sign the renegotiated contract. Using  $p > p^{out}$  in (39) and subsequently solving for  $p$  yields

$$\begin{aligned} p &= p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}}[\hat{v} - v^{out} - \lambda^{out}[v^{out} - \hat{v}]^+ + \lambda[\bar{v} - v^{out}]^+ + \lambda[p^{out} - \bar{p}]^+] \\ &\quad + \alpha[\hat{c} - c^{out} + \lambda^{out}[\hat{c} - c^{out}]^+ - \lambda[c^{out} - \bar{c}]^+ - \lambda[\bar{p} - p^{out}]^+]. \\ &= p^{out} + \frac{1 - \alpha}{1 + \lambda^{out}}[\Delta_v + \lambda[p^{out} - \bar{p}]^+] - \alpha[\Delta_c + \lambda[\bar{p} - p^{out}]^+] \equiv p^{out} + \Delta_{p+}^0, \end{aligned} \quad (40)$$

where  $\Delta_v = \hat{v} - v^{out} - \lambda^{out}[v^{out} - \hat{v}]^+ + \lambda[\bar{v} - v^{out}]^+$  and  $\Delta_c = c^{out} - \hat{c} - \lambda^{out}[\hat{c} - c^{out}]^+ + \lambda[c^{out} - \bar{c}]^+$ . To see that  $p$  is larger than  $p^{out}$ , note that the fact that the buyer is better off when the price is unchanged implies  $\Delta_v + \lambda[p^{out} - \bar{p}]^+ > 0$ . In a similar fashion, that the seller is worse off implies  $\Delta_c + \lambda[\bar{p} - p^{out}]^+ < 0$ . Let us now consider case (iii), in which the buyer is worse off when the price is unchanged. For the buyer to be willing to sign the renegotiated contract we must have  $p < p^{out}$ . Using this in (39) and subsequently solving for  $p$  yields

$$p = p^{out} + (1 - \alpha)[\Delta_v + \lambda[p^{out} - \bar{p}]^+] - \frac{\alpha}{1 + \lambda^{out}}[\Delta_c + \lambda[\bar{p} - p^{out}]^+] \equiv p^{out} + \Delta_{p-}^0, \quad (41)$$

showing  $p$  is smaller than  $p^{out}$ . In case (i) both parties are (weakly) better off when the price is unchanged. Since the GNP is strictly concave in  $p$ , the solution must be unique. It is either given by (40), (41), or the price is unchanged,  $p = p^{out}$ .

When  $\Delta_{p+}^0 \geq 0$ , the solution is given by (40) and when  $\Delta_{p-}^0 \leq 0$  it is given by (41). Otherwise it is  $p = p^{out}$ . To see this, note that  $\Delta_{p+}^0 > 0$  implies  $\Delta_{p-}^0 > 0$  and  $\Delta_{p-}^0 < 0$  implies  $\Delta_{p+}^0 < 0$ . Finally, when  $\Delta_{p+}^0 \leq 0$  and  $\Delta_{p-}^0 \geq 0$  the solution must be  $p = p^{out}$ .<sup>19</sup>

■

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<sup>19</sup>Both (40) and (41) simplify to  $p = p^{out}$  when  $\Delta_{p+}^0 = 0 = \Delta_{p-}^0$ . Moreover, when  $\Delta_{p+}^0 < 0 < \Delta_{p-}^0$  the first order condition (39) is not equal to zero. Since the GNP is a continuous and strictly concave in  $p$  the solution must be the critical point that is the kink at  $p = p^{out}$ .

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