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Breach remedies, reliance and renegotiation

Randolph Sloof*, Hessel Oosterbeek, Arno Riedl,
and Joep Sonnemans

Department of Economics, University of Amsterdam

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Abstract

Breach penalties can be used to protect specific investments and are therefore a remedy against holdup. Not all breach remedies are, however, equally efficient. Some common types are predicted to protect too well thereby inducing overinvestment. Theoretically overinvestment is driven by two motives: the *insurance* motive and the *separation prevention* motive. This paper presents results from an experiment designed to test the effect of different breach remedies on specific investments in a setting where ex post renegotiations are possible. In line with other experimental studies we find that actual investment levels tend to exceed the predicted levels somewhat. Nevertheless the results provide ample support for the theory: investment levels under the different remedies vary in accordance with the theoretical predictions. More specifically, where predicted the insurance motive and the separation prevention motive are indeed at work. JEL codes: K12, J41, C91.

1 Introduction

When a party makes a relationship-specific investment, the investment is at risk because the other party may end the relationship. This may lead to underinvestment (cf. Williamson 1985). To protect the investment the parties may in advance agree on a contract which stipulates that the breaching

*Corresponding author: Department of Economics, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, The Netherlands. e-mail: sloof@fee.uva.nl.

party has to pay damages to the investor. As an example, consider a labor relationship between an employer and a worker. To increase the worker's productivity within the firm, the employer might want to give him a firm-specific training. To protect her investment, the employer can incorporate a damage measure into the labor contract stipulating that in case of a quit the worker has to pay a certain amount.

There are various methods to determine the amount of damages. We focus on the four most prominent. First, the labor contract could specify a fixed amount the worker has to pay when he quits. Alternatively, the contract could require the worker to reimburse the employer the training costs. In a third possibility the worker compensates the employer for the loss of the future stream of net surpluses she would obtain from the labor contract. A final possibility is to prohibit the worker to work for another firm in the industry for some period of time. This effectively comes down to a prohibitively large damage payment.

The above four rules correspond to the following commonly used breach remedies (cf. Posner 1977):

- liquidated damages: the breacher has to pay a fixed amount – specified in the contract – to the victim of breach;
- reliance damages: the breacher compensates the victim such that the latter is equally well off as before the contract had been signed;
- expectation damages: the breacher has to pay the amount that makes the victim equally well off as under contract performance;
- specific performance: breach of contract is not possible. An agent is required to stay in the relation if the other party asks him to do so.

The theoretical literature reveals that breach remedies are sometimes overzealous in protecting reliance expenditures, because they typically induce overreliance.¹ This holds irrespective of whether renegotiation of the initial contract is possible (Rogerson 1984) or not (Shavell 1980). There are generally two motives to overinvest. First, with the exception of liquidated damages the above breach remedies effectively insure the investor against separation. She then still gets some private return on the specific investment, even when the parties efficiently separate and the investment has no social return. This is

¹Within the Law and Economics literature, specific investments are usually referred to as reliance expenditures. In this paper we use the terms investment and reliance interchangeably.

the insurance motive. The second motive to overinvest is only operative under reliance damages. In this case the investor is always better off when the parties trade than when they separate. She may therefore have an incentive to reduce the probability of efficient separation by investing too much. This is the separation prevention motive.

Sloof et al. (2000) report results from an experiment that considers the effects of breach remedies on reliance levels in a setting in which renegotiation of the initial contract is not possible. There observed investment levels closely follow the theoretical predictions. In particular, optimally designed liquidated damages induce efficient reliance as is predicted. The insurance motive to overinvest is clearly present in the data, but is slightly weakened by considerations of fairness. Reciprocal behavior appears to reduce the working of the separation prevention motive predicted for reliance damages.

In reality it is unlikely that the interaction between the contracting parties ends with a breach decision when this decision is inefficient. Parties typically cannot credibly commit not to renegotiate inefficient outcomes (cf. Edlin and Hermalin 2000). Rather they are likely to renegotiate the contract terms to arrive at the ex post efficient outcome. A natural and interesting extension is therefore to give parties the possibility of ex post renegotiation. This paper considers this more realistic setting.

The paper is divided into two parts. Section 2 presents results for the two extreme cases of no contract and specific performance. In both cases there is no breach decision stage because in the absence of a contract there is simply no contract that can be breached while under specific performance breach is explicitly excluded. These two cases can be seen as polar benchmark cases in which breach of contract is costless and prohibitively costly, respectively. Section 3 turns to the three breach remedies that are based on (intermediate) damage payments. In Section 4 we compare all five different cases of Sections 2 and 3 in terms of efficiency. The final section summarizes our main findings.

2 No contract and specific performance

2.1 Basic setup of the model

We consider a bilateral trade relationship between a female buyer and a male seller. Both parties are assumed to be risk-neutral. The three-stage game studied for the benchmark cases has the following setup:²

²In Appendix A we discuss a more general specification of this model. The particular parameters used in the experiment are chosen as to draw the theoretical predictions sufficiently far apart such that our main hypotheses become testable.

1. *Investment stage.* The buyer makes a specific investment $I \in \{0, 5, 10, \dots, 100\}$. Investment costs equal $C(I) = I^2$ and are immediately borne by the buyer.
2. *Nature draws outside bid.* The value of the seller's alternative trading opportunity $b \in \{0, 7000\}$ becomes publicly known. The prior probability that $b = 7000$ equals either $p = \frac{1}{5}$ (Low-treatment) or $p = \frac{3}{5}$ (High-treatment).
3. *Bargaining stage.* The buyer and the seller bargain over the division of the gross renegotiation surplus RS . The buyer has threat point TP_B , while the seller has threat point TP_S . The parties have equal bargaining power. Under no contract it holds that:

$$RS = R(I) \equiv 1000 + 100 \cdot I, \quad TP_B = 0 \quad \text{and} \quad TP_S = b,$$

while under specific performance:

$$RS = b, \quad TP_B = R(I) - 600 = 400 + 100 \cdot I \quad \text{and} \quad TP_S = 600.$$

This game represents the following situation. The buyer and the seller may trade one unit of a particular good. In case they do so gross surplus equals $R(I)$, with I the specific investment made by the buyer. (Production costs are normalized to zero.) The seller may also sell his single unit outside the relationship at a competitive fixed price. This outside bid b is unknown at the time the buyer decides on her investment. It can either be low or high. The probability p that the latter case applies is used as a treatment variable.

Without a contract the status quo equals no trade between the buyer and the seller. After the outside bid becomes known the parties may renegotiate to attain the trade outcome. The surplus up for renegotiation then equals the gross surplus $R(I)$ that can be obtained from trade, while the status quo payoffs serve as threat points. Under specific performance it is assumed that the parties have signed a contract that stipulates trade at a fixed price of 600. Here contract performance serves as the status quo outcome. When b becomes known the buyer and the seller may renegotiate to induce separation. The renegotiation surplus then equals b and threat points are given by the payoffs under contract performance.

The parameter values are such that for the efficient investment level trade is efficient when $b = 0$, while separation is efficient when $b = 7000$. From a social point of view the investment thus only pays off when $b = 0$. It follows immediately that the efficient level equals $I^* = 40$ in the Low-treatment ($p = \frac{1}{5}$) and $I^* = 20$ in the High-treatment ($p = \frac{3}{5}$).

2.2 Equilibrium predictions

The game is solved through backwards induction. First consider the bargaining stage. In equilibrium actual renegotiations take place only when the status quo outcome appears to be inefficient ex post. This is the case when the gross renegotiation surplus RS exceeds the sum of the two threat point payoffs. The net renegotiation surplus in excess of the threat point payoffs is then split evenly; the buyer gets a share of $TP_B + \frac{1}{2} \cdot (RS - TP_B - TP_S)$. This corresponds with the split-the-difference solution. When the gross renegotiation surplus falls short of the sum of the threat points actual renegotiations do not occur in equilibrium. Both parties then simply obtain their threat point payoffs. This situation applies when $R(I) < b$ under no contract, and when $R(I) \geq b$ under specific performance.

Given the outcome of the bargaining, the buyer chooses the investment level that maximizes her expected payoffs. In the absence of a contract she has to bear the full costs, but obtains only half of the (social) returns on the investment. She therefore chooses a level that is only 50% of the efficient level: $I_{NC} = \frac{1}{2}I^*$. Without a contract holdup is predicted to occur.

Things are somewhat more complicated under specific performance. When the contract is performed only when $b = 0$ the buyer chooses the efficient investment level I^* . In case the contract would always be performed she would choose $I = 50$. Under specific performance the buyer can always ensure trade. But when $b = 7000$ separation is efficient whenever $R(I) < 7000$ (which holds for $I = 50$). The joint gain that can be obtained from separation then equals $7000 - R(I)$, and is thus decreasing in I . The buyer obtains an equal share of this joint gain. She therefore has to balance the negative effect of I on this gain against the positive effect of I on her threat point payoff $R(I) - 600$. The outcome of this balancing is that the buyer is predicted to choose $I_{SP} = \frac{1}{2}(I^* + 50)$. Hence, specific performance is predicted to cause overreliance.³ The driving force is the partial insurance of the buyer against separation.

The predictions on investment levels are summarized in the following hypothesis:

H1 Without a contract there will be holdup. Under specific performance overinvestment will be observed. In both cases reliance levels are decreasing in p .

³It should be noted that specific performance differs from an exclusivity provision, under which the seller is restricted to sell his product to the incumbent buyer only but is not required to do so. In our setup investment incentives are not affected at all by such a provision, and we still predict holdup to occur (cf. Segal and Whinston 2000).

2.3 Experimental design

In each session either the case of no-contract or the case of specific performance was considered. Within a session subjects were confronted with both values of p . We ran two sessions for each of the two contract situations. These were held in the fall of 2000. Per session 20 subjects participated, giving 80 subjects in total. They were recruited from the undergraduate student population of the University of Amsterdam. Most of them were students in economics. Subjects received a show up fee of 30,000 experimental points. The conversion rate was one guilder for 2200 points, such that one US dollar corresponded with about 5500 points. Average earnings were USD 21 in about two hours.

Each session consisted of 12 periods in which subjects played the three-stage game. The 12 periods were divided into two blocks of six. In one block the value of p was $\frac{1}{5}$ (Low), in the other block p was equal to $\frac{3}{5}$ (High). To control for order effects we conducted per contract situation one Low-High session and one High-Low session. Within each block of six periods each subject was assigned the role of buyer exactly three times, and the role of seller also three times. In each period subjects were anonymously paired. Within each block of six periods they could meet each other only once. Subjects were informed about this.

The experiment was framed as follows. At the start of each period subjects learned their roles. Then the buyer (subject A) had to choose the amount T , a multiple of five between 0 and 100. The costs of this choice equalled $4 \cdot T^2$ and were immediately subtracted from the buyer's account. In the second stage a wheel of fortune was turned around to determine the value of the outside bid. The wheel had two colors in proportions to the respective probabilities of a low (blue) and a high (yellow) outside bid. When the wheel came to a stop it pointed at a particular color, and this color determined the value of the outside bid.

The bargaining stage had the following form. First the buyer and the seller decided simultaneously whether they wanted to renegotiate or not. Only when both agreed to do so, actual renegotiations took place. In that case subjects alternated in making offers, up to a maximum of four bargaining rounds, of how to divide four equally sized pies. The seller always made the first offer. In case of acceptance all remaining pies – including the one of the current round – were divided according to the proposal agreed upon. During a round of disagreement the pie of that round vanished and both agents received their threat point payoffs.⁴ We did not divide the renegotiation

⁴The predicted outcome of this bargaining game equals the one described in Subsection 2.2. The pie in excess of the sum of the threat point payoffs is divided equally. This

surplus and the threat point values by four, in order to account for the four bargaining rounds. This would have led to non-integers in some cases. We therefore multiplied the gross payoffs by four. For the investment costs we then used the same scaling factor, explaining the use of $4 \cdot T^2$ instead of T^2 . When parties decided not to renegotiate the period-game ended and the buyer and the seller obtained four times their threat point payoffs.

The experiment was computerized. Subjects started with on-screen instructions. All subjects had to answer a number of questions correctly before the experiment started. For example, they had to calculate their earnings for some hypothetical situations. Subjects also received a summary of the instructions on paper. The instructions and the experiment were phrased neutrally. In particular, words like opponent, game, investment, player, buyer or seller were not used. Before the play of the 12 periods one practice period was played. At the end of the experiment subjects filled out a short questionnaire and the earned experimental points were exchanged for money. Subjects were paid individually and discreetly.

It needs to be emphasized that while the description may give the impression that it was rather complicated for subjects to play this game, it was presented to them in a very clear and accessible way. The instructions explain clearly how the combination of buyer's choice of T in stage 1 and Nature's draw of b in stage 2 together determine the threat points and the renegotiation surplus for stage 3. After each decision/draw, the consequences were made explicit. In particular, before the buyer's investment choice the subjects have on their screens a table which expresses payoffs as functions of T and b (the color of the wheel). After the buyer made her investment choice, the chosen value of T replaces the symbol T . Before the wheel of fortune turns, the table has amounts in yellow and blue. When the wheel stops at e.g. yellow, the amounts in yellow remain yellow, while those in blue are no longer relevant and become grey. In this way, subjects could never be confused about which decisions and draws were made in the previous stages and what the consequences were. Appendix B contains some examples of the computer screens described here.

equilibrium prediction also applies when the buyer formulates the first offer, and in fact holds for any even number of bargaining rounds. The advantage of having the seller moving first is that it directly reveals how much the buyer at least can earn on her investment. In regard to the number of bargaining rounds, Sonnemans et al. (2001) use a setup with 10 rounds. Because they find that bargaining typically takes two to three rounds, we restricted the number of rounds to four.

Table 1: Mean investment levels

		Low: $p = \frac{1}{5}$		High: $p = \frac{3}{5}$	
		efficient: 40		efficient: 20	
		actual	predicted	actual	predicted
All decisions (mean)	NC	^c 28.83 _a	20	^d 21.88 _a	10
	SP	^c 49.88 _b	45	^d 46.63 _b	35
Final decision	NC	^f 28.38 _e	20	^g 19.63 _e	10
	SP	^f 49.25	45	^g 46.88	35

Remark: Subscripts indicate significant differences at the 5% level within a row according to a Wilcoxon signrank test. Superscripts indicate significant differences at the 5% level within a column according to a Mann-Whitney ranksum test.

2.4 Results

The main finding for the benchmark treatments is summarized in Result 1 (cf. Hypothesis H1).

Result 1. (Investment) *Without a contract holdup is less of a problem than theory predicts. Specific performance induces more overinvestment than predicted. Under no contract investment levels are decreasing in p , while under specific performance they remain virtually constant when p changes.*

Evidence for Result 1 is provided in Table 1, which reports average investment levels by treatment. For each subject we calculated the mean investment level for the low p -level and the high p -level.⁵ Statistical tests are based on the average investment levels of individual investors, rather than on separate investment decisions. We use Wilcoxon signrank tests for differences within a row and Mann-Whitney ranksum tests for differences within a column. There appears to be no holdup problem when the probability of a high outside bid is high. Without a contract buyers on average choose the first best investment level. In the Low-treatment holdup does occur, but is less severe than predicted. Under specific performance buyers invests significantly more than in the absence of a contract. Substantial overinvestment occurs mainly in the High-treatment.

In line with theoretical predictions investment levels are decreasing in p . Under specific performance this result is, however, not robust to learning

⁵Each subject in the experiment makes 6 investment decisions: 3 decisions in the Low-treatment and 3 decisions in the High-treatment.

effects. When we only consider final investment decisions, reliance levels under specific performance are not significantly different between the Low and the High-treatment. Moreover, the observed significant decrease based on all investment decisions is much smaller ($6\frac{1}{2}\%$) than predicted (22%). We therefore conclude that under specific performance investment levels remain virtually constant. This indicates the presence of the insurance motive. But in contrast to theoretical predictions insurance appears to be complete rather than partial.

The actual return the buyer obtains on her investment is determined by the share she gets out of the bargaining together with the actual time needed to reach agreement. Theory predicts that when it is efficient to renegotiate subjects immediately settle at the split-the-difference solution. Without a contract the predicted outcome is then the equal split when $b = 0$. The actual mean first offer equals 1395 where an average offer of 1797 is predicted. The mean final agreement is also below the prediction: $1673 < 1778$. Under specific performance with $b = 7000$ the average first offer equals 5024, while an average offer of 5682 is predicted. For final agreements the average is above the prediction: $5741 > 5681$. Taken together we thus observe that first offers give the buyer on average a smaller share than predicted. Final agreements do give the buyer a larger share than first offers do. But in the process of getting a larger share some of the surplus is lost. Without a contract it takes on average 1.60 rounds to reach agreement, under specific performance this is 1.97. On average the buyer is therefore better off by accepting the seller's initial offer. Overall we observe that buyers on average get less than the predicted split-the-difference share out of the renegotiations.

For investment incentives the marginal return on investment is important. In the absence of a contract holdup is caused by the so-called *holdup effect* (cf. Edlin and Hermalin 2000). This effect says that in the renegotiations the seller can hold up the buyer, such that the buyer does not capture the full marginal return on her investment. In our setup it is predicted that the buyer obtains 50% of the marginal returns. We observe, however, that holdup is less severe than theory predicts. This is a robust finding in the experimental economics literature.⁶ A plausible explanation for this result – that received considerable support in these earlier papers – is positive reciprocity. Investment by the buyer makes both agents better off and thus can be considered as a kind act. The seller might want to reward this kind behavior with a larger than predicted return on investment. If such reciprocal behavior is anticipated by the buyer, it is optimal for her to invest more than

⁶See e.g. Ellingsen and Johannesson (2000), Hackett (1994), Königstein (2001) and Sonnemans et al. (2001).

predicted. In short, positive reciprocity may weaken the holdup effect and thereby reduce holdup.

In the presence of a fixed price contract the buyer's investment increases her valuation of this contract, improving her bargaining position in the renegotiations. Edlin and Hermalin (2000) refer to this as the *threat point effect*, because the buyer's improved bargaining position is reflected in a higher threat point. The threat point effect is theoretically the driving force behind overinvestment under specific performance. It is only present in the contingency that the outside bid is high and separation is efficient. Overinvestment is therefore predicted to be relatively larger when p is large. When the threat point effect is stronger than predicted, overinvestment will be relatively more severe especially in the High-treatment. This is what we observe.

The reliance levels in Table 1 suggest that buyers count on a weaker than predicted holdup effect in the absence of a contract and on a stronger than predicted threat point effect under specific performance. Our next result relates to whether such expectations are warranted.

Result 2. (Bargaining) *Without a contract the actual holdup effect is by and large as predicted. Under specific performance the threat point effect is also by and large as predicted.*

Result 2 is based on the regression results in Tables 2 and 3. Seller's first offers and final agreements have been regressed on the investment level.⁷ To correct the estimates for possible learning effects we also included the period number t as a regressor. The dependent variable is always expressed as the amount the buyer gets. For the no contract case the focus is on the contingency in which $b = 0$. This is the appropriate case to consider, because it is the only one where renegotiation is predicted to occur. The seller's first offer gives the buyer a return on investment slightly above 50%. The buyer can guarantee such a return simply by accepting this offer. Moreover, when $b = 0$ the seller is willing to renegotiate in 137 of the 144 cases. The expected obtainable marginal return is thus $\frac{137}{144} \cdot 52.7 \approx 50.1$. Would the buyer always have accepted the seller's offer immediately (which she does in 73 out of 134 cases in which renegotiations take place), her expected marginal return when $b = 0$ would be about 50%. This shows that the holdup effect is as predicted. The private returns from bargaining do not justify the buyers' observed high investment levels.⁸

⁷We also considered specifications that included the investment costs I^2 as a second regressor besides I . These regressions lead to the same conclusions as in Result 2.

⁸When $b = 7000$ we do not get a significant coefficient for I in the regression of first offers. Moreover, the number of cases in which renegotiations then occur are rather small:

Table 2: Regressions explaining first offers/final agreements

	No Contract, $b = 0$		
	predictions	first offer	agreement
const.	500	41	213
I	50	(147)	(113)*
t	0	(3.64)*	(2.87)*
n	144	134	125
adj. R^2		.61	.77

Remark: Standard deviations within parentheses. Significant coefficients (10% level) are marked with an *.

Under specific performance we consider the contingency where $b = 7000$ and separation is efficient (cf. Table 3). The coefficient on I is again almost equal to the predicted 50%. It must be noted though that when no renegotiations take place at all (or as long as no agreement has been reached), the buyer gets a 100% marginal return through her threat point. In 18 out of 96 cases no renegotiations take place. In 15 cases the buyer does not want to renegotiate, in only 3 the seller does not want to do so. Effectively, the buyer can obtain an expected marginal return of around 50% when $b = 7000$ if she wants so. This indicates that the actual threat point effect is also as predicted.

The above results suggest that buyers typically do not choose the privately “optimum” investment level given actual bargaining outcomes. The holdup and threat point effect are by and large as predicted, suggesting that it would be optimal – from the selfish point of view of the buyer – to choose the theoretically predicted amount. We estimated regression equations with the buyers’ *net* payoffs as dependent variable, and the level of investment and investment squared as independent variables. To control for potential learning effects we also included a time trend. The “optimum” levels of investment can be directly obtained from the estimated coefficients.

13 out of 96 cases. (In 12 of these 13 cases renegotiation is actually inefficient. Still in 11 of them agreement is reached.) In the contingency where the outside bid is high the buyer thus gets no return on the investment, as is predicted.

Table 3: Regressions explaining first offers/final agreements

	Specific Performance, $b = 7000$		
	predictions	first offer	agreement
const.	3400	2667 (603)*	3588 (302)*
I	50	51.8 (11.9)*	48.3 (5.81)*
t	0	-1.23 (37.9)	-7.27 (18.9)
n	96	78	72
adj. R^2		.18	.49

Remark: Standard deviations within parentheses. Significant coefficients (10% level) are marked with an *.

Table 4: “Optimum” investment levels

	Low: $p = \frac{1}{5}$		High: $p = \frac{3}{5}$	
	optimum	actual	optimum	actual
NC	12.00 (7.80)	28.83	3.44 (7.30)	21.88
SP	47.54 (2.39)	49.88	35.93 (2.90)	46.63

Remark: Standard deviations within parentheses.

Without a contract the “optimum” investment levels do not differ significantly from zero. The variance in actual bargaining outcomes is in that case particularly large, resulting in large standard deviations. This is not the case under specific performance. There the “optimum” investment levels can be determined quite accurately and are near the theoretical predictions. Relative to these calculated optima buyers overinvest in the absence of a contract and also in the SP-High treatment. An explanation for the latter result is that buyers overlook that when their own threat point increases, the net surplus up for renegotiation decreases (when $b = 7000$). They thus take the gross marginal return to be 100% in every contingency, making an investment of 50 optimal. Indeed, even in the High-treatment the distribution of reliance levels is very concentrated around the mode of 50 (the frequency belonging to this mode exceeds 80%).

The overinvestment in the absence of a contract is more difficult to explain. Because the buyer bears the full costs of investment and also does not have a positive threat point, she is always worse off than the seller in equilibrium. She therefore has no reason to invest more than is privately optimal out of fairness considerations. One explanation for the observed overinvestment is that she does not anticipate the outcome of the bargaining correctly. The return on investment is higher for final agreements than for first offers. (Note that this is not the case for specific performance.) This suggests a conflict of opinion about the buyer’s return on investment. In particular, the buyer expects a larger than 50% marginal return on the investment and/or compensation for the sunk investment costs borne. As Table 2 illustrates final agreements yield a return of about 59%. This higher return can be explained by positive reciprocity. But even such a higher return cannot justify the high investment levels observed. From the perspective of private returns the investment results without a contract remain somewhat puzzling.

3 Remedies based on damage payments

3.1 Extension of the basic setup

The situations considered in the previous section are in a sense degenerate cases of breach remedies. Without a contract we essentially have the situation in which the breach payment is zero, i.e. the seller is free to go. Specific performance at the other extreme amounts to a situation in which the breach payment is infinitely high. Theoretically, no contract is optimal only when the probability of a high outside bid equals one. Specific performance is optimal only when this probability equals zero.

In this section we turn to intermediate forms of breach remedies. The setup is as before, but now we assume that parties have signed a contract specifying trade at a fixed price of 600 that incorporates a damage schedule $\delta(I)$. The seller may choose, after the outside bid becomes known, to breach this contract. But if he does so, he has to pay $\delta(I)$ in damages to the buyer. After the breach decision the parties can renegotiate this decision to obtain the ex post efficient outcome. Stage 3 of the game now becomes:

3^E . *Breach and bargaining stage.* The seller first decides whether to breach the contract or not. This decision determines the starting point of the bargaining, which then takes place in the same way as described in Subsection 2.1. If the seller it holds that:

$$RS = R(I), TP_B = \delta(I) \text{ and } TP_S = b - \delta(I),$$

and if the seller does not breach we have:

$$RS = b, TP_B = R(I) - 600 \text{ and } TP_S = 600.$$

At the start of the game the status quo is trade according to the terms of the contract. After the outside bid becomes known the seller may change this status quo outcome into separation, just by paying $\delta(I)$ to the buyer. This change may be attractive for him, either because separation itself is more profitable, or because it leads to a profitable renegotiation of the terms of trade. Breach of contract does not necessarily lead to separation, because the parties may renegotiate this decision into trade. The same applies when the seller decides not to breach. This does not necessarily lead to trade, because parties may renegotiate into separation at a lower damage payment. After breaching the contract and the payment of $\delta(I)$ the bargaining situation corresponds to the one without a contract. Likewise, no breach leads to a bargaining situation similar to the one under specific performance. We consider three different damage schedules:

- Liquidated damages: $\delta_{LI}(I) = 3400$;
- Expectation damages: $\delta_{EX}(I) = R(I) - 600$;
- Reliance damages: $\delta_{RE}(I) = I^2$.

3.2 Equilibrium predictions

The predicted outcome of the renegotiations is the same as before, that is, the surplus in excess of the sum of the threat points is split evenly. The seller's breach decision then depends on the damage payment in place. Only under expectation damages the breach decision is always efficient in equilibrium, i.e. leads to the efficient trade decision without further need for renegotiation. This does not apply for the other two damage measures. (See Appendix A for a thorough discussion of the seller's breach decision.)

Our main interest lies in the equilibrium investment levels. With liquidated damages this level depends on the exact amount of the fixed payment. Three main cases can be distinguished. First, for a sufficiently low fixed payment the situation is equivalent to the no contract case. Second, for a sufficiently high fixed payment the situation corresponds with the specific performance case. Third, the fixed payment equals an intermediate value such that the seller breaches only when $b = 7000$. Then investment is predicted to be efficient: $I_{LI} = I^*$. Our choice of $\delta_{LI} = 3400$ gives this intermediate case. Reliance and breach are then predicted to be efficient. As a result, renegotiation is predicted not to occur.

With expectation damages the buyer always obtains at least her expectancy $R(I) - 600$, and the efficient breach decision of the seller ensures that she gets nothing more. It follows immediately that she chooses $I_{EX} = 50$ in equilibrium, irrespective of the value of p . Since under expectation damages the equilibrium breach decision is efficient for any investment level chosen, there will be no renegotiation on the equilibrium path. Overinvestment under expectation damages is due to the full insurance motive. The buyer is fully protected against separation.

Under reliance damages the buyer is also fully insured against the risk that the investment appears socially unprofitable after all. She therefore invests at least 50. But there is an additional motive to overinvest. If the seller breaches and separation is efficient, the buyer obtains a net payoff of zero. She can only get a positive net payoff when $b = 7000$ in case separation is inefficient. She therefore may have an additional incentive to overinvest in order to make it so. Whether this indeed is the case depends on p . When a high outside bid is rather unlikely ($p = \frac{1}{5}$), it does not pay for the buyer to affect the outcome under this contingency. Here only the insurance motive to overinvest is present and the buyer chooses $I_{RE} = 50$. But when p is relatively high it does pay for the buyer to affect the efficient outcome when the outside bid is high. The buyer then anticipates an additional payoff of $\frac{1}{2}(R(I) - 7000)$ when $b = 7000$, and has a stronger incentive to invest. The buyer makes such an investment that the seller surely breaches when

$b = 7000$. The higher investment yields the buyer a better starting point in the subsequent renegotiations, which are needed to obtain the ex post efficient outcome. In this second case both the insurance and the separation prevention motive are present. For our parameter choices it holds that the buyer is indifferent between $I_{RE} = 85$ and $I_{RE} = 90$ when $p = \frac{3}{5}$.⁹

Based on the above predictions we formulate three hypotheses:

- H2** Under LI reliance levels are *decreasing* in p , under EX they are *independent* of p and under RE reliance levels are *increasing* in p .
- H3** (i) Under LI observed investment levels equal the efficient levels; (ii) Reliance levels are higher under EX and RE than under LI; (iii) Reliance levels are higher under RE-High than under EX-High.
- H4** The Pareto-ranking of the different breach remedies equals $NC < RE = EX < SP < LI$ in the Low-treatment and $RE < EX < SP < NC < LI$ in the High-treatment.

Hypotheses 2 and 3 are related to the two motives to overinvest. Hypothesis 4 is based on the prediction that efficiency losses are due solely to inefficient investments; the breach and renegotiation stage causes no waste of the available surplus.

3.3 Experimental design

Again we ran two sessions for each of the three breach schedules. In each session subjects were confronted with the low and the high level of p . Per session 20 subjects participated, so that 120 (new) subjects participated in these six sessions. Subjects earned on average USD $19\frac{1}{2}$ in two hours.

The damage payment sessions resembled the benchmark sessions as close as possible. The game played in each period was framed as a four-stage game. We separated the breach decision and the renegotiations of stage 3^E . In the third stage the seller simply chose between X (no-breach) and Y (breach). The breach decision of the seller determined the starting point of the potential renegotiations. The renegotiation stage was framed in the same way as in the benchmark sessions. The game was presented to the subjects in the simple and accessible way described earlier. Appendix B contains an example of the sequence of computer screens the buyer faced during one play of the four-stage game.

⁹This indifference follows from allowing only investment levels that are a multiple of 5. In the continuous case the equilibrium reliance level is unique and equals $87\frac{1}{2}$ (cf. Appendix A).

Table 5: Mean investment levels

		Low: $p = \frac{1}{5}$		High: $p = \frac{3}{5}$	
		efficient: 40		efficient: 20	
	damages	actual	predicted	actual	predicted
All decisions (mean)	LI	^{de} 46.71 _a	40	^{hi} 32.21 _a *	20
	EX	^{df} 52.54 _b	50	^{hj} 49.25 _b	50
	RE	^{ef} 58.08 _c	50	^{ij} 68.88 _c **	85 or 90
Final decision	LI	^{mn} 46.75 _k	40	^{op} 25.75 _k *	20
	EX	^m 53.25	50	^{oq} 50.25	50
	RE	ⁿ 56.50 _l	50	^{pq} 74.63 _l **	85 or 90

Remark: Subscripts and */** indicate significant differences at the 5% level according to a Wilcoxon signrank test. Letter superscripts indicate significant differences at the 5% level according to a Mann-Whitney ranksum test.

3.4 Results

Our first result in this subsection concerns the relationship between reliance levels and the probability of a high outside bid (cf. Hypothesis H2).

Result 3. (Investment) *Under LI reliance levels are decreasing in p , while under EX they remain virtually constant. Under RE reliance levels increase when p increases.*

Evidence supporting this result is provided in Table 5. Comparative statics test results are indicated by the subscripts a through c and k and l . As before they are based on individual mean investment levels, using a Wilcoxon signrank test. In line with theoretical predictions investment levels are decreasing in p in case of liquidated damages. Under expectation damages comparative statics in p are not robust to learning effects. When we consider all investment decisions we observe an unpredicted 6% decrease in case p increases. While statistically significant the size of this effect is economically not very significant. When we consider final investment decisions differences are no longer statistically significant. We therefore conclude that under expectation damages investment levels remain virtually constant. Under reliance damages investment levels are increasing in p , as is predicted.

The next result relates to the absolute reliance levels and to a comparison across the different damage payments (cf. Hypothesis H3).

Result 4. (Investment) *(i) Average reliance levels are fairly close to predicted levels. This is especially true when subjects have gained experience. (ii)*

Reliance levels are significantly higher under EX and RE than under LI, and (iii) also significantly higher under RE-High than under EX-High.

Evidence is again provided in Table 5. When we consider the means of all investment decisions, reliance levels in two of the six treatments deviate substantially from theoretical predictions. This is the case for the LI-High and RE-High treatments. For LI-High the actual investment level exceeds the predicted (efficient) level by more than 50%. For RE-High the average investment level is below the predicted level. In the other four treatments the mean reliance levels are fairly close to the predicted levels. When we consider final investment decisions, we observe that these are not different from the means of all investment decisions in four of the six treatments. The two exceptions are exactly LI-High and RE-High. In both treatments the adjustment is in the direction of the predicted investment levels. For LI-High the mean investment level goes down and for RE-High it goes up. We therefore conclude that, after some learning, subjects choose investment levels which are fairly close to the predicted levels.

Results from ranksum tests reveal that between the different remedies (within a column) differences in reliance levels are in most cases significant. More specifically, under LI reliance levels are lower than under EX and RE, and reliance levels are higher in the RE-High treatment than in EX-High. These conclusions hold irrespective of whether we consider all investment decisions, or final decisions only.

Results 3 and 4 together provide strong evidence that both motives for overinvestment are at work. First, the operation of the full insurance motive is supported by the difference between the comparative statics results for EX and LI, and by the across remedies comparison between EX (and RE) and LI. Second, both the difference between the comparative statics results for RE and EX and the significant difference between observed investment levels under RE-High and EX-High point at the presence of the separation prevention motive. Our experimental results thus confirm the distortionary impact of breach remedies on the incentives to invest.

The buyer's return on investment is determined by the outcome of the breach and bargaining stage. Actual breach decisions are typically in line with theoretical predictions; the percentage of equilibrium choices are equal to 85%, 92% and 78% for LI, EX and RE respectively. Theory predicts that renegotiations occur only when the seller's breach decision induces an inefficient outcome. In line with this we observe that effective renegotiations are extremely rare when the breach decision is efficient.¹⁰ Overall we observe only 4 of them out of 546 observations in which the breach decision is

¹⁰*Effective* renegotiations refer to renegotiations that end in agreement. When renegotiations

efficient. As a result effective renegotiations hardly ever occur under expectation damages, because there the breach decision is typically efficient (as is predicted). In case the breach decision is inefficient, renegotiations take place in about 80% of the cases (138 out of 174). Overall inefficient non-breaches are quite rare, while inefficient breaches occur far more often. Renegotiations therefore typically follow after an inefficient decision to breach, either under liquidated damages or under reliance damages.

Turning to the outcome of the renegotiations that actually take place, we find a similar pattern as in Subsection 2.4. For all three damage payments first offers and final agreements give the buyer less than the predicted ‘split-the-difference’ solution. Bargaining duration is fairly similar over the three damage payments: under liquidated damages it takes about 2.28 rounds to reach agreement, under EX and RE this is 1.90 and 1.89 respectively. Again we observe that buyers on average get less than predicted when it comes to renegotiations.

With regard to investment incentives we are interested in the actual holdup and threat point effect. Tables 6 and 7 present results from regressing first offers and final agreements on the value of the outside bid, the investment level (squared) and a period trend. Table 6 pertains to liquidated damages and Table 7 to reliance damages. Both tables are restricted to renegotiations after inefficient breach.

Table 6 provides information about the actual holdup effect under liquidated damages. Looking at the first column the seller’s first offer gives the buyer a marginal return on investment of about 82%. When we consider final agreements average marginal returns are somewhat lower at 76%. Under liquidated damages the holdup effect is thus smaller than predicted. This provides a rationale for the somewhat higher than predicted investment levels (see below).

With reliance damages sunk investment costs are predicted to proportionally affect the buyer’s share. This follows from her threat point being increasing in I^2 together with the seller’s threat point being decreasing in I^2 . The former was previously referred to as the threat point effect. Here it occurs only in combination with lowering the seller’s threat point, such that we cannot disentangle both effects. From Table 7 it can be observed that for the relevant range of investment levels $I \geq 50$ the marginal return on investment is always lower than predicted. Given Result 2 it is likely that the driving force here is a weaker than predicted effect of lowering the threat point of the seller. Although this should theoretically weaken his bargaining position, the

tiations do not result in agreement this is equivalent to at least one of parties refusing to enter the renegotiation stage.

Table 6: Regressions explaining first offers/final agreements

	Liquidated damages, after inefficient breach		
	predictions	first offer	agreement
const.	3900	-881 (916)	1057 (634)
b	-.5	-.313 (.089)*	-.446 (.069)*
I	50	82.1 (13.3)*	76.0 (9.29)*
t	0	93.8 (77.3)	89.2 (55.1)
n	48	37	30
adj. R^2		.49	.71

Remark: Standard deviations within parentheses. Significant coefficients (10% level) are marked with an *.

seller may not be willing to give in out of negative reciprocity considerations. In particular, he may want to punish the buyer for excessive overinvestment, because the higher investment makes him worse off in expected payoffs (and both could be made better off under lower investment).

For the three (intermediate) damage payments we also calculated the “optimum” investment levels given actual bargaining outcomes, see Table 8. In the RE-High treatment the variance in actual bargaining outcomes was so large that no sensible estimate of the “optimum” investment level could be obtained.¹¹ The calculated optimum investment levels are close to the actual investment levels for RE-Low, EX-Low and EX-High. For the LI-treatments actual levels exceed the privately optimum levels.

4 Efficiency comparison

Our final result relates to the realized efficiency of all five different breach schedules (cf. Hypothesis H4).

¹¹In the regression of net payoffs both I and I^2 were insignificant and the adjusted R^2 equalled .01. In all other treatments both I and I^2 were highly significant. In none of the treatments the learning parameter was significant.

Table 7: Regressions explaining first offers/final agreements

	REliance damages, after inefficient breach		
	predictions	first offer	agreement
const.	500	-224 (903)	556 (729)
b	-.5	-.091 (.051)*	-.250 (.042)*
I	50	65.6 (32.3)*	34.3 (26.3)
I^2	1	.284 (.300)	.815 (.248)*
t	0	77.0 (40.3)	59.4 (33.2)*
n	100	86	79
adj. R^2		.67	.81

Remark: Standard deviations within parentheses. Significant coefficients (10% level) are marked with an *.

Table 8: “Optimum” investment levels

	Low: $p = \frac{1}{5}$		High: $p = \frac{3}{5}$	
	optimum	actual	optimum	actual
LI	33.40 (3.16)	46.71	19.10 (5.97)	32.21
EX	50.00 (0.04)	52.54	48.47 (0.79)	49.25
RE	56.24 (4.46)	58.08	.	68.88

Remark: Standard deviations within parentheses.

Result 5. (Efficiency) *The ranking of the remedies in terms of attained efficiency levels varies with p . In the Low-treatments the ranking is: $NC < RE = LI < EX = SP$. In the High-treatments this is: $RE < EX = SP = LI = NC$.*

The result is supported by the findings on joint payoffs reported in Table 9. The amounts are normalized per bargaining round. Column (1) gives the expected value of the joint payoffs when subjects make equilibrium choices. The second column contains the average values of the actual joint payoffs. By subtracting these amounts from the maximum surplus $S(I^*)$ the overall observed inefficiencies are obtained. Columns (3) to (5) disentangle these into three different sources: investment inefficiency, bargaining inefficiency and residual inefficiency. The inefficiency due to suboptimal investment is $S(I^*) - S(I_{actual})$ calculated for each interaction and then averaged over interactions. In calculating the investment inefficiency it is thus assumed that the bargaining stage is efficient. The bargaining inefficiency in column (4) is the sum of losses owing to parties deciding not to renegotiate when they should and losses due to delay of agreement.¹² The third source of inefficiency is due to the fact that the empirical distribution of b conditional on the investment level chosen may differ from the theoretical distribution.¹³ The resulting (in)efficiency cannot be attributed to subjects' decisions and is therefore referred to as residual inefficiency (which can be negative, meaning an efficiency gain on these grounds). The last two columns express the predicted and the actual joint payoffs as fractions of maximum expected joint payoffs $S(I^*)$.

The actual efficiency rankings deviate from the predicted ones mainly with respect to liquidated damages. In both treatments LI is less efficient than predicted and outperformed either by specific performance (Low-treatment) or no contract (High-treatment). Given the observed overinvestment under this damage payment this is not surprising. In the Low-treatment specific performance appears to be most efficient. When the probability p that separation is efficient is low, parties are best off by entering into a full commitment contract. Both the investment and the bargaining inefficiency are then lowest. In contrast, when p is high it is in the parties' joint interest to write no contract at all. In that case especially the investment inefficiency

¹²Notice that the breach decision itself can never be a source of inefficiency because an inefficient breach decision can always be renegotiated.

¹³Our design ensured that the realized frequencies of high outside bids exactly equalled 20 percent and 60 percent in the Low and High treatments respectively. That is, we controlled the unconditional empirical distribution of b . We did not control the distribution of b conditional on I .

Table 9: Joint payoffs and efficiency

	predicted expected (1)	average realized (2)	inv. ineff. (3)	barg. ineff. (4)	res. ineff. (5)	(1) / $S(I^*)$	(2) / $S(I^*)$
NC-Low	3400	2586 _{abcd}	332	842	40	0.89	0.68
NC-High	4900	4169 _i	248	535	48	0.98	0.83
SP-Low	3775	3575 _{ae f}	121	100	4	0.99	0.94
SP-High	4775	3894 _j	823	331	-48	0.96	0.78
LI-Low	3800	2792 _{be g}	244	729	35	1	0.73
LI-High	5000	4040 _k	518	367	75	1	0.81
EX-Low	3700	3292 _{cg h}	270	221	17	0.97	0.87
EX-High	4100	3813 _l	921	225	41	0.82	0.76
RE-Low	3700	2725 _{df h}	535	564	-24	0.97	0.72
RE-High	2275	2535 _{ijkl}	1940	527	-2	0.46	0.51

Remark: $S(I^*) = 3800$ in the Low-treatments and $S(I^*) = 5000$ in the High-treatments. It holds that $S(I^*) - (2) = (3) + (4) + (5)$. Subscripts indicate that amounts within the second column are significantly different from each other according to a ranksum test (at the 10% level). In the RE-High treatment we assume $I = 85$ in column (1). In case of $I = 90$ the “predicted expected” would be 1900.

is small. Theoretically specific performance is optimal only in the limit when $p \rightarrow 0$, while no contract is optimal only when $p \rightarrow 1$. Our results suggest that the empirical cutoff values for p lie in the interior. The range of p -values for which it may be optimal to make elaborate contractual arrangements with (intermediate) damage payments may thus be more limited than theory suggests.

In line with theoretical predictions, for both p -values investment inefficiencies are largest under reliance damages. This was already apparent from the mean reliance levels reported in the previous subsection. Theory also predicts that efficiency losses are solely due to suboptimal investment. But as we already saw in Subsections 2.4 and 3.4 parties sometimes do not renegotiate when they should and when they do renegotiate they often waste surplus by delaying agreement. Column (4) reveals that the ranking of remedies in terms of bargaining losses is fairly constant over the different values of p . Under specific performance and expectation damages relatively small amounts are wasted in the bargaining stage. For the latter this follows because there are only a few instances in which effective renegotiations take place. On average losses due to suboptimal investment exceed losses due to inefficient bargaining. But this is not true for each of the separate treatments.

For the LI, EX and RE treatments the efficiency levels reported in Table 9 can also be compared with those achieved in the no-renegotiation setup of Sloof et al. (2000). For all treatments efficiency levels are higher in the latter. Only in the RE-High treatment the difference is small. This finding can be explained by the following observations. Reliance levels in the no-renegotiation setup are somewhat closer to the optimal levels. The presence of renegotiation typically induces higher reliance levels on average. Furthermore, in the no-renegotiation setup losses due to suboptimal breach decisions appear to be small, while in the current setup we find substantial losses during the bargaining stage. In this application, the possibility of ex post renegotiation does more harm than good.

5 Conclusion

Breach remedies serve an important role in protecting relationship-specific investments. Theory predicts that some commonly used types of breach remedies may protect too well, in the sense that they induce overinvestment. This result is driven by two motives to overinvest. The first one is the *insurance* motive. Breach remedies either partially or completely insure the investor against separation. The investor gets some private return on the investment made, even when the parties efficiently separate and the invest-

ment has no social return. The second motive is *separation prevention*. The investor may get a positive net return only when separation does not occur. She then has an incentive to overinvest such that separation becomes inefficient in all possible contingencies.

The main result of this paper is that in a setting where ex post renegotiation is possible the insurance and separation prevention motive are both at work and cause overreliance. In line with theoretical predictions the insurance motive is present under specific performance, expectation damages and reliance damages. The separation prevention motive is indeed operative only under reliance damages, but is somewhat weaker than predicted. An explanation for this might be the presence of negative reciprocity. The non-investor is prepared to punish the investor for too much overinvestment. Anticipating this, the investor has less incentive to overinvest.

Furthermore, we find that holdup is less of a problem than theory predicts it to be. Without a contract there is less underinvestment than predicted. This result is in line with findings from other experimental studies. But while in most other studies this deviation from the theoretical prediction is supported by a positive reciprocity mechanism in which non-investors permit investors a larger than predicted return on their investment, this mechanism is not at work in the current experiment. Private investment incentives cannot provide a convincing explanation for less underinvestment, because in the renegotiations the return for the investor is by and large as predicted. Apparently investors do not anticipate the outcome of the bargaining correctly and count on a weaker than predicted holdup effect. A related result is found for liquidated damages. Investors invest more than the predicted efficient level and are not rewarded for that during the bargaining stage. As a result liquidated damages are no longer optimal when renegotiation is allowed for.

The relative ordering of the breach remedies in terms of the average reliance levels they induce are in line with theory. Our experimental results suggest the following: (i) reliance damages should not be used in practice because they result in excessive overreliance; (ii) when the ex ante probability of efficient separation is rather high, not much can be gained by an elaborate contract with damage payments and the parties may well be best off by writing no contract at all; (iii) in case the ex ante probability of efficient separation is small, parties are likely to gain from protecting the investment contractually either through expectation damages or specific performance.

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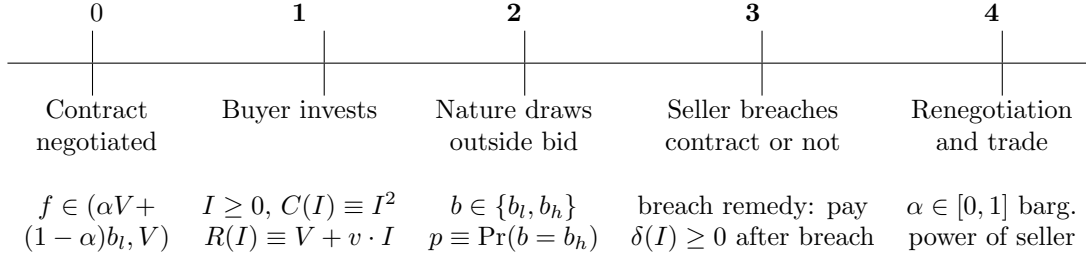


Figure 1: Timing of events in the holdup game

Appendix A

A.1 Description of the model

In this appendix we analyse a more general specification of the holdup game studied in the experiment. The buyer can make a specific investment that increases the joint surplus from trade, while the seller has an alternative trading opportunity outside this relationship.¹⁴ In case the buyer and the seller trade gross surplus equals $R(I) \equiv V + v \cdot I$, with $I \geq 0$. Production costs of the single unit are normalized to zero. Parameter $V > 0$ represents the buyer's basic valuation of trading with the seller, while $v > 0$ gives the constant increment in her valuation with each unit of investment. Investment costs are equal to $C(I) \equiv I^2$. The seller's alternative trading opportunity can either be of low ($b = b_l$) or of high value ($b = b_h$, where $b_l < b_h$). The prior probability that the latter case applies equals $p \equiv \Pr(b = b_h)$. The outside bid b is assumed to be competitive, such that it also represents the outside buyer's valuation of the seller's product.

Figure 1 shows the timing of events. The game starts with the two parties negotiating a contract that governs their future relationship. This initial contract specifies trade at a fixed price f . The buyer subsequently chooses the investment level. Then uncertainty about the outside bid is resolved. Knowing the price he can get from the outside buyer, the seller decides whether to breach the contract or not. If he does so he has to pay an amount of $\delta(I)$ in damages to the buyer. In the last stage the parties may renegotiate the outcome that pertains after the seller's breach decision. For instance,

¹⁴The assumption that the buyer invests and that the seller has an outside opportunity is without loss of generality. We could as well assume that this is the other way around (cf. Rogerson 1984, Shavell 1980). The important assumption here is that the investor has no outside opportunity. She therefore never has an incentive to breach the contract.

they may mutually agree upon lowering the damage payment $\delta(I)$ in order to induce an efficient separation. Parameter α represents the bargaining power of the seller, implying that he receives a fraction of α of the net surplus up for renegotiation. The final trade decision agreed upon determines the payoffs the players obtain.

Our ordering of the breach and renegotiation stage follows Che and Chung (1999) and deviates from Rogerson (1984). The latter paper allows renegotiation only *before* the seller's breach decision. In that case the breach decision is independent of α . In contrast, in our setup the breach decision will be affected by the anticipated outcome of the renegotiations and thus by α . For given parameters the equilibrium outcome may be different for the two orderings. But as Spier and Whinston (1995) show, results with respect to the *optimality* of certain types of damage schedules remain unaffected. The order of play assumed here has two clear advantages. First, it extends the game without renegotiation by adding a final stage rather than fitting in an in-between stage. This makes the present experiment better comparable with the no-renegotiation setup studied earlier. Second, our order of play is also better justified on theoretical grounds. When renegotiation is not possible after the seller's breach decision, this decision may induce an ex post inefficient outcome. But, in a Coasian world in which all gains from trade are exhausted parties cannot credibly threaten not to renegotiate inefficient outcomes (cf. Edlin and Hermalin 2000). As renegotiation is typically introduced to rule out inefficient separations, a model that is based on the threat of such inefficient outcomes can be considered inconsistent.

The renegotiation stage has the following setup. The gross surplus up for renegotiation is denoted RS , the threat point payoffs the players obtain when no agreement is reached equal TP_B and TP_S , respectively. When the seller does not breach the parties may renegotiate this decision to induce separation. In that case RS equals b and the (gross) payoffs under contract performance serve as threat point values. This yields the entries in the first row of Table 10. When the seller breaches the contract the parties may renegotiate to induce the trade outcome. RS is then equal to $R(I)$ and the (gross) payoffs under breach of contract serve as threat points. The entries in the second row of Table 10 reflect this. This row necessarily applies in the absence of a contract (with $\delta(I) = 0$). Under specific performance breach is not possible and the starting point of the renegotiations is always given by the first row in Table 10.

In line with most of the theoretical literature we do not explicitly consider the contract negotiation stage. We simply assume that a contract specifying f and $\delta(I)$ already exists. For the fixed price f we assume that $\alpha \cdot V + (1 - \alpha) \cdot b_l < f < V$. This ensures that both parties can always obtain a payoff from

Table 10: Setup renegotiation stage

	RS	TP_B	TP_S
No-breach	b	$R(I) - f$	f
Breach	$R(I)$	$\delta(I)$	$b - \delta(I)$

performing the contract that exceeds the payoff they at least obtain in the absence of a contract. The breach remedies listed in the introduction each imply a different damage schedule $\delta(I)$. In particular, we have $\delta_{SP}(I) = \infty$, $\delta_{LI}(I) \equiv \delta_{LI} \geq 0$, $\delta_{EX}(I) \equiv R(I) - f$ and $\delta_{RE}(I) = C(I) = I^2$. The case in which an initial contract is absent is equivalent with $f = \delta(I) = 0$.¹⁵

In the presence of renegotiation inefficient separations theoretically do not occur. The focus is therefore on whether the various breach remedies encourage efficient reliance. The efficient level of investment I^* follows from maximizing expected net social surplus $S(I)$, where

$$S(I) \equiv (1 - p) \cdot R(I) + p \cdot \max\{R(I), b_h\} - I^2$$

The first term follows from our assumption that $b_l < V$, such that trade between the buyer and the seller is always efficient when the outside bid turns out to be low. As shown in Sloof et al. (2000) the efficient investment level is given by $I^* = \frac{1}{2}v$ when $b_h \leq V + \frac{1}{4}(2 - p)v^2$ and by $I^* = \frac{1}{2}(1 - p)v$ when $b_h \geq V + \frac{1}{4}(2 - p)v^2$. In the first case it holds that for the efficient level of reliance trade between the buyer and the seller is always efficient. In the second case I^* is such that separation is efficient when b is high. An investor who wants to choose the efficient level then has to take into account that the investment pays off only when $b = b_l$. We take this case as being both the more plausible and the more interesting one. Assumption 1 below is therefore made, together with those reflected in Figure 1 above:

Assumption 1. $b_h > V + \frac{1}{2}v^2$

Assumption 1 is in fact somewhat stronger than actually needed; $b_h > V + \frac{1}{4}(2 - p)v^2$ would already be sufficient. The stronger assumption is made because it makes the equilibrium analysis easier, without seriously affecting equilibrium predictions.

¹⁵In the experiment we have $V = 1000$, $v = 100$, $f = 600$, $b_l = 0$, $b_h = 7000$, $p_{Low} = \frac{1}{5}$, $p_{High} = \frac{3}{5}$, $\alpha = \frac{1}{2}$ and $\delta_{LI} = 3400$.

A.2 Equilibrium predictions

We use backward induction to derive the subgame perfect Nash equilibria. First consider the renegotiation stage. In equilibrium actual renegotiations occur only when the seller's breach decision induces an ex post inefficient outcome. This is the case when the gross renegotiation surplus RS exceeds the sum of the two threat point payoffs. The net renegotiation surplus in excess of the threat point payoffs is then split in proportion to the parties' relative bargaining powers; the buyer gets a share of $TP_B + (1 - \alpha) \cdot (RS - TP_B - TP_S)$ while the seller obtains the remainder. This corresponds with a generalized split-the-difference rule.

Next consider the breach decision of the seller, given the equilibrium outcome of the renegotiation stage. If $R(I)$ exceeds b , no-breach yields him f while breach gives him $b - \delta(I) + \alpha \cdot (R(I) - b)$. In the opposite case where b exceeds $R(I)$ no-breach gives the seller $f + \alpha \cdot (b - R(I))$ while breach yields him $b - \delta(I)$. When we resolve any indifference in favor of choosing to stay in the relation it is optimal for the seller to breach iff $\alpha \cdot R(I) + (1 - \alpha) \cdot b > f + \delta(I)$. (The tie-breaking assumption is inessential for our results.) Note that the seller sometimes breaches not with the intention to separate, but rather to get a better deal from the original buyer. Likewise, the seller may not breach not because he wants to trade with the original buyer, but to arrive at a lower damage payment through renegotiation.

Given the equilibrium breach decision of the seller, the buyer's equilibrium investment level follows from maximizing $\pi(I)$:

$$\pi(I) \equiv \sum_{i=l,h} q_i \cdot (\max \{ (1 - \alpha) \cdot [R(I) - b_i], 0 \} + \min \{ R(I) - f - (1 - \alpha) \cdot [R(I) - b_i], \delta(I) \}) - I^2 \quad (1)$$

where $q_l \equiv 1 - p$ and $q_h \equiv p$. The first max-term represents the gross payoffs without a contract, while the second min-term represents the net gain from having the contract. The third term simply reflects the investment costs $C(I)$. In Appendix A.3 we derive the equilibrium investment levels for the various specifications of $\delta(I)$ considered. Table 11 summarizes the results.

In the absence of a contract we obtain the well-known underinvestment result (for $\alpha > 0$). Breach remedies typically induce overinvestment in relation-specific capital. To assess their relative performance the theoretical literature typically compares them under the assumption of *optimal* contracts; at the contracting stage the buyer and the seller pick a value of f that maximizes their joint surplus. For these type of contracts, Table 11 confirms the Pareto-ranking as derived by Rogerson (1984): $RE \leq EX < SP < LI$.

Table 11: Equilibrium investment levels

	$\delta(I)$	Case	Investment
NC	0 ($f = 0$)		$\frac{1}{2}(1 - \alpha)(1 - p)v$
SP	∞		$\frac{1}{2}(1 - p + \alpha p)v$
LI	δ_{LI}	$\alpha V + (1 - \alpha)b_l + \frac{1}{2}\alpha(1 - p)v^2 < f + \delta_{LI} < \alpha V + (1 - \alpha)b_h + \frac{1}{2}\alpha(1 - p)v^2$	$\frac{1}{2}(1 - p)v$
EX	$R(I) - f$		$\frac{1}{2}v$
RE	I^2	$p < \frac{4(b_h - V) - 2v^2}{4(b_h - V) - (1 + \alpha)v^2}$ $p \geq \frac{4(b_h - V) - 2v^2}{4(b_h - V) - (1 + \alpha)v^2}$	$\frac{1}{2}v$ $\frac{1}{2} \frac{(1 - \alpha p)}{(1 - p)} v$
	efficient		$\frac{1}{2}(1 - p)v$

Remark: For the RE case we have made the additional assumption that $\alpha V + (1 - \alpha)b_l + \frac{1}{2}v^2 (\alpha - \frac{1}{2}) < f < \alpha V + (1 - \alpha)b_h + \frac{1}{4}v^2 \left[\alpha^2 - \frac{(1 - \alpha)^2}{(1 - p)^2} \right]$.

Under liquidated damages the equilibrium reliance level depends on the value of δ_{LI} . Three main cases have to be distinguished. First, δ_{LI} is that low such that the seller always breaches. This situation is equivalent to the one without a contract. We thus obtain $I_{LI} = I_{NC}$. Second, δ_{LI} can be that high such that the seller never breaches. This case corresponds with the one of specific performance and we get $I_{LI} = I_{SP}$. Third, δ_{LI} equals an intermediate value such that the seller breaches only when $b = b_h$. Then reliance is predicted to be efficient. Here we focus on this intermediate case. The restriction on $f + \delta_{LI}$ in Table 11 ensures this. The remedy of *efficient expectation damages* that specifies $\delta_{LI} = R(I^*) - f$ fits within this class. It in general constitutes the optimal private damage schedule in a variety of settings (cf. Spier and Whinston 1995).

Under the remaining three breach remedies overinvestment is induced by two motives. The first one is the insurance motive; the breach remedy protects the buyer against separation. Even when separation is efficient ($b_h > R(I)$) and the investment does not pay off from a social point of view, the buyer gets some gross return on her investment. Under specific performance the buyer is only partially insured. Here the seller never breaches, even when it would be socially efficient to do so. In the latter case the parties

renegotiate the contract as to make efficient separation possible. The overall return of an additional investment unit is then $\alpha \cdot v$ for the buyer; one extra unit increases her threat point by v , but also lowers the gross surplus up for renegotiation by v . As the buyer bears a share of $(1 - \alpha)$ of the reduction in the renegotiation surplus, a return of $\alpha \cdot v$ remains. Hence when $\alpha < 1$ the buyer is not completely insured against separation.

In case of expectation damages the buyer is fully insured against separation. She just chooses the investment level that maximizes her expectancy $R(I) - f$ net of investment costs $C(I)$. The full insurance motive also applies under reliance damages, because the buyer then always recovers at least her investment costs. Yet under this rule there may also be a second motive to overinvest. The intuition behind this separation prevention motive is as follows. When the parties do not trade the buyer obtains a net payoff of zero. She can only get a positive net payoff when separation is inefficient. She therefore may have an additional incentive to overinvest in order to make it so even for $b = b_h$. Whether this is indeed the case depends on the probability p that the latter contingency occurs. (The additional assumption on f is made to rule out border cases.) In case p is low it does not pay for the buyer to affect the outcome after $b = b_h$. Then only the (full) insurance motive to overinvest is present. When p is high it is attractive for the seller to bear some additional investment costs to generate a positive net payoff when $b = b_h$. The buyer makes such an investment that trade is always efficient, but the seller surely breaches when $b = b_h$. The higher investment yields the buyer a better starting point in the subsequent renegotiations, which are needed to obtain the ex post efficient outcome.

A.3 Derivation of equilibrium reliance levels

No contract: $f \equiv \delta_{NC}(I) \equiv 0$. In expression (1) the min-term vanishes. Clearly then $\frac{\partial \pi(I)}{\partial I} \leq \frac{\partial R(I)}{\partial I} - 2I = v - 2I$. (In case the derivative does not exist, i.e. at the kinks of the max-terms, the inequality holds for both the left and the right derivatives.) For the equilibrium level of investment it thus necessarily holds that $I \leq \frac{1}{2}v$. Using $b_l < V$ and Assumption 1 expression (1) reduces to $\pi(I) = (1 - p) \cdot (1 - \alpha) \cdot [R(I) - b_l] - I^2$ for $I \leq \frac{1}{2}v$. Solving for the maximum we obtain $I_{NC} = \frac{1}{2}(1 - \alpha)(1 - p)v$.

Specific performance: $\delta_{SP}(I) = \infty$. In the min-term of (1) always the first argument applies. Again we get $\frac{\partial \pi(I)}{\partial I} \leq v - 2I$ such that necessarily $I \leq \frac{1}{2}v$. For this range we have $\pi(I) = R(I) - f - p \cdot (1 - \alpha) \cdot [R(I) - b_h] - I^2$ under Assumption 1. We directly get $I_{SP} = \frac{1}{2}(1 - p + \alpha p)v$ from maximizing the latter expression.

Liquidated damages: $\delta_{LI}(I) \equiv \delta_{LI} \geq 0$. Because δ_{LI} is independent of I it again follows that $\frac{\partial \pi(I)}{\partial I} \leq v - 2I$. Necessarily then $I \leq \frac{1}{2}v$, and thus $b_l < R(I) < b_h$ at the equilibrium investment level.

The first argument of the min-term in (1) is increasing in b_i . Hence when the first argument applies for b_h , it also necessarily does so for b_l . Three main cases can thus be distinguished. First, assume that the equilibrium investment level is such that the first argument applies for both b_l and b_h . This situation is equivalent to the one under SP and we immediately obtain $I_{LI} = \frac{1}{2}(1 - p + \alpha p)v$. To satisfy the assumption made it must hold that $f + \delta_{LI} > \alpha V + (1 - \alpha)b_h + \frac{1}{2}\alpha(1 - p + \alpha p)v^2$. Second, suppose that for both values of b_i always the second argument δ_{LI} applies. This case is equivalent to the one under NC and we directly get $I_{LI} = \frac{1}{2}(1 - \alpha)(1 - p)v$. To satisfy the assumption made it is now required that $f + \delta_{LI} < \alpha V + (1 - \alpha)b_l + \frac{1}{2}\alpha(1 - \alpha)(1 - p)v^2$. Third, let the first argument of the min-term apply for b_l and the second one for b_h . Then expression (1) reduces to $\pi(I) = (1 - p) \cdot [R(I) - f] + p \cdot \delta_{LI} - I^2$. Maximizing this expression we obtain $I_{LI} = \frac{1}{2}(1 - p)v$. For this investment level the assumption on the min-term holds whenever $\alpha V + (1 - \alpha)b_l + \frac{1}{2}\alpha(1 - p)v^2 < f + \delta_{LI} < \alpha V + (1 - \alpha)b_h + \frac{1}{2}\alpha(1 - p)v^2$. This is the case considered in the main text.

Apart from the three main cases two border cases exist. In the first one $I_{LI} = \frac{1}{\alpha v}[f + \delta_{LI} - \alpha V - (1 - \alpha)b_l]$, such that for b_l the two arguments in the min-term are equal. This case applies when $\alpha V + (1 - \alpha)b_l + \frac{1}{2}\alpha(1 - \alpha)(1 - p)v^2 < f + \delta_{LI} < \alpha V + (1 - \alpha)b_l + \frac{1}{2}\alpha(1 - p)v^2$. The condition reflects the requirement that the left (right) derivative of $\pi(I)$ is positive (negative) at the equilibrium reliance level. In the second border case $I_{LI} = \frac{1}{\alpha v}[f + \delta_{LI} - \alpha V - (1 - \alpha)b_h]$ and the requirement here reads $\alpha V + (1 - \alpha)b_h + \frac{1}{2}\alpha(1 - p)v^2 < f + \delta_{LI} < \alpha V + (1 - \alpha)b_h + \frac{1}{2}\alpha(1 - p + \alpha p)v^2$. The five cases together exhaust all possibilities under the assumptions made.

Expectation damages: $\delta_{EX}(I) = R(I) - f$. Expression (1) simplifies to $\pi(I) = R(I) - f - I^2$, which attains its maximum at $I_{EX} = \frac{1}{2}v$.

Reliance damages: $\delta_{RE}(I) = I^2$. First, assume that the equilibrium investment level is such that the first argument in the min-term of expression (1) strictly applies for both b_l and b_h . This situation is equivalent to the one under SP and we immediately obtain $I_{RE} = \frac{1}{2}(1 - p + \alpha p)v$ as equilibrium candidate. To satisfy the assumption made on b_h it must then hold that $\alpha v I + [\alpha V + (1 - \alpha)b_h - f] \leq I^2$. Under Assumption 1 (and $f < V$) this necessarily requires $I > \frac{1}{2}v \geq I_{RE}$. Hence this situation is not possible in equilibrium. Second, suppose that for both values of b_i always the second argument I^2 applies. This requires $I^2 \leq \alpha v I + [\alpha V + (1 - \alpha)b_l - f]$

and yields $\pi(I)$ strictly increasing in I . But then the requirement cannot be satisfied for the optimal investment level. Hence, necessarily the first (second) argument in the min-term must apply for b_l (b_h). This generates three different situations: (i) the first (second) argument in the min-term applies for b_l (b_h) in an ϵ -neighborhood (with $\epsilon > 0$) around the equilibrium investment level, (ii) the equilibrium level is such that the two arguments are equal for b_l and (iii) the latter applies for b_h . In all three cases $\pi(I) = (1-p)(R(I) - f - I^2) + p(1-\alpha) \max\{R(I) - b_h, 0\}$. The optimum can never be at $R(I) = b_h$, because at that point the right derivative of $\pi(I)$ exceeds the left derivative.

We first show that cases (ii) and (iii) are not possible under the assumption made on f . Consider the former. The assumption that $\alpha V + (1-\alpha)b_l + \frac{1}{2}v^2(\alpha - \frac{1}{2}) < f$ implies that this case applies for some $I < \frac{1}{2}v$. But then the right derivative of $\pi(I)$ equals $(1-\alpha p)v - 2(1-p)I$, strictly positive for $I < \frac{1}{2}v$. Next, consider case (iii). From the expression for $\pi(I)$ it follows that for the optimum the max-term necessarily must be strictly positive, otherwise $\pi(I)$ falls short of $\pi(\frac{1}{2}v)$. The left derivative of $\pi(I)$ evaluated at the kink equals $(1-\alpha p)v - 2(1-p)I$, the right derivative equals $v - 2I$. For the left derivative to be positive at $I = \frac{1}{2} \left[\alpha v + \sqrt{\alpha^2 v^2 + 4(\alpha V + (1-\alpha)b_h - f)} \right]$ it is then required that $f > \alpha V + (1-\alpha)b_h + \frac{1}{4}v^2 \left[\alpha^2 - \frac{(1-\alpha)^2}{(1-p)^2} \right]$.

From the above necessarily case (i) applies. First, suppose $\max\{R(I) - b_h, 0\} = R(I) - b_h > 0$ at the optimum. Then we get $I_{RE} = \frac{1}{2} \left[\frac{1-\alpha p}{1-p} \right] v$. To ensure $R(I) - b_h > 0$ it is then required that $b_h < V + \frac{1}{2} \left[\frac{1-\alpha p}{1-p} \right] v^2$. Moreover, for the assumption on the min-term to hold it is needed that $\alpha V + (1-\alpha)b_l < f - \frac{1}{4}v^2 \left\{ \alpha^2 - \frac{(1-\alpha)^2}{(1-p)^2} \right\} < \alpha V + (1-\alpha)b_h$. Next, assume that $\max\{R(I) - b_h, 0\} = 0 > R(I) - b_h$ at the optimum. Then we get $I_{RE} = \frac{1}{2}v$. To ensure $R(I) - b_h < 0$ it is then required that $b_h > V + \frac{1}{2}v^2$, equivalent to Assumption 1. The assumptions on the min-term require $\alpha V + (1-\alpha)b_l < f - \frac{1}{2}v^2(\alpha - \frac{1}{2}) < \alpha V + (1-\alpha)b_h$. Both candidates exist when the additional assumption on f (cf. Remark below Table 11) holds and $b_h < V + \frac{1}{2} \left[\frac{1-\alpha p}{1-p} \right] v^2$. With respect to the expected payoffs we get:

$$\pi \left(\frac{1}{2} \left[\frac{1-\alpha p}{1-p} \right] v \right) = \pi \left(\frac{1}{2}v \right) + p(1-\alpha) \left\{ V + \frac{1}{4} \left[\frac{2-p-\alpha p}{1-p} \right] v^2 - b_h \right\}$$

where $\pi(\frac{1}{2}v) = (1-p)(V + \frac{1}{4}v^2 - f)$. The case distinction in Table 11 on the basis of p follows from the term within $\{\cdot\}$.

Appendix B

This appendix contains translations of the computer-screens buyers faced during the experiment. The example concerns the four-stage game of Section 3 for the case of reliance damages. In the simpler games of Section 2 the third stage is left out.

Overview stage 1 to 3 of the present period					
Period:	3	Your role:	A	Total points:	10700
		Blue:	80%	Yellow:	20%
T = ??	X	Y	X	Y	
Round pie:	0	$1000 + 100 * T$	7000	$1000 + 100 * T$	
Bottom A:	$400 + 100 * T$	$T * T$	$400 + 100 * T$	$T * T$	
Bottom B:	600	$-T * T$	600	$7000 - T * T$	


Overview stage 4					Your decision in stage 1	
Round:	Proposal:	You:	Other:	State:	Earnings	
1						
2						
3						
4						
Earnings in stage 1:						
Earnings this period:						

Your decision in stage 1	
Decide on the amount T:	
<input type="text" value="50"/>	
Type an amount between 0 and 100 and press Enter.	

In the experiment the buyer has code 'A' and the seller code 'B'. In the overview at the top of the screen the pie sizes ('Round pie') and the threat points ('Bottom') are presented as formulas. When the subject enters the investment T in stage 1, these formulas are replaced by numbers and the subject has to confirm or change the decision (not shown here).

Overview stage 1 to 3 of the present period					
Period:	3	Your role:	A	Total points:	10700
		Blue:	80%	Yellow:	20%
T = 50	X	Y	X	Y	
Round pie:	0	6000	7000	6000	
Bottom A:	5400	2500	5400	2500	
Bottom B:	600	-2500	600	4500	

Overview stage 4					Stage 2: The turning of the wheel	
Round:	Proposal:	You:	Other:	State:	Earnings	
1						
2						
3						
4						
Earnings in stage 1:					-10000	
Earnings this period:						


Stage 2: The turning of the wheel	
The color of the wheel is ??	
	

After the confirmation the wheel of fortune spins...

Overview stage 1 to 3 of the present period					
Period:	3	Your role:	A	Total points:	10700
Blue: 80%			Yellow: 20%		
T = 50	X	Y	X	Y	
Round pie:	0	6000	7000	6000	
Bottom A:	5400	2500	5400	2500	
Bottom B:	600	-2500	600	4500	

Overview stage 4					Stage 2: The turning of the wheel
Round:	Proposal:	You:	Other:	State:	Earnings
1					
2					
3					
4					
Earnings in stage 1:					-10000
Earnings this period:					

The color of the wheel is yellow !



The outcome of the wheel of fortune is presented in the overview at top of the screen; the now irrelevant blue numbers have turned grey.

Overview stage 1 to 3 of the present period					
Period:	3	Your role:	A	Total points:	10700
Blue: 80%			Yellow: 20%		
T = 50	X	Y	X	Y	
Round pie:	0	6000	7000	6000	
Bottom A:	5400	2500	5400	2500	
Bottom B:	600	-2500	600	4500	

Overview stage 4					The decision of the other
Round:	Proposal:	You:	Other:	State:	Earnings
1					
2					
3					
4					
Earnings in stage 1:					-10000
Earnings this period:					

The other has chosen
X.

When the seller (B) has chosen 'X' (No Breach) the now irrelevant yellow numbers under 'Y' have turned grey. (In the three-stage game of Section 2 this stage is absent; without a contract always case 'Y' applies (with the then appropriate numbers), under specific performance always case 'X' applies.)

Overview stage 1 to 3 of the present period					
Period:	3	Your role:	A	Total points:	10700
Blue: 80%			Yellow: 20%		
T = 50	X	Y	X	Y	
Round pie:	0	6000	7000	6000	
Bottom A:	5400	2500	5400	2500	
Bottom B:	600	-2500	600	4500	

Overview stage 4					Your decision in stage 4	
Round:	Proposal:		State:	Earnings		
	You:	Other:				
1					<p>Do you want to negotiate ?</p> <p><input type="button" value="No"/> <input type="button" value="Yes"/></p>	
2						
3						
4						
Earnings in stage 1:				-10000		
Earnings this period:						

At the start of the final stage both subjects are asked whether they want to negotiate.

Overview stage 1 to 3 of the present period					
Period:	3	Your role:	A	Total points:	10700
Blue: 80%			Yellow: 20%		
T = 50	X	Y	X	Y	
Round pie:	0	6000	7000	6000	
Bottom A:	5400	2500	5400	2500	
Bottom B:	600	-2500	600	4500	

Overview stage 4					The decision of the other	
Round:	Proposal:		State:	Earnings		
	You:	Other:				
1	5000	2000	cntpr.	5400	<p>The other has chosen to accept your proposal.</p>	
2	6000	1000	accept	6000		
3				6000		
4				6000		
Earnings in stage 1:				-10000		
Earnings this period:				13400		

If both are willing to negotiate, the B-player (seller) formulates the first proposal. The actions of the other player are always displayed in green while own actions always appear in black. Negotiations end when a proposal is accepted, or the fourth proposal is rejected.