Better Later than Never?
An Experiment on Bargaining under Adverse Selection*

Olivier Bochet[†] Simon Siegenthaler[‡]

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Abstract

A central result in the literature on bargaining with asymmetric information is that the uninformed party (buyer) can screen the informed party (seller) over time. Screening eliminates trade failures that are otherwise common in the presence of adverse selection, but the downside of the bargaining institution is the cost associated with repeated offers and time frictions. This paper reports an experimental test of these predictions. We find that rates of trade are substantially higher in the bargaining institution than in control treatments in which we remove the possibility to make repeated offers (take-it-or-leave-it offer) or the time frictions. However, we also observe a persistent over-delay before agreements are reached, i.e., bargaining takes longer than theoretically predicted. This lowers efficiency below its predicted level and below the level observed in the take-it-or-leave-it offer institution. We identify possible channels for over-delay in the form of fairness preferences and loss aversion, concluding that there are important behavioral deviations from the standard model that are detrimental to the efficiency of bargaining under incomplete information.

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1 Introduction

An important issue in economics is why mutually beneficial agreements are often hard to reach. While there are many possible impediments to reaching efficient agreements, an obvious obstacle is the asymmetry of information that may prevail among parties. For instance, when adverse selection is severe, the price mechanism fails to allocate goods efficiently and the market for high

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[†]NYU Abu Dhabi, email: olivier.bochet@nyu.edu

[‡]NYU Abu Dhabi, email: s.siegenthaler@nyu.edu

quality goods breaks down (Akerlof, 1970). While first-best efficiency is out-of-reach in such a case, institutions that differ from Walrasian markets may help alleviate the adverse selection effect.

In real-life situations, where asymmetry of information is often prevalent, it is common that buyers and sellers *bargain* for some time over prices before an agreement is reached. For instance, in the housing market, a potential buyer may make several successive offers for the same house. This process tends to be costly for both parties, either because there are explicit time and effort costs or due to the risk that the other party takes an outside option; prolonged negotiations may also trigger psychological costs. Other examples where bargaining under asymmetric information is witnessed are hiring decisions (the worker may have superior knowledge about his level of productivity), the sale of an oil tract (the buyer may possess information about the richness of the deposit that is relevant to the owner's willingness to sell) or bargaining over the price of a software product (the buyer's knowledge about the expenses needed for the development of a new software may be limited). There as well, time costs play an important role in speeding up or delaying decisions.[1]

This paper is concerned with an experimental test of bargaining under incomplete information. Our choice of institution is rooted in the theoretical literature. In a series of papers, Vincent (1989), Evans (1989), and Deneckere and Liang (2006) (henceforth DL) consider the case of a possibly infinite number of interactions between an uninformed buyer and an informed seller, in which the buyer makes an offer and the seller accepts or rejects. They show that the lack of commitment of the buyer coupled with frictions (in the form of discounting on payoffs) has a striking effect: despite the strong information asymmetries, in equilibrium trade occurs with any type of seller, and at different prices which signal qualities. The buyer uses a monotonic price sequence to screen out low type sellers, while updating his belief towards the high type following each rejection along the sequence. Frictions facilitate trade, but they are also a source of efficiency loss because of the costly delay before reaching an agreement.

One may be satisfied with DL's prediction and the trade-off it presents in terms of rate of trades and cost of delay. There are, however, several reasons to put this prediction to an experimental test. (i) As usual, the sequential equilibrium construction involves a high degree of sophistication on behalf of the agents. This concern alone is sufficient to warrant a thorough check to see if, qualitatively, screening patterns identified at a sequential equilibrium are observed in the lab. (ii) The construction of the sequential equilibrium relies also on standard payoff maximization assumptions. The experimental literature documents systematic deviations from these assumptions – often in the form of loss aversion and concerns for fairness. These departures from the standard model may trigger unexpected effects, either improving the performance of bargaining institutions or adding new impediments to trade and efficiency.

We first extend DL's model to the case where the number of offers is finite. In doing so, we provide a general treatment of bargaining with interdependent values and a finite number of stages that was not previously available in the literature. We show that if the number of periods is large

[1] Another example is the academic market for professors, where long deadlines may impose high cost. In case a final rejection occurs, alternative opportunities may have been foregone; in case of a late acceptance, the "exhaustion" of the employer's patience may decrease substantially the surplus generated from the transaction.

enough, there exists a unique sequential equilibrium that is similar to the one obtained with an infinite horizon. This finding allows us to implement the model in the laboratory without using random continuation rules.[2] On the other hand, if the number of periods is small, the unique equilibrium predicts all offers to be equal to the low quality seller's cost and high quality sellers do not trade. We are interested in the former case where the buyer uses an increasing price sequence to identify the seller's type.

We compare bargaining to a benchmark institution in which adverse selection prevails. Consider the case where the buyer commits to make a unique offer and walks away in the absence of a deal. The downside of such a take-it-or-leave-it offer is the status-quo on trade failures and market breakdown. But the advantage of the buyer's full commitment is that trade with low types occurs without delay. This highlights the trade-off of any institution that attempts to reduce adverse selection: increasing rates of trade always comes at the cost of introducing inefficiencies on some other margin.

In our experiment, depending on their type, sellers can either produce a high quality good at high costs or a low quality good at a low cost. The uninformed buyer makes repeated offers to the seller. We find that the bargaining situation leads to screening of low and high type sellers, much like the qualitative predictions of the model. Trade failures that are common in the take-it-or-leave-it offer situations are almost eliminated in the bargaining institution. However, we observe a significant over-delay compared to the theoretical predictions, i.e., trading pairs need longer than theoretically predicted to reach an agreement. Over-delay is persistent with experience and substantially lowers efficiency (sum of payoffs). Hence, if allocative efficiency is an important criterion, e.g. keeping a market "liquid", then the bargaining treatment is successful. However, if the sum of payoffs is the main criterion for evaluating an institution's performance, then the delay introduced by bargaining offsets the positive effects of higher rates of trade.

In addition to the bargaining and the take-it-or-leave-it offer institutions, we also study four other treatments to explore the robustness of our findings. In one treatment we allow for repeated interaction, as in the bargaining institution, but eliminate the frictions between offers. In theory, repeated offers are only effective in conjunction with discounting. Behaviorally, the possibility to make repeated offers could reduce trade failures even in the absence of time frictions. We also ran a treatment in which the buyer is fully informed. This allows us to check whether the asymmetry of information is responsible for the delay of agreements. Finally, we study two treatments, a bargaining and a take-it-or-leave-it offer institution, where the buyer has no incentive to screen the seller. There, the probability that the seller is a high type is large enough so that first-best efficiency is possible and, theoretically, trade should occur immediately with both types. In this case, there is no difference between the theoretical predictions for the bargaining and take-it-or-leave-it offer

[2] The recent literature on experimental repeated games (Dal Bó, 2005; Dal Bó and Fréchette, 2011) uses random continuation rules. There are two reasons we chose to implement a finite time version of the model. First, random continuation rules by design frequently end interactions prematurely. Using discounting allows us to always observe the complete price sequence. Second, our bargaining game is not a repeated game but involves belief updating between rounds. It is behaviorally interesting to study the effects of discounting and the fact that the gains from trade at stake gradually become smaller over time.

institution. However, we find that over-delay is a robust phenomenon, i.e. even when there are no incentives to screen, the bargaining institution still exhibits a significant over-delay before offers are accepted.

We are left with a puzzle regarding the systematic over-delay we observe. Potential reasons for over-delay may be behavioral assumptions which are missing from DL's model. We confirm theoretically that over-delay may stem from fairness preferences of the form proposed in Fehr and Schmidt (1999) or from buyers' loss aversion. To explore the effect of fairness preferences, we build on arguments presented in Fanning (2014a) who showed that buyers with fairness concerns can be reluctant to offer high prices. We gather data on subjects' fairness preferences and loss aversion using auxiliary tasks and confirm the theoretical insights: trade failures can often be explained by conflicting fairness preferences, and loss averse buyers are less likely to make risky offers that are needed for successful screening. In addition, high type sellers insist on getting a non-trivial share of the surplus and often reject acceptable offers, in contrast with DL's predictions. Incorporating fairness preferences and loss aversion thus helps reconcile the data with the theoretical predictions. The behavioral effects we identify are unfortunately detrimental to both trade and efficiency.

The experimental studies closest to ours are Rapoport, Erev and Zwick (1995) and Reynolds (2000). Both studies report on a bargaining experiment where the uninformed party is the proposer. They, however, look at the case of independent valuations. In contrast, we analyze a setting in which adverse selection prevails: valuations are interdependent and the uninformed party is exposed to the risk of making losses.[3] A further difference to previous bargaining experiments with incomplete information is that we provide several control treatments which help pin down the implications of screening.

Our experiment is also more generally related to the vast experimental literature on bargaining. Roth and Malouf (1979) show that with complete information, bargaining tends to lead to equal splits of the gains from trade, see also Güth and Tietz (1990). Roth and Murnighan (1982) and Roth and Schoumaker (1983) show that bargaining outcomes are driven away from equal division if there is asymmetric information about valuations or bargainers have formed specific expectations about bargaining outcomes. This is confirmed in the literature on ultimatum games with incomplete information.[4] In particular, Mitzkewitz and Nagel (1993) demonstrate that in incomplete information settings, subjects may disagree about what constitutes a fair allocation. This literature also establishes that the shares offered are often best interpreted as the a receiver's minimum acceptable amount rather than a reflection of the proposer's pro-social preferences (e.g. Schmitt, 2004). We will use this form of fairness preferences in the second part of the paper.

[3] With interdependent values trade failures are a larger concern than when valuations are independent, because beneficial trade with a high quality seller requires buyers to update their beliefs. Thus, our paper provides evidence for screening and belief updating, but the latter tends to be sluggish, a phenomenon that is consistent with Eyster and Rabin (2005)'s cursed equilibrium. Fanning (2014a) shows that allowing for fairness preferences in a bargaining setting with independent values introduces interdependencies in values that are similar to an adverse selection situation. In other words, interdependent values can be seen as the more general case.

[4] See for instance Straub and Murnighan (1995), Croson (1996), Rapoport, Sundali and Seale (1996), Güth and Van Damme (1998) and Nagel and Harstad (2004).

Cason and Reynolds (2005) consider the impact of bounded rationality in sequential bargaining. Embrey, Fréchette and Lehrer (2015) study repeated offers bargaining when there are behavioral types which are obstinate in their demands. They show that – in line with theory – subjects attempt at mimicking such types. In addition, subjects participate in longer conflicts before reaching agreements than is predicted. We will also identify a substantial delay before agreements are reached, although for different reasons.

The paper unfolds as follows. In the next section we define the bargaining model and characterize the sequential equilibrium as a function of the number of stages. We also discuss some important comparative statics of the model. In Section 3, we present the experimental design, the corresponding theoretical predictions, and a set of testable hypotheses. Section 4.1 presents our main results. In Section 4.2, we examine the experimental data in the light of fairness preferences and loss aversion. Finally, Section 5 concludes.

2 Preliminaries

2.1 The Model

A buyer and a seller bargain over the price at which a single, indivisible good is sold. The seller's type $\theta = \{L, H\}$ determines the quality of the good (low or high). The buyer's valuation for the good is v_L if the seller's type is L and v_H if the seller's type is H. The seller's cost to provide the good is $c_L = 0$ and c_H for an L and H-type, respectively. Gains from trade are positive for both qualities, i.e., $v_H > c_H$ and $v_L > 0$, and this is common knowledge. The seller's type is private information to the seller. The probability of a seller to be type H is $q_H \in (0, 1)$. The buyer is uncertain about both his own valuation and the seller's cost of providing the good.

Bargaining takes the following form. There is a finite number of stages T. In each stage $t = 1, 2, \ldots, T$ the buyer makes an offer. Each offer can be accepted or rejected by the seller. If an offer is rejected, the next stage is entered and the buyer makes a new offer. The game ends if the seller accepts an offer or rejects the offer made in the last stage. Bargaining parties may be impatient, and this is captured by a discount factor $\delta \in [0, 1]$ which imposes costs on both parties when agreement is delayed. More precisely, if the trading price is p, the seller's type is θ and trade occurs in stage t, the buyer's payoff is $\delta^{t-1}u_B(p, \theta)$ and the seller's payoff is $\delta^{t-1}u_S(p, \theta)$, where $u_B(p, \theta) = v_\theta - p$ and $u_S(p, \theta) = p - c_\theta$.

Despite the known gains from trade with both types of sellers, q_H drives the incentive constraints. Indeed, these may or may not preclude first-best efficient trade, as seen in the following example.

Example 1 (Only lemons trade)**.** *Let* $v_L = 1750$*,* $c_L = 0$*,* $v_H = 3500$*, and* $c_H = 2500$*. Moreover, let* $q_H = 0.4$ *and* $T = 1$*. The buyer's expected valuation of* $(0.6 * 1750) + (0.4 * 3500) = 2450$ *falls short of the high production cost. This precludes first-best efficient trade. At equilibrium, the buyer offers a price* $p = 0$*, which is accepted only by an L-type seller.*

Given the valuations and costs in Example 1, high quality goods change hands only if $(3500 - 2500)q_H + (1750 - 2500)(1 - q_H) \geq (1750 - 0)(1 - q_H) \Leftrightarrow q_H \geq \frac{5}{7}$. Hence, whenever $q_H < \frac{5}{7}$ the buyer's full commitment to a take-it-or-leave-it offer leads to a market breakdown for H-type sellers. It is worth mentioning that a take-it-or-leave-it offer is the institution that maximizes the buyer's welfare (Samuelson, 1984).

2.2 Repeated Offers with Frictions

We now turn to repeated offers with frictions. The difference between our model and the one commonly studied in the literature is the finite number of stages.[5] For sufficiently large T, the equilibrium is equivalent to the familiar screening equilibrium observed in the infinite horizon case. On the other hand, if T is sufficiently small, the buyer focuses on maximizing his gains from trade with the L-type and offers a price of zero in all stages. In the following, we discuss both equilibrium patterns. We are interested in sequential equilibrium (Kreps and Wilson, 1982).

Screening equilibrium: If T is sufficiently large, the unique equilibrium in our game is equivalent to the screening equilibrium of the infinite horizon case studied in DL.[6] The equilibrium takes the following form. The buyer follows an increasing price sequence given by

$$p_t = \delta^{\bar{T}-t} c_H \quad \text{for } t = 1, \ldots, \bar{T}. \tag{1}$$

where $\bar{T}$ is the latest stage reached in equilibrium. In other words, $\bar{T}$ is the length of the observed price sequence if the seller is an H-type. The buyer's price sequence gradually increases in such a way that the L-type seller is indifferent between accepting and delaying acceptance in all stages. The L-type seller accepts with positive probability in all stages up to $\bar{T} - 1$, and the buyer updates his belief that the seller is an H-type accordingly. In stage $\bar{T} - 1$, an L-type seller that has rejected all previous offers then accepts with probability 1. The sequence ends with an offer of c_H which is accepted by the H-type. Intuitively, the buyer exhausts the L-type seller's patience before trade with an H-type can take place. We revisit Example 1 in the light of these predictions.

Example 2 (Goods change hands)**.** *Recall Example 1, but let* $T = 50$ *and* $\delta = 0.8$*. The unique sequential equilibrium is the screening equilibrium with the associated price sequence* $(1280, 1600, 2000, 2500)$*. Notice that* $\delta^3 * 2500 = \delta^2 * 2000 = \delta * 1600 = 1280$ *and thus the L-type seller is indifferent between accepting and delaying in all stages. The L-type seller randomizes over acceptance and rejection up to* $p = 2000$*, at which point he accepts with probability 1. A further rejection tells the buyer that the seller is an H-type and* $p = 2500$ *follows. The corresponding ex ante acceptance probabilities for the L-type seller are* $(0.5, 0.23, 0.27, -)$*. Despite the fact that both*

[5] An advantage of a finite T is that we can implement the model in the laboratory without using random termination rules. The sequential equilibrium characterization for finitely many offers is also of independent interest. For instance, the predictions for finite T could be used to study deadline effects (Roth, Murnighan and Schoumaker, 1988; Fuchs and Skrzypacz, 2013; Fanning, 2014b).

[6] This is only true along the equilibrium path. Strategies necessarily differ from the infinite horizon case once we are relatively close to the final stage T, but for large T such stages are never reached.

seller types trade, the expected gains from trade (1105) *fall short of the first-best efficiency level* (1450) *due to the delay imposed by screening.*[7]

On and off-equilibrium behavior: The length of the price sequence is determined by the L-type seller's acceptance probabilities. The L-type seller chooses her acceptance probabilities such that the buyer cannot gain by accelerating or slowing down trade with an off-equilibrium move. To explain the intuition, note that in Example 2 the first equilibrium offer is $p_1 = 1280$. Clearly, an offer of $p_1' = p_1 + \epsilon$ just slightly above p_1 should not be accepted with a larger probability than the equilibrium offer p_1, as otherwise the buyer could profitably deviate. Hence, the L-type seller must be indifferent between accepting and rejecting p_1' (since in equilibrium she also mixes between accepting and rejecting p_1). This can only be true if the expected offer in the next stage is $p_1'/\delta > p_2 = 1600$. But then it must be that the buyer in stage 2 is indifferent between offering at least two prices, one of which is p_2 and another one strictly larger than p_2. It turns out that the buyer is always indifferent between the actual equilibrium offer and the offer that follows in equilibrium in the next stage. In our example, the buyer is indifferent between $p_2 = 1600$ and $p_3 = 2000$. Hence, if the buyer deviates from equilibrium by offering p_1', his continuation strategy is to randomize between 1600 and 2000 in the next stage, such that the expected price is p_1'/δ. It is as if by offering a higher price than 1280, the buyer raises expectations for higher future offers, so that the L-type seller finds it optimal not to increase her acceptance probability. This reasoning pins down the L-type seller's acceptance probability and the buyer's strategy after an off-equilibrium offer.

When $v_L < \delta c_H$, an interesting feature of the screening equilibrium is that in the second to last stage (and possibly in other stages) the buyer makes an offer that is acceptable only to an L-type, but at which the buyer makes a sure loss in case of acceptance – e.g., the second to last offer made in Example 2. The buyer is willing to make such an offer because he hopes to eventually trade with an H-type, but is not yet sufficiently certain to offer c_H. Instead, he offers δc_H to reduce the loss incurred in case the seller is an L-type, and in return he learns the seller's type.

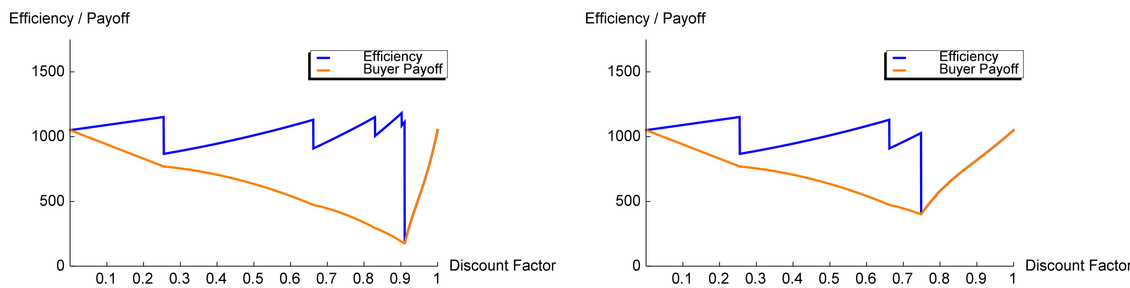
Zero offer equilibrium: If T is relatively small, the buyer may prefer to offer 0 in all stages. The zero offer sequence allows to buyer to extract all gains from trade with the L-type seller, at the cost of foregoing trade with H-type sellers. In this case, the L-type seller accepts an offer of 0 in each stage with positive probability and accepts with probability 1 in stage T.

As in the screening equilibrium, the L-type is indifferent between accepting and rejecting in all stages and her acceptance probabilities must ensure that the buyer does not want deviate to an offer slightly above 0. This is again achieved if the buyer is indifferent between offering two prices, which are now the zero offer (played in equilibrium) and the optimal screening offer at a given stage. In equilibrium, a deviation to an offer above 0 induces the buyer to randomize in the next

[7] It is worth emphasizing the computations of the two payoffs concluding the example. As is standard, first-best efficiency is the sum of payoffs obtained when the seller's type is observable, i.e. $1450 = (0.6*1750)+(0.4*1000)$. The ex-ante gains from trade are computed using the ex-ante equilibrium acceptance probabilities and the discounting, i.e., $1105 = 0.6[(0.5*1750)+(0.23*0.8*1750)+(0.27*0.8^2*1750)]+0.4*[0.8^3*1000]$. In the sequel, ex-ante gains from trade are simply referred to as (ex-ante) efficiency.

Figure 1: Theoretical Efficiency and Payoffs

(a) $T = 50$ (b) $T = 10$



Efficiency (discounted sum of payoffs) and buyer's expected payoff. The difference between efficiency and the buyer's expected payoff corresponds to the seller's expected payoff. Parameters: $v_H = 3500$, $v_L = 1750$, $c_H = 2500$, $c_L = 0$.

stage between continuing to offer 0 and switching to the screening sequence.

We summarize the discussion in Proposition 1.

Proposition 1. *Let $\delta < 1$. The bargaining game has a generically unique sequential equilibrium. The equilibrium price sequence is given by $(p_1, p_2, \ldots, p_{\bar{T}}) = (\delta^{\bar{T}-1} c_H, \delta^{\bar{T}-2} c_H, \ldots, c_H)$ if $T \geq T^*$ and $(p_1, p_2, \ldots, p_T) = (0, 0, \ldots, 0)$ otherwise. The H-type seller accepts with probability 1 if $p_t \geq c_H$ and rejects otherwise, for all $t = 1, \ldots, T$. The L-type seller's acceptance probabilities and T^* are derived in the appendix.*

Proof. See appendix. □

Why is the screening pattern the unique equilibrium for sufficiently large T? To see this, note that in the screening equilibrium the probability an offer is accepted (and thus the buyer's payoff) remains constant in T for T large enough. In Example 2, for instance, the buyer needs four offers to reach 2500 if $T = 50$, and the same remains true if T were larger. On the other hand, the buyer's earnings in the zero offer equilibrium are always decreasing in T. The reason is that the buyer's belief that the seller is an H-type cannot be too large in any stage. Otherwise screening is his preferred strategy. Hence, the larger T, the smaller the probability an offer of 0 is accepted in early stages, and the buyer's payoff in the zero offer pattern approaches 0 as T becomes large. For a fixed $\delta < 1$, there is thus a threshold period T^*, such that, for $T \geq T^*$, screening is preferable to offering 0. For the parameters used in Example 2, we obtain $T^* = 15$.

Efficiency and comparative statics: Figure 1 depicts the efficiency level (in blue) and the buyer's expected payoff (in orange) for the parameters used in Examples 1 and 2 for all levels of the discount factor. Figure (a) shows the case $T = 50$; figure (b) shows the case $T = 10$. Efficiency is measured as the ex ante discounted sum of payoffs of the buyer and the seller.

If $T = 50$, the threshold $\delta^* \approx 0.91$ determines which of the two offer patterns (screening or zero offer) prevails in equilibrium. For lower discount factors, the buyer prefers the screening strategy.

Table 1: Experimental Design

	D50	D1	ND50	D50-CI	D50-HP	D1-HP
Probability H-type (q_H)	0.4	0.4	0.4	0.4	0.8	0.8
Number of Offers (T)	50	1	50	50	50	1
Discounting (δ)	0.8	–	1	0.8	0.8	–
Asymmetric Information	✓	✓	✓	No	✓	✓
Subjects	106	48	36	46	60	48

Notes: The data consists of 30 sessions. The first wave of data collection (Fall 2012 and Spring 2013) included six sessions for D50 and D50-HP and four sessions for D1 and D1-HP. The second wave (January 2015) included the control treatments ND50 and D50-CI and three additional sessions for D50 to gather more information on subjects' fairness preferences.

For higher discount factors, the buyer prefers to offer 0 in all stages. Efficiency is non-monotonic in δ. At discount factor δ^*, where the equilibrium pattern switches from screening to zero offers, efficiency drops from above 1000 to its minimum, and then gradually increases as frictions become small. Thus, efficiency reaches its maximum for intermediate values of δ and the presumption that smaller frictions increase efficiency is not generally true. There is a second type of non-monotonicity. For values of δ for which the screening equilibrium is played, raising δ increases efficiency as long as the number of screening stages is unaffected, but efficiency is reduced on the margin if raising δ induces the buyer to screen more finely over more stages.

The buyer's payoff is monotonically decreasing in δ for $\delta < \delta^*$, and monotonically increasing in δ for $\delta > \delta^*$. As long as screening is optimal, the buyer loses commitment power as δ increases, which reduces his payoff. On the other hand, the buyer prefers frictions to be low in the zero offer equilibrium: as δ approaches 1, offering 0 for a finite number of stages does not cause much discounting. The buyer's gains approach the gains that he would obtain in the take-it-or-leave-it offer institution (i.e. if $T = 1$ or $\delta = 0$). For $T = 10$ the same reasoning applies, but note that the threshold discount factor δ^* is now below 0.8.

When adverse selection is not severe: Whenever q_H is such that the expected payoff from offering c_H is sufficiently high ($q_H \geq \frac{c_H}{v_H}$), the incentives to screen vanish and the equilibrium outcome of the bargaining game is identical to the take-it-or-leave-it offer. In other words, whenever first-best efficiency is obtained in a take-it-or-leave-it offer setting, the equilibrium of the bargaining game has a single price offer c_H and there is no delay before an agreement is reached.

3 The Experiment

3.1 Procedures

All sessions of the experiment were conducted at the experimental laboratory of the University of Bern. The data consists of 30 sessions and 344 participants. Participants were students, mainly from business, economics and law degrees. A session is in general composed of twelve participants, except three sessions with ten participants. We used the z-Tree software developed by Fischbacher (2007). A session lasted approximately 75 minutes and average earnings were 33 CHF, including a show-up fee of 10 CHF.[8]

A typical session proceeded as follows. First, the participants were randomly assigned to the computer terminals and given time to read the instructions. The instructions are provided in the online appendix. Once everyone had correctly answered a set of control questions, each subject was randomly assigned to be one of the six buyers or sellers. Roles were fixed throughout the experiment. Subjects played ten periods (bargaining games) and were paid for each period. To marginalize the role of reputation, subjects were randomly re-matched after each bargaining game. At the start of each bargaining game, sellers were informed about their types. The type was drawn according to q_H. Upon completion of the ten bargaining games, in some of the sessions, we used two additional tasks to gather information about subjects' loss aversion and their fairness preferences. Subjects were informed at the beginning of the experiment that there will be several parts but did not know any specifics. The additional tasks will be described in Section 4.2.

3.2 Experimental Design

We ran six treatments using a between-subjects design. As a fixed set of parameters, we used the ones introduced in Examples 1 and 2: the buyer's valuation is given by $v_H = 3500$ and $v_L = 1750$, and the seller's cost is $c_H = 2500$ and $c_L = 0$. The treatments are summarized in Table 1.

The main treatment D50 (discounting and 50 stages) implements the bargaining model introduced in the Section 2: buyers can make up to 50 offers and each rejection implies discounting costs on payoffs for both the buyer and the seller. The seller is an H-type with probability $q_H = 0.4$. The discount factor is $\delta = 0.8$. As shown in Figure 1, the discount factor of 0.8 is actually quite favorable to the bargaining institution D50. In particular, the predicted efficiency exceeds the one of the take-it-or-leave-it offer institution (i.e., if $\delta = 0$ in Figure 1). Buyers can offer prices from the discrete grid $\{0, 0.1, 0.2, ..., 4000\}$.[9] We do not require offers to be increasing, i.e., subjects are free to increase or decrease offers across stages.

The other five treatments use the same basic setting as D50. Treatment D1 implements the take-it-or-leave-it offer setting discussed in Example 1, i.e., $T = 1$. Treatment ND50 retains $T = 50$, but removes the discounting frictions, i.e., $\delta = 1$. In D50-CI there is complete information. Thus, in contrast to D50, a buyer is informed about the seller's type. The last two treatments D50-HP

[8]At the time of the experiments 1 CHF corresponded roughly to 1 USD. Final earnings were rounded up to the next higher 0.5 CHF. We find it important to mention that rounding may weaken the monetary incentives to adhere to equilibrium play toward the end of an experiment: earning or losing an additional small amount of experimental points in the last period may not affect the final earnings. We address this concern in a number of ways: (1) the fact that earnings in our experiment are relatively high and that in all sessions there were several parts in which subjects could earn money dilute a potential rounding effect; (2) the results are robust to excluding bargaining games (periods) 9 and 10 from the analysis. In response to a comment by a reviewer, we also ran two extra sessions in which we varied the rounding of final payments. We did not find significant differences in behavior depending on the degree of rounding. The extra sessions are not included in the analysis.

[9]A discrete price grid does not change the equilibrium as long as all price offers that are used by the buyer at the sequential equilibrium are still available.

Table 2: Theoretical Predictions

	D50	D1	ND50	D50-CI	D50-HP	D1-HP
(q_H, T, δ)	$(0.4, 50, 0.8)$	$(0.4, 1, -)$	$(0.4, 50, 1)$	$(0.4, 50, 0.8)$	$(0.8, 50, 0.8)$	$(0.8, 1, -)$
Price Seq.	$(1280, 1600, 2000, 2500)$	0	$(0, \ldots, 0)$	0 / 2500	2500	2500
Accept L	$(0.5, 0.23, 0.27, 0)$	1	$(0.73, 0, \ldots, 0.27)$	1	1	1
Accept H	$(0, 0, 0, 1)$	0	$(0, \ldots, 0)$	1	1	1
Efficiency	1105	1050	1050	1450	1150	1150

Notes: Acceptance probabilities and efficiency (discounted sum of payoffs) are in ex ante terms. In ND50 the last number in the price and acceptance probability sequences are for period 50. Price offers in D50-CI are for L-type / H-type.

and D1-HP are similar to their counterparts D50 and D1, except that the prior probability to face an H-type seller is $q_H = 0.8$.

Table 2 lists the theoretical predictions for all treatments. The predictions follow from the discussion in Section 2. Notice that the acceptance probabilities of the L-type seller are ex ante probabilities. For example, viewed from the start of the game, the L-type seller in D50 is predicted to trade in stage 1 with probability 0.5, in stage 2 with probability 0.23 and in stage 3 with probability 0.27. Given that stage 2 has been reached, the L-type seller's acceptance probability in stage 2 is $0.23/(1 - 0.5) = 0.46$, and given stage 3 has been reached, the L-type seller accepts with probability 1.

3.3 Hypotheses

Our discussion will be centered around three questions / testable hypotheses. We first ask whether the described screening equilibrium is observed in the lab.

Question 1. *Does bargaining in conjunction with discounting (D50) alleviate the trade failures generated by adverse selection?*

Treatment D1 is a benchmark in which theory predicts adverse selection to prevail and H-types never trade. Observing higher rates of trade in D50 than in D1 would provide evidence that repeated bargaining with discounting alleviates adverse selection.

Several robustness checks are necessary. The first one is to identify whether the higher rates of trade in D50 are triggered by the possibility to make repeated offers, or whether frictions are essential. Recall that ND50 is derived from D50 by removing the frictions, i.e., the discount factor is set to 1. As can be seen in Table 2, the predictions for ND50 lead to the same outcome as in D1.[10] However, the possibility to make repeated offers may introduce behavioral differences between D1 and ND50.

[10]The L-type seller in ND50 accepts with positive probability in the first and the last stage. In the first stage, the acceptance probability of 0.73 renders the buyer indifferent between offering 0 and 2500 in subsequent periods. Hence, when the buyer deviates to an offer slightly above 0 in stages 2 to 49, the L-type seller rejects the offer and the buyer continues by mixing between 0 and 2500 off the equilibrium path to ensure that the seller's rejection was optimal.

A second robustness check is to assess the impact of asymmetric information on bargaining outcomes. Treatment D50-CI serves this purpose: buyers are always informed about the type of the seller they are matched with. In theory trade occurs in stage 1, the buyer extracts all gains from trade and welfare is at its maximum. A comparison between D50 and D50-CI is important to test if behavior in D50 (e.g., increasing price sequences) is not a feature of repeated offer bargaining per se, but is also due to the presence of informational asymmetries.

In Section 2, we have established that the discounting costs inherent in D50 (but not in D1 or ND50) may offset the efficiency gains from the higher rates of trade. An interesting question is therefore if D50 is the preferred institution in terms of efficiency.

Question 2. *Does bargaining in conjunction with discounting (D50) generate efficiency gains compared to a situation in which adverse selection is predicted to prevail (D1 and ND50)?*

The theoretical answer to Question 2 depends on the chosen discount factor. In Figure 1 (a), we have shown that D1 (and thus ND50) outperforms D50 in terms of efficiency if frictions are small (i.e., if $\delta > 0.91$). However, there are also values of the discount factor for which predicted efficiency is higher in D50 than in D1. In particular, at $\delta = 0.8$, efficiency is 1105 in D50, while it is only 1050 in D1. The discount factor of $\delta = 0.8$ used in the experiment is thus favorable to the bargaining institution.

Despite the fact that parameters are favorable to D50, our results will show that D1 and ND50 generate a higher efficiency level than D50. The reason is that there is a persistent *over-delay* in D50, i.e. trade with L and H-types occurs later than theoretically predicted.[11] In light of the previous experimental literature on bargaining, a possible explanation for the observed over-delay is the presence of behavioral preferences. We focus on two well-known candidates: loss aversion and fairness.

Question 3. *How is bargaining under adverse selection affected by the presence of behavioral preferences such as loss aversion and concerns for fairness?*

We provide a theoretical discussion of the bargaining institution in the presence of behavioral preferences in Section 4.2. We also gathered information about subjects' loss and inequality aversion using additional tasks at the end of the experiment. Our results show that over-delay is explained well by these behavioral departures.

4 Results

We now present the main experimental findings, beginning with Questions 1 and 2. Explaining the observed over-delay will be the object of the second part of the results section and will provide an answer to Question 3.

[11]Over-delay also seems to be a robust phenomenon. For treatments D50-HP and D1-HP, recall that $q_H = 0.8$. At such a high probability, first-best efficiency can be reached. The equilibrium predictions for both treatments are then the same with trade occurring in the first stage for D50-HP at $p = 2500$. We find that trade occurs significantly later in D50-HP than in D1-HP.

Table 3: Descriptive Statistics

	Bargaining Games	Average Opening Offer	Average Trading Price	Rate of Trade	Average Trading Stage	Efficiency	Average Buyer Profit	Average Seller Profit
D50	530	775 (1024)	1776 (1928)	0.90 (1)	6.5 (2.6)	784 (1105)	306 (337)	479 (768)
L	318 (318)	757 (1280)	1265 (1547)	0.97 (1)	4.8 (1.76)	1150 (1500)	403 (220)	748 (1280)
H	212 (212)	803 (1280)	2698 (2500)	0.81 (1)	9.6 (4)	236 (512)	160 (512)	76 (0)
D1	230	740 (0)	1085 (0)	0.47 (0.6)	1 (1)	775 (1050)	400 (1050)	375 (0)
L	116 (138)	757 (0)	885 (0)	0.82 (1)	1 (1)	1433 (1750)	708 (1750)	725 (0)
H	114 (92)	723 (0)	2672 (–)	0.11 (0)	1 (–)	105 (0)	87 (0)	18 (0)
ND50	180	616 (0)	1438 (0)	0.68 (0.6)	28.5 ([1,50])	1108 (1050)	417 (1050)	691 (0)
L	118 (108)	655 (0)	1232 (0)	0.86 (1)	27.7 ([1,50])	1513 (1750)	448 (1750)	1065 (0)
H	62 (72)	542 (0)	2440 (–)	0.34 (0)	32.3 (–)	339 (0)	359 (0)	-20 (0)
D50-CI	230	1594 (1000)	1713 (1000)	0.97 (1)	2.4 (1)	1248 (1450)	609 (1450)	639 (0)
L	142 (138)	848 (0)	915 (0)	0.96 (1)	2.2 (1)	1490 (1750)	707 (1750)	783 (0)
H	88 (92)	2797 (2500)	2969 (2500)	0.99 (1)	2.7 (1)	858 (1000)	452 (1000)	406 (0)
D50-HP	350	1341 (2500)	2698 (2500)	0.98 (1)	5.2 (1)	655 (1150)	247 (650)	352 (500)
L	64 (70)	1271 (2500)	2248 (2500)	0.98 (1)	3 (1)	1246 (1750)	-328 (-750)	1574 (2500)
H	286 (280)	1357 (2500)	2799 (2500)	0.98 (1)	5.7 (1)	523 (1000)	376 (1000)	147 (0)
D1-HP	240	2397 (2500)	2600 (2500)	0.68 (1)	1 (1)	784 (1150)	408 (650)	432 (500)
L	38 (48)	2333 (2500)	2385 (2500)	0.92 (1)	1 (1)	1612 (1750)	-585 (-750)	2197 (2500)
H	202 (192)	2409 (2500)	2659 (2500)	0.63 (1)	1 (1)	629 (1000)	529 (1000)	100 (0)

Notes: Key descriptive statistics averaged over all, L-type and H-type seller cases. Theoretical predictions are given in parentheses.

4.1 Screening and Efficiency

We define screening as the attempt of an uninformed party to use price offers to extract information from an informed party. In the experiment, screening translates to buyers using increasing price sequences in an attempt to trade with L-types early at a price below 2500 and with H-types later at a price of 2500. The result of screening is that both seller types trade, and they do so at different prices.

Result 1. *The bargaining protocol (D50) generates screening and increases rates of trade far above the ones observed in the absence of repetitions (D1) or time frictions (ND50).*

The bargaining protocol D50 generates high rates of trade, 97% with L-types and 81% with H-types as shown in Table 3. In contrast, in D1 the rate of trade with L-types is 82%, but only 11% with H-types. Hence, D50 facilitates trade, while D1 mimics well the standard adverse selection scenario. The possibility to make several offers seems to facilitate trade even if there are no frictions, but to a limited extent – in ND50 the rate of trade is 86% with L-types and 34% with H-types. We conclude that D50 is more successful in triggering trade with H-types than D1 and ND50, as confirmed by Mann-Whitney U tests between D50 and D1 ($p < 0.01$) and between D50 and ND50 ($p = 0.021$).[12] The difference between D1 and ND50 is not significant ($p = 0.157$). These results are confirmed in the mixed effects regression reported in the first column of Table 4.

In the sequential equilibrium of D50, buyers screen by using an increasing price sequence to exhaust the patience of the L-type seller. A first piece of evidence for screening in the data is the sharp price wedge between opening and accepted prices in D50, and this for both seller types. For L-types, prices open on average at 757 and close at 1265, while for H-types these are 803 and 2698 (see Table 3). More detailed information on price sequences is presented in Figure 2, showing the average observed and theoretically predicted price jumps between stages. The price in stage 1 corresponds to the opening price. In addition, the figure depicts the fraction of bargaining games where at least one offer along the price sequence exceeds the 2500 threshold. The increasing price sequence in D50 is consistent with screening.

It should be noted that in D50 trades in later stages occur over negligible amounts of money, because discounting has eliminated most of the gains from trade. Such trades may thus not be treated as an instance of successful screening. However, most trades with H-types occur before stage 10, at which point the rate of trade is already 56%; until stage 36 we observe a further increase to 81%. This can be seen in Figure 3, which depicts the cumulative acceptance probabilities. The figure also shows that buyers are able to separate H-types and L-types in D50. Almost 40% of the L-type sellers accept in stage 1, and close to 80% have accepted by stage 5. As predicted by screening, trade with H-type sellers occurs later than with L-types (Wilcoxon signed rank test, $p<0.01$). Counting trades in D50 that occur in stage 11 or later as unsuccessful, a Mann-Whitney U test between D50 and D1 still yields a significant difference in the rate of trade with H-types

[12] All non-parametric statistical comparisons between treatments will be based on Mann-Whitney U tests, with sessions averages used as the (independent) unit of observation.

Table 4: Mixed Effects Regressions

Dep. Var.:	Trade	Trade ($\leq$ 10)	Trading Price	Trading Stage	Efficiency
D1	-0.168***	-0.0475	-433.7***	-3.646***	263.4***
	(0.0315)	(0.0381)	(162.7)	(0.540)	(68.85)
ND50	-0.111**	0.009	-66.21	23.15***	354.3***
	(0.0512)	(0.0550)	(100.9)	(1.518)	(97.23)
H	-0.187***	-0.326***	1353.9***	5.512***	-947.9***
	(0.0533)	(0.0321)	(44.26)	(0.507)	(47.77)
D1*H	-0.509***	-0.372***	77.60	-5.123***	-367.4***
	(0.103)	(0.092)	(239.1)	(0.913)	(119.9)
ND50*H	-0.348***	-0.210***	-306.3*	0.850	-240.9*
	(0.122)	(0.115)	(186.1)	(0.806)	(134.2)
Constant	0.977***	0.858***	1094.0***	6.286***	1225.9***
	(0.0301)	(0.0430)	(86.41)	(1.414)	(63.42)
Observations	940	940	709	709	940
Individuals	94	94	94	94	94

Notes: (1) Mixed effects regression with individual and session random intercepts. Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. (2) Baseline is D50 L-type seller. (3) All estimations include period dummies. (4) Trade ($\leq$ 10) counts trades occurring in stage 11 or later in D50 as unsuccessful (i.e., no trade).

(p<0.01). In the second column in Table 4, we also report a corresponding regression. Rates of trade in D50 are significantly higher than in D1 and ND50, even when counting trades after stage 10 in D50 as trade failures.[13]

Robustness Check I: *Is screening only due to repetitions?*

Figure 2 shows a substantive positive price change between stages over the course of the first ten stages in D50, whereas the price offers in ND50 are not increasing. In D50 buyers make offers that cover the H-type seller's cost relatively early – around 40% of offers are acceptable to H-types in stage 5, and 67% in stage 10. In contrast, this fraction stays lower in ND50 at around 20% after stage 20, noticeably with a sudden jump in the last two stages of play. Figure 3 also shows apparent differences between D50 and ND50 in the acceptance behavior of L and H-type sellers. L-type sellers are much more reluctant to accept offers in ND50 than in D50.[14]

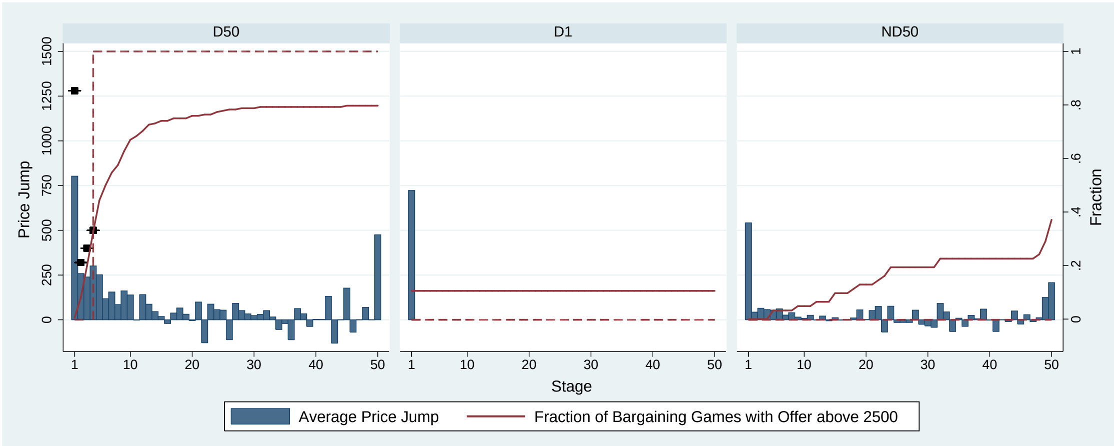
Robustness check II: *Price increase and asymmetry of information*

Another valid question is whether the observed price increases are linked to asymmetric information or whether they are a natural feature of bargaining that we should expect to observe even under complete information. Treatment D50-CI keeps all the features of D50 except the asymmetry of information. Unlike in D50, the observed behavior in D50-CI is straightforward (see Table 3):

[13]Further evidence that negligible monetary incentives in later stages are not a driving factor of the rate of change with H-types is that some bargaining pairs in D50 haggle for a large number of stages before they agree to trade. In particular, in 19% of the cases H-type sellers do not trade at all, and if trade occurs, only 7% of the trades occurred at a price that is not individually rational for the H-type seller. This suggests that subjects are sufficiently motivated, even if discounting has eliminated most monetary incentives.

[14]We also identify an effect of pure repetition of offers in ND50 compared to the take-it-or-leave-it setting in D1. The regression in the first column of Table 4 shows that the rate of trade with H-types is higher in ND50 than D1 (p< 0.1). The third column shows that trading prices with L-types are also significantly higher in ND50 than D1.

Figure 2: Price Offers



Price jumps and fraction of bargaining games with an offer above 2500. The price jump in stage 1 corresponds to the opening offer. The black bars in figure D50 indicate the theoretical price jumps. The dashed line indicates the theoretical fraction of bargaining games with an offer above 2500.

buyers and seller split the gains from trade equally, such that the average trading prices is 915 with L-types and 2969 with H-types. The median trading stage is 1, in line with the prediction that trade should occur immediately. The delay imposed by screening disappears.

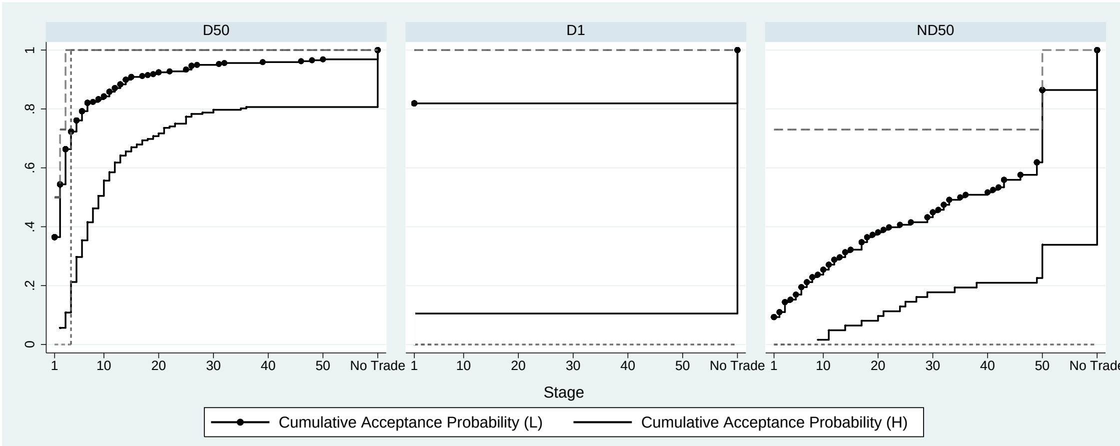
We close the discussion on Result 1 with a closer look at the price sequences offered by buyers. We restrict the discussion to bargaining games where the seller was an H-type, since for L-types offers are often accepted before the full price sequence is observed. There are three patterns of price sequences. In 21% of the bargaining games, buyers' offers never exceed 1750 and there is no attempt to reach trade with H-type sellers. In 57% of the cases, buyers use threshold screening: there are several offers of 875 ± 200, followed by a sudden jump to 2750 ± 250. The median stage in which the switch to a high offer occurs is stage 6. In a smaller fraction of cases (19%), buyers screen L-type sellers by continuously raising offers from a median of 800 to prices of 2750 ± 250.

It is interesting to see whether buyers are successful at screening. Let the rate of screening be the fraction of cases at which trade with an L-type occurred at a price below 2500. The theoretical prediction for the rate of screening is 100%. Threshold screening was successful in 73% of the cases. The screening rate for the continuous screening strategy was 98%. This successful separation of L and H-types comes, however, at the price of a long delay: the median stage of trade with H-types when continuous screening is used is 12. A common feature across all price sequences is that opening offers are substantially below the predicted 1280, and buyers do not catch up by increasing offers faster than predicted.[15]

We have established that screening is present in D50. In conclusion, (i) if buyers make a take-it-or-leave-it offer (D1), we get the adverse selection phenomenon, (ii) if frictions are removed (ND50),

[15]The buyers' earnings were on average around 300 points for both continuous and threshold screening. The threshold screening strategy is more successful at generating gains with H-types (214) than continuous screening (100) or no screening (5), but less successful for L-types (214) than continuous screening (462) or no screening (480). It is also apparent that threshold screening is the most efficient of the offer patterns.

Figure 3: Trading Stage



Cumulative acceptance probabilities separated by L and H-type sellers. The line with long (short) dashes indicates the theoretical prediction for L-type (H-type) sellers.

then rates of trade are higher than in D1, but there are no price increases reminiscent of D50, and (iii) if the asymmetry of information is removed (D50-CI), then there is no price increase and trade often occurs immediately. However, price sequences in D50 are often flatter and trade occurs later than predicted in theory. This is the message of the following result.

Result 2. *There is a significant and persistent over-delay in D50.*

Over-delay is defined as the excess delay in the trading stage compared to the theoretical predictions. The average trading stage in D50 with L-types is 4.8 against a prediction of 1.76, while for H-types it is 9.6 against a prediction of 4 (Wilcoxon signed rank tests, $p < 0.01$).[16]

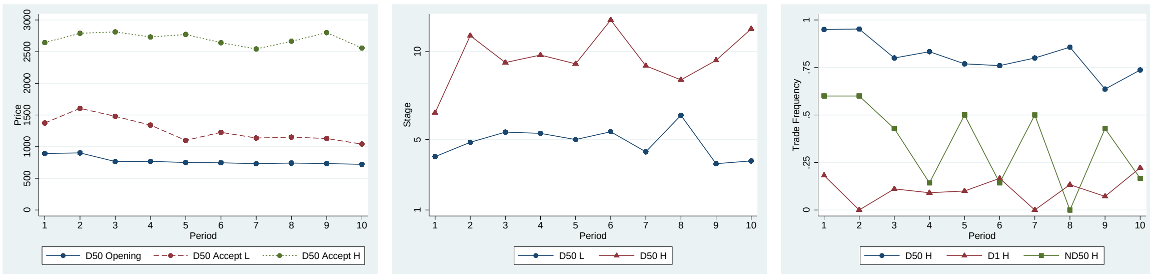
Over-delay is a *persistent* phenomenon. Figure 4 (b) shows that the average trading stage is in excess of the predictions for both H and L-types in all bargaining games, and the over-delay is not mitigated by experience. Subfigures (a) and (c) depict average opening offers, accepted offers and trade frequencies with H-type sellers for different treatments, highlighting the relative stability of behavior across bargaining games.

Over-delay is also a *robust* phenomenon across different parameter values. In D50-HP, where $q_H = 0.8$, trade should occur in stage 1 at a price of 2500. In contrast, the average observed trading stage in D50-HP is 3 with L-type sellers and 5.7 with H-type sellers, a significant difference with the theoretical predictions ($p < 0.01$). As in D50, buyers in D50-HP start low in their price sequences compared to equilibrium offers and engage in screening. For instance, this is illustrated by the wedge between the average opening price of 1271 and the average accepted price of 2248 with L-type sellers. A possible explanation is that many buyers generate delay to dilute potential losses. On the other hand, immediate trade with both seller types is observed in D1-HP, despite the fact that equilibrium predictions are the same for D50-HP and D1-HP. This underlines that the buyer's inability to commit to a single offer leads to inefficient postponements of agreement.

[16]All non-parametric statistical comparisons with the theoretical predictions will use Wilcoxon signed rank tests.

Figure 4: Outcomes over the Ten Bargaining Games

(a) Opening & Accepted Offers (b) Trading Stage (c) Trade Frequency (H-type)



We next look at the implications of over-delay for efficiency. Recall that efficiency is defined as the (ex-ante) expected discounted sum of payoffs of the buyer and the seller.

Result 3. *Efficiency falls short of the theoretical predictions in most treatments. Moreover, efficiency is lower in D50 than in D1, i.e., the losses due to over-delay in D50 are larger than the gains generated by the higher rates of trade.*

Table 3 contains information on efficiency. However, the realized frequency of L and H-types in the experiment does not always match the theoretical frequencies implied by q_H. We therefore calculate the efficiency level by weighting the outcomes for L and H-types in each treatment by the expected frequencies. The resulting efficiency levels are 784 for D50, 902 for D1, 1043 for ND50, 1237 for D50-CI, 667 for D50-HP and 825 for D1-HP.

In D50 efficiency is below its predicted level for L (1150 vs 1500) and H-types (236 vs 512) as well as for overall efficiency (784 vs 1105). All differences are significant ($p < 0.01$). Given the high rates of trade in D50, it is clear that the channel driving efficiency loss is the over-delay documented in Result 2. The same conclusions apply to D50-HP, where overall efficiency is also significantly lower than predicted (667 vs 1150, $p < 0.01$). In D1 efficiency is also below its predicted level for L-types (1433 vs 1750) and the same applies to overall efficiency (902 vs 1050). Both comparisons are significant (p=0.07).

Overall efficiency in D1 is significantly higher than in D50 ($p = 0.03$). Recall that this is despite the fact that efficiency is predicted to be higher in D50 than in D1 (1105 vs 1050). Interestingly, the take-it-or-leave-it offer institution outperforms the bargaining institution also when adverse selection should not have an impact: efficiency increases from 655 in D50-HP to 784 in D1-HP ($p = 0.06$). We cannot exclude the possibility that for some choices of δ, bargaining as in D50 would perform better than the take-it-or-leave-it offer institution. Recall however that our choice of the discount factor already favors the bargaining institution, and we have observed over-delay in D50 as well as D50-HP. It therefore seems that over-delay is an inherent "negative externality" generated by the presence of asymmetric information.[17] We next examine the reasons for over-delay, providing further evidence that one should not expect over-delay to disappear easily.

[17]The results for ND50 further show that frictions are crucial for trade with H-types: efficiency is higher in ND50 than in D1 ($p = 0.02$), but does not achieve the first-best efficiency level of 1450.

4.2 Explaining Over-Delay

We now turn the spotlight to two behavioral assumptions which are missing in the standard model. These are *fairness preferences* and *loss aversion.*

4.2.1 Bargaining, Fairness and Loss Aversion: Theoretical Considerations

Fairness: Fanning (2014a) studies bargaining with independent values when players have concerns for fairness and shows that delay increases if the uninformed party incurs a behavioral cost when giving a large share of the surplus to the informed party. We take a similar approach and assume the following preferences.

$$u_B^f(p,\theta) = u_B(p,\theta) - \alpha_B \max\left[0, \beta_{B,\theta}(v_\theta - c_\theta) - u_B(p,\theta)\right] \tag{2}$$

$$u_S^f(p,\theta) = u_S(p,\theta) - \alpha_S \max\left[0, \beta_{S,\theta}(v_\theta - c_\theta) - u_S(p,\theta)\right] \tag{3}$$

Parameters $\alpha_B, \alpha_S \geq 0$ measure the costs for outcomes (p,θ) that are perceived as unfair from the buyer's or seller's perspective, respectively. Parameters $\beta_{B,\theta}, \beta_{S,\theta} \in [0,1]$ determine whether an outcome is perceived as unfair. For instance, a buyer perceives outcome (p,θ) as unfair if the share of the gains he obtains is smaller than $\beta_{B,\theta}$.

The qualitative features of the equilibrium remain unchanged in the presence of fairness concerns.[18] When T is large enough, the screening equilibrium prevails. The price sequence still makes the L-type seller indifferent between accepting and rejecting. Notice, however, that for the L-type seller delaying agreement has an additional advantage: it avoids the behavioral costs of accepting the current, low offer in favor of accepting a higher offer in the future that the seller perceives as fairer. As a result, the price sequence becomes flatter in the region where offers are below $\beta_{S,L}(v_L - c_L)$. Conversely, for buyers, an early acceptance avoids the cost of making a higher offer they perceive as less fair. Hence, the probability of acceptance that renders a buyer indifferent between making the current equilibrium offer and the next-stage equilibrium offer is smaller in the presence of fairness preferences. This slows down acceptance at the higher end of the price sequence. As a consequence, fairness preferences lead to longer price sequences and more delay.

An additional new feature is that for both seller types there is a lowest acceptable offer $\overline{p}_{S,\theta} = \frac{\alpha_S \beta_{S,\theta}(v_\theta - c_\theta)}{1+\alpha_S} + c_\theta$, found by setting (3) equal to zero. Similarly, there is a highest offer the buyer is willing to make, which equals to $\bar{p}_{B,\theta} = v_\theta - \frac{\alpha_B \beta_{B,\theta}(v_\theta - c_\theta)}{1+\alpha_B}$. This implies that concerns for fairness can explain trade failures if $\bar{p}_{B,L} < \bar{p}_{S,L}$, i.e., if there is no price that simultaneously yields a positive utility to the buyer and the L-type seller.[19] A necessary condition for this inequality to hold is that $\beta_{B,L} + \beta_{S,L} > 1$: there must be disagreement about what constitutes a fair distribution in order to explain trade failures along these lines. Under complete information $\beta_{B,\theta} = \beta_{S,\theta} = 0.5$

[18] We omit a formal derivation, but the arguments in Fanning (2014a) allow us to extend the proof of Proposition 1 to include the presence of fairness preferences.

[19] The condition $\bar{p}_{B,L} < \bar{p}_{S,L}$ is equivalent to $1 < \frac{\alpha_B \beta_{B,L}}{1+\alpha_B} + \frac{\alpha_S \beta_{S,L}}{1+\alpha_S}$. This is the same condition that prevents trade in a take-it-or-leave-it offer setting. See Evans (1989) for a similar result when assuming $v_L = c_L$, i.e. there are no gains from trade with the low type. See also Camerer and Loewenstein (1993).

seems to be a natural choice. However, the presence of incomplete information may give rise to conflicting fairness preferences. For instance, an L-type seller may deviate from the 50-50 norm on the grounds of his informational advantage.

Loss aversion: The importance of loss aversion is well-documented and has often been shown to be detrimental to efficiency (Kahneman, Knetsch and Thaler, 1991; Tversky and Kahneman, 1991; Thaler, Tversky, Kahneman and Schwartz, 1997).[20] We assume that loss averse buyers are characterized by the following utility function: $u_B(p, \theta)$ if $u_B(p, \theta) \geq 0$ and $\lambda u_B(p, \theta)$ otherwise, where $\lambda \geq 1$. The seller never faces the risk of a loss. Hence, loss aversion does not affect the price sequence that renders the L-type seller indifferent between offers. Loss aversion affects the buyer's utility if the equilibrium price sequence involves an offer that results in a negative payoff if accepted. For the experimental parameters, this is the second to last offer of 2000. A loss averse buyer prefers to postpone such offers to stages where discounting is more severe and thus tends to start the screening process at lower prices. As a result, delay increases.[21]

4.2.2 Behavioral Tasks

In a subset of the sessions subjects were asked to complete additional tasks after the bargaining experiment. The first task elicits fairness preferences. To collect information regarding subjects' loss aversion, we used the same lottery task as Fehr, Herz and Wilkening (2013). The tasks are described below.[22]

Fairness task. We elicited fairness preferences in 3 sessions of D50 and 4 session of D50-CI. The task is as follows. Person A has to distribute 40 points (8 CHF) between herself and Person B. Person B knows that A makes this decision and has to specify a minimum offer that she is willing to accept before knowing A's proposed distribution. If A allocates an amount to B that covers B's minimum acceptable offer, the proposed distribution is implemented. Otherwise both earn 0. Both subjects in a pair made the decision in both roles A and B. The computer then randomly assigned the actual role.

The minimum acceptable offer (MAO) is assumed to be a proxy for α_i, $i = B, S$. The mean observed MAO over all 84 subjects who completed the task is 16.5. The median MAO is 18, with 29 subjects stating a MAO of 20, and 20 subjects stating a MAO of 15. We split subjects into two subgroups that are approximately equal in size. Subjects with a MAO above 18 are considered to have larger concerns for fairness than those with a MAO of 18 or lower.

Loss aversion task. We gathered information on loss aversion in 6 sessions of D50 and 3 sessions

[20] A recent paper by Benkert (2015) addresses the loss aversion problem in a mechanism design bilateral trade set-up.

[21] While with an infinite bargaining horizon loss aversion cannot explain trade failures, it may do so for finite T. The reason is that a buyer with a high λ may prefer the zero offer equilibrium pattern. In the online appendix we discuss three equilibrium scenarios with fairness and loss aversion preferences, illustrating their impact on delay and the possibility of trade failures.

[22] Responses in the fairness and the lottery task were not significantly different across treatments. The instructions for both tasks are provided in the online appendix.

of ND50. Subjects were presented six lotteries which they could either accept or decline. Each lottery gave a 50-50 chance between winning 6 CHF or losing an amount that differed between lotteries. The loss was either 2, 3, 4, 5, 6 or 7 CHF. One of the six lotteries was randomly selected for payment. If the lottery was declined, no additional earnings or losses were realized.

We restrict our analysis to the 57 out of 60 buyers that have a unique switching point from accepting lotteries with a relatively low loss to rejecting all lotteries with higher losses. The mean switching point is 3.5, between the lotteries with a loss of 3 CHF and 4 CHF. Correspondingly, we split subjects into two groups, where the more loss averse buyers are those who rejected the lottery between winning 6 CHF and losing 4 CHF (or worse lotteries), while the other group accepted this lottery.

4.2.3 Individual Level Analysis

This section demonstrates that the fairness and loss aversion measures drive behavior in the way suggested by the theoretical arguments in Section 4.2.1. The dummy *High MAO* is used to categorize subjects into the subgroups created in the fairness task. If *High MAO* equals 1, the subject has stated a minimum acceptable offer of 19 or higher. Similarly, the dummy loss averse (*LA*) represents the categorization created in the loss aversion task, where *LA* equals 1 if a subject belongs to the more loss averse subgroup.

Determinants of sellers' acceptance decisions: Table 5 presents average marginal effects of a probit model in which the dependent variable is equal to 1 if the offer is accepted and 0 otherwise. We provide separate estimates for the two seller types and treatments D50, ND50 and D50-CI. Note that average marginal effects for price offers are multiplied by 100 for convenience. Not surprisingly, higher offers ($Offer_t$) are in general more likely to be accepted. In addition, the positive effect of a higher discounted offer ($Discounted\ Offer_t$) in D50 shows that L-type sellers are more likely to accept a given offer if it is made in an earlier stage.

The regressions show that fairness concerns play a role for sellers' acceptance behavior. In D50, as well as D50-CI, L-type sellers with a high MAO in the fairness task are about 10% points more likely to reject offers, contributing to the observed over-delay.[23] For H-type sellers we do not observe the same impact of the *High MAO* dummy, in fact we observe the opposite in D50. This suggests that sellers who feel entitled to obtain a large share of the surplus as an L-type are also willing to reward buyers who attempt at trade with an H-type.[24]

The variable *Difference to Best Offer* is calculated as the difference between the offer that maximizes the seller's payoff (the highest discounted offer) in the observed price sequence and any given discounted offer. It equals 0 if the seller accepts the highest discounted offer, and becomes

[23]Notice that we do not restrict offers to be below 875 in the regressions. The reason is that under incomplete information it is not obvious that the "fair" allocation of gains is the 50-50 split; separate regressions for offers below and above 875 show the same sign and a similar magnitude of the "High MAO" variable.

[24]The *High MAO* dummy is only available for treatments D50 and D50-CI. The reason is that the fairness task was not part of the initial experimental design, but was collected in several extra sessions for D50 and D50-CI.

Table 5: Probit Estimates of Sellers' Acceptance Decisions

	D50		ND50		D50-CI	
	L	H	L	H	L	H
Offer_t	0.0184***	0.0681***	0.00738***	-0.0283	0.0474***	0.112***
	(0.00303)	(0.0207)	(0.000969)	(0.0212)	(0.0107)	(0.0256)
Offer_{t-1}	-0.00718***	-0.00352	-0.00492***	0.00639	-0.0101*	-0.00566**
	(0.00267)	(0.00255)	(0.000933)	(0.00455)	(0.00564)	(0.00273)
High MAO	-0.0847***	0.102**			-0.107***	-0.0932
	(0.0233)	(0.0516)			(0.0262)	(0.0698)
Discounted Offer_t	0.0113***	0.00363			0.000221	0.00861
	(0.00421)	(0.00446)			(0.0113)	(0.00585)
Difference to	-0.0225***	-0.0144**	-0.00644***	-0.283***	-0.0220**	0.00932
Best Offer	(0.00371)	(0.00677)	(0.00125)	(0.101)	(0.00987)	(0.00619)
Pseudo R^2	0.319	0.195	0.245	0.476	0.544	0.476
Observations	1912	582	3628	114	554	190
Individuals	53	51	18	14	23	23

Notes: (1) Average marginal effects of a change in the explanatory variable of 100 points on the probability to accept. *High MAO* is a dummy constructed using the fairness task. Robust standard errors clustered on individuals in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. (2) Estimations include period dummies. (3) Observations with offers below 2500 are excluded for H-type sellers.

larger as the seller engages in unprofitable delay. The negative marginal effects show that payoff maximization was a relevant determinant of seller behavior.

Yet, there is also evidence that both seller types engage in unprofitable delay of agreement. H-types frequently reject offers that exceed their reservation cost, even if prices do not increase significantly above 2500. In D50 only 27% of all offers that cover 2500 were accepted by H-type sellers. As for L-type sellers, the negative average marginal effect for the previous stage offer Offer_{t-1} implies that high current offers trigger expectations of even higher offers in future stages. The higher the current offer is, the more demanding the L-type sellers become. We refer to such behavior by H-types and L-types as haggling. Both forms of haggling considerably complicate screening.[25]

Determinants of buyers' decisions: Table 6 explores how buyers' behavior depends on loss aversion and fairness concerns. The main message concerns rates of trade and delay in D50 (columns 1 and 3). Trade failures with H-type sellers can be explained by loss aversion, i.e., summing *LA* and *LA*H* yields a 30% points lower trading probability for loss averse buyers ($p = 0.07$). Trade failures with L-type sellers are also more likely in the presence of loss aversion (7% points), and an even stronger effect is observed for fairness preferences: buyers with a high MAO are 16% points less likely to trade with an L-type seller. In addition, bargaining with H-types takes longer for the subgroup with larger fairness concerns (the effect *High MAO* + *High MAO*H* is significant at the 1% level).

[25] Using the estimation results in Table 5, one can compute estimates of the buyer's payoff for different price sequences given the seller's actual behavior. Threshold screening, continuous screening and no screening result in payoffs of around 300 points, substantially better than the theoretically predicted sequence (1280, 1600, 2000, 2500)

Table 6: Mixed Effects Regression on Loss Aversion and Concerns for Fairness

	Bargaining Length		Trade		Buyer Profit	
	D50	ND50	D50	ND50	D50	ND50
Loss Averse (LA)	0.969**	3.141	-0.0748***	0.0775***	-45.62	388.2***
	(0.432)	(6.451)	(0.0101)	(0.00552)	(309.7)	(113.7)
H	6.407***	-0.317	-0.0715**	-0.321***	-172.9	285.9*
	(1.245)	(1.805)	(0.0363)	(0.0920)	(195.7)	(146.9)
LA x H	-2.157	12.86***	-0.226	-0.356***	-51.96	-632.2***
	(1.312)	(2.583)	(0.177)	(0.0608)	(371.4)	(31.34)
High MAO	1.971		-0.159***		-113.1	
	(1.412)		(0.0497)		(87.79)	
High MAO * H	2.690**		0.126		29.57	
	(1.121)		(0.104)		(115.1)	
Constant	1.605	35.77***	1.019***	0.881***	581.5**	449.7***
	(1.019)	(8.605)	(0.0535)	(0.0369)	(293.6)	(118.6)
Observations	147	123	170	180	170	180
Individuals	17	18	17	18	17	18

Notes: (1) Mixed effects regressions with individual and session random intercepts. Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. (2) Estimations include period dummies. (3) *LA* and *High MAO* are dummies constructed using the lottery and fairness task, respectively.

The results for ND50 confirm the impact of loss aversion. The last column of Table 6 provides the motivation for the result: loss averse buyers raise their payoffs with L-type sellers by keeping offers low and avoiding potential losses. This comes at the cost of lower earnings with H-type sellers.

We summarize the discussion provided in this section in the following result.

Result 4. *Bargaining behavior is affected by fairness preferences, buyers' loss aversion and sellers' haggling. These behavioral deviations from the standard model lower the efficiency of the bargaining institution D50 in overcoming adverse selection.*

It could have been possible that bargaining outcomes lead to higher efficiency levels than theoretically expected. For instance, preferences for efficiency could have accelerated trade. Similarly, rules of thumb have been shown to raise efficiency (Rapoport et al., 1995). Extended social preferences accounting for different aspects such as lie aversion (Gneezy, 2005) or guilt aversion (Charness and Dufwenberg, 2006) could have reduced the L-type sellers' tendency to exploit their informational advantage. We find the opposite: information is used strategically and the deviations from standard predictions we identify in the data considerably reduce the efficiency of bargaining.

5 Conclusion

A welfare-based evaluation of our experimental treatments yields that repeated offers bargaining, as well as the take-it-or-leave-it offer institution, perform worse than theoretically predicted. In

with an expected payoff of 115.

the former, the buyers' lack of commitment power leads to a substantial over-delay before trade is reached. In the latter, disagreement between buyers and L-type sellers about how to split the gains from trade lead to inefficiencies beyond the predicted trade failures with H-types. Overall, we find evidence that the cost associated with the over-delay observed in the bargaining institution is substantial. In many cases it may thus be advisable to restrict bargaining possibilities, even if this implies frequent trade failures due to adverse selection.

Despite the deviations from equilibrium predictions, our assessment of the predictions for the bargaining protocol made by sequential equilibrium is rather positive. On the one hand, we show that fairness preferences and loss aversion can reconcile the observed data with the theoretical predictions. On the other hand, the main message of the bargaining model carries over to the experimental results: buyers use the possibility of repeated offers to screen sellers. This leads to trade with H-type sellers, even though incentive constraints preclude this in the take-it-or-leave-it offer protocol.

The finding that loss aversion and fairness concerns can hinder the efficiency of negotiations has also been made elsewhere in the literature, although in different settings. Murnighan, Roth and Schoumaker (1988), Kahneman (1992) and Bottom (1998) provide results on loss aversion. Babcock and Loewenstein (1997) discuss how self-serving biases about fairness may lead to a bargaining impasse. Our results confirm these findings. In addition, we show that the bargaining institution leads to inefficiencies, even in a setting where adverse selection should not occur (due to the high probability that the seller is a high type) and is not observed if a buyer can only make a take-it-or-leave-it offer. Hence, subjects inefficiently use the possibility to screen, even if they behave optimally when restricted to a take-it-or-leave-it offer.

We conclude with a note on the persistence of over-delay. Previous work has shown that the impact of behavioral preferences on equilibrium outcomes tends to be mitigated in market settings (e.g., Fehr and Schmidt, 1999). In line with this, our conjecture is that the presence of competition may considerably reduce the over-delay we observe in the bilateral setting. Institutions that feature competitive bargaining (Blouin and Serrano, 2001; Hörner and Vieille, 2009) may perform well in the lab. We leave this important question for future research.

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A Proof of Proposition 1

We first restate Proposition 1 to also include a description of the L-type seller's acceptance probabilities and off-equilibrium behavior. Consider a point (q,t) in the bargaining game (on or off the equilibrium path), where $t \in \{1,2,\dots,T\}$ is the current stage and $q \in (0,1]$ the corresponding belief of the buyer to face an H-type seller. If the seller takes the next decision, the description of the bargaining situation (q,t,p) also includes the buyer's current price offer p. Let $a_i(q,t,p)$ be the ex ante acceptance probability of the L-type seller in stage $i \geq t$ viewed from point (q,t,p). The buyer's belief is denoted by $q_i(q,t)$ and his price offer by $p_i(q,t)$. For $i = t,\dots,\bar{T}(q,t)$, define the price sequence

$$p_i^s(q,t) = \delta^{\bar{T}(q,t)-i} c_H \tag{4}$$

where $\bar{T}(q,t)$ follows from

$$a_i^s(q,t) = \begin{cases} 0 & \text{if } t < i = \bar{T}(q,t) \\ \frac{v_H - c_H}{c_H}\frac{q}{1-q} & \text{if } t < i = \bar{T}(q,t) - 1 \\ \frac{v_L}{p_{i+1}^s(q,t)} a_{i+1}^s(q,t) & \text{if } t \leq i < \bar{T}(q,t) - 1 \end{cases} \tag{5}$$

and

$$\bar{T}(q,t) = \min\left\{\max\left(k : \sum_{i=t}^{k} a_i^s(q,t) < 1\right), T\right\}. \tag{6}$$

Then, redefine $a_t^s(q,t)$ to be

$$a_t^s(q,t) = 1 - \sum_{i=t+1}^{\bar{T}(q,t)} a_i^s(q,t). \tag{7}$$

That is, the acceptance probability in stage t includes a residual stemming from the fact that the belief at t will generally not render the buyer indifferent between two price offers. The intuition behind the acceptance probabilities is described in the main text. The acceptance probabilities pin down $q_i^s(q,t) = \frac{q}{1-(1-q)\sum_{j=t}^{i-1} a_j^s(q,t)}$ for $i = t,\dots,\bar{T}(q,t)$. For the zero offer pattern define

$$a_i^z(q,t) = \begin{cases} \frac{v_H - c_H}{c_H}\frac{q}{1-q} & \text{if } i = T,\ t < T \\ \frac{(1-\delta)v_L}{p_i^s(q,t)}\Delta_i^1(q,t) & \text{if } t < i < T,\ \bar{T}(q_i^z(q,t),i) = \bar{T}(q_{i+1}^z(q,t),i+1)+1 \\ (1-\delta)[\frac{v_L}{p_i^s(q,t)}\Delta_i^1(q,t) - \Delta_i^0(q,t)] & \text{if } t < i < T,\ \bar{T}(q_i^z(q,t),i) = \bar{T}(q_{i+1}^z(q,t),i+1) \\ 1 - \sum_{j=i+1}^{T} a_j^z(q,t) & \text{if } i = t \end{cases} \tag{8}$$

where $\Delta_i^k(q,t) \equiv \sum_{j=i+1}^{T} a_j^z(q,t) - \sum_{j=i+k}^{\bar{T}(q,t)-1} a_j^s(q,t)$ and $q_i^z(q,t) = \frac{q}{1-(1-q)\sum_{j=t}^{i-1} a_j^z(q,t)}$ for $i = t,\dots,T$.

The buyer's continuation payoffs at (q,t) for the screening and the zero offer pattern are

$$R^s(q,t) = (1-q)\sum_{i=t}^{\bar{T}(q,t)-1}\left[\delta^{i-t} a_i^s(q,t)(v_L - p_i^s(q,t))\right] + q\delta^{\bar{T}(q,t)-t}(v_H - c_H) \tag{9}$$

$$R^z(q,t) = (1-q)\sum_{i=t}^{T}\delta^{i-t} a_j^z(q,t) v_L, \tag{10}$$

where in (10) the price is 0 in all stages.

Proposition 2 (Generalized Version of Proposition 1)**.** *The bargaining game introduced in Section 2.1 has a generically unique sequential equilibrium. For any period $t \in \{1, 2, \ldots, T\}$ and belief $q \in (0, 1]$, the equilibrium is given by the following strategies:*
(i) The H-type seller accepts with probability (w.p.) 1 if $p_t(q, t) \geq c_H$ and rejects otherwise.
(ii) The L-type seller's acceptance probabilities are[26]

$$a_t(q,t,p) = \begin{cases} \sum_{i=t}^{j:t\leq j\leq \bar{T}(q,t)} a_i^s(q,t) & \text{if } p_t(q,t) \in [p_j^s(q,t), p_{j+1}^s(q,t)) \\ a_t^s(q,t) - \frac{v_L}{p_{t+1}^s(q,t)} a_{t+1}^s(q,t) & \text{if } p_t(q,t) \in [\delta p_t^s(q,t), p_t^s(q,t)) \text{ and } t < \bar{T}(q,t) - 1 \\ a_t^s(q,t) - \frac{v_H - c_H}{c_H} \frac{q}{1-q} & \text{if } p_t(q,t) \in [\delta p_t^s(q,t), p_t^s(q,t)) \text{ and } t = \bar{T}(q,t) - 1 \\ 0 & \text{if } p_t(q,t) < \delta p_t^s(q,t) \text{ and } R^s(q,t+1) \geq R^z(q,t+1) \\ a_t^z(q,t) & \text{if } p_t(q,t) < \delta p_t^s(q,t) \text{ and } R^s(q,t+1) < R^z(q,t+1). \end{cases}$$

(iii) The buyer's price offer is

$$p_t(q,t) = \begin{cases} p_t^s(q,t) \text{ w.p. } \lambda \text{ and } p_{t+1}^s(q,t) \text{ w.p. } 1-\lambda & \text{if } R^s(q,t) \geq R^z(q,t) \\ 0 & \text{if } R^s(q,t) < R^z(q,t) \end{cases}$$

where (letting $p_{-1} = 0$)

$$\lambda = \begin{cases} 1 & \text{if } \frac{p_t^s(q,t) - p_{t-1}}{(1-\delta) p_t^s(q,t)} \notin (0,1] \\ \frac{p_t^s(q,t) - p_{t-1}}{(1-\delta) p_t^s(q,t)} & \text{otherwise.} \end{cases}$$

Moreover, $R^s(q, t) > R^z(q, t)$ holds for any (q, t) if T is sufficiently large.

One can verify that the strategies in Proposition 2 constitute a sequential equilibrium. It remains to show uniqueness. Fix (q, t). We start with some observations for the last equilibrium stage. The last equilibrium stage is either $\bar{T}(q, t)$ with a price offer c_H or T with a price offer of 0. The former holds since c_H is accepted by both seller types w.p. 1 and offers below c_H are rejected by H-type sellers (i.e. there is another equilibrium stage). The latter holds, since any offer strictly between 0 and c_H is dominated by an offer of 0, which is still accepted by an L-type seller.

Moreover, the buyer does not randomize between c_H and 0 in the last equilibrium stage.[27] If this were the case, the last equilibrium stage would be T and the L-type seller must accept p_{T-1} w.p. strictly between 0 and 1. If the acceptance probability is 0, the beliefs would not change between $T - 1$ and T and the buyer should have offered $p_{T-1} = c_H$. If the acceptance probability is 1, the buyer would conclude that the seller is an H-type and offer c_H in T (no randomization). Now consider any $c_H > p_{T-1} > 0$ (an offer of 0 would be rejected w.p. 1 if the buyer randomizes in T) and a deviating offer $p'_{T-1} = p_{T-1} - \epsilon$. This deviation is profitable, unless we can construct a situation in which the L-type accepts p_{T-1} with a larger probability than p'_{T-1}. But this would imply that p'_{T-1} is followed by an offer of 0, because the belief is lower after p'_{T-1} than after p_{T-1} and we started with the assumption that with p_{T-1} the buyer would be indifferent between 0 and c_H in T. Hence, the L-type must accept p'_{T-1} w.p. 1, a contradiction.

We now prove the following three requirements on optimal behavior, which inductively pin down the equilibrium given the possible final offers c_H or 0 and the fact that the buyer does not randomize in the last

[26] Let $p^s_{\bar{T}(q,t)+1}(q, t)$ to be the maximal possible price offer.

[27] The buyer may randomize if $T = 1$, as will become clear in the following, but for generic q_H this is a measure 0 event.

stage.
(1) On the equilibrium path, it holds that $p_t(q,t) = \delta p_{t+1}$ for any $t < \bar{T}(q,t) \leq T$.
(2) If the final equilibrium offer is c_H, the buyer is indifferent between offering $p_t(q,t) = p_t^s(q,t)$ and $p_t(q,t) = p_{t+1}^s(q,t)$ for all $1 < t < \bar{T}(q,t)$.
(3) If the final equilibrium offer is 0, the buyer is indifferent between offering $p_t(q,t) = 0$ and $p_t(q,t) = p_t^s(q,t)$ for all $1 < t \leq T$.

For the final equilibrium stage, points (1) and (2) are moot. The arguments for point (3) are almost identical to the general case for stages $t < \bar{T}(q,t) \leq T$. Any differences will be made explicit. Thus, consider a stage $t < \bar{T}(q,t) \leq T$ and assume steps (1)-(3) hold for $t+1$.

Step (1). Since (1) holds for all future stages, any offer that exceeds $p_t(q,t)$ is accepted by an L-type seller w.p. 1 and c_H would follow immediately, which cannot be an equilibrium; for the second to last stage in the screening case, offers larger than δc_H are dominated by δc_H. Any offer below $p_t(q,t)$ is rejected w.p. 1. This contradicts step (3) for $t+1$, because if indifference between $p_{t+1}(q,t+1) = 0$ and $p_{t+1}(q,t+1) = p_{t+1}^s(q,t+1)$ is obtained at belief q, $p_{t+1}^s(q,t+1)$ would be strictly preferred in period t. For the screening sequence, an offer below $p_t^s(q,t)$ would only postpone the continuation payoff without affecting behavior in future stages, since this behavior is pinned down by (1) and (2) for $t+1$. Hence, $p_t(q,t)$ is the unique optimal offer on the equilibrium path.

Step (2). Consider a non-equilibrium offer $p'_t(q,t) \neq p_t^s(q,t)$ and an arbitrary acceptance probability leading to $(q', t+1)$. By sequential rationality, the buyer's offer at $(q', t+1)$ must again be of the form in step (1). Moreover, for the deviation $p'_t(q,t)$ just slightly above $p_t^s(q,t)$, the acceptance probability of the L-type seller cannot be different from the one in equilibrium. Hence, $q' = q$ and at $(q', t+1)$ the buyer must randomize between $p_t^s(q,t)$ and a higher offer $p_i^s(q,t)$ for some $t < i \leq \bar{T}(q', t+1)$. This higher offer must be $p_{t+1}^s(q,t)$. To see this, assume the offer is $p_{t+i}^s(q,t)$ for $i > 1$ and note that then $p_{t+1}^s(q,t)$ would be strictly preferred to $p_t^s(q,t)$ at t.

Step (3). For the zero offer sequence, the same reasoning as in step (2) implies that 0 cannot be the uniquely best offer. Hence, after an offer of just slightly above 0, the buyer must randomize at $(q', t+1)$, where $q' = q$, between 0 and the best screening offer $p_t^s(q,t)$, since the only sequentially rational alternative to offering 0 is to start optimal screening.

It remains to explicitly pin down the acceptance probabilities. The buyer's continuation payoff at (q,t) can be written as

$$R(q,t) = (v_L - p_t(q,t))a_t(q,t) + \delta R(q_{t+1}(q,t), t+1). \tag{11}$$

For the screening sequence, the advantage of antedating $p_{t+1}^s(q,t)$ is that $R(q_{t+1}^s(q,t), t+1)$ is obtained one stage earlier. On the other hand, the buyer loses $p_{t+1}^s(q,t) - p_t^s(q,t)$ on the L-type seller with probability $a_t^s(q,t)$. According to step (2) above, the gains from accelerating trade must balance out the losses, i.e., $(1-\delta)R(q_{t+1}^s(q,t), t+1) = (p_{t+1}^s(q,t) - p_t^s(q,t))a_t^s(q,t)$. Combining this with expression (11), the ex ante acceptance probabilities are given recursively by (5).

For the zero offer sequence, note first that $q_T^z(q,t) = \frac{c_H}{v_H}$ (since this is the belief for which the buyer is indifferent between offering 0 and c_H) and thus $a_T^z(q,t) = \frac{q}{1-q}\frac{c_H}{v_H - c_H}$. When working towards stage 1, the following equations need to hold for all $1 < t < T$.

$$R^z(q,t) = R^s(q,t) \tag{12}$$
$$R^s(q,t) = (v_L - p_t^s(q,t))(a_t^z(q,t) + \Delta_i^1(q,t)) + \delta R^s(q_{t+1}^s(q,t), t+1) \tag{13}$$
$$R^z(q,t) = v_L a_t^z(q,t) + \delta(v_L - p_t^s(q,t))\Delta_i^1(q,t) + \delta^2 R^s(q_{t+1}^s(q,t), t+1) \tag{14}$$
$$R^z(q,t) = v_L a_t^z(q,t) + \delta(v_L - p_{t+1}^s(q,t))\Delta_i^1(q,t) + \delta R^s(q_{t+1}^s(q,t), t+1) \tag{15}$$

where (14) applies if $\bar{T}(q,t) = \bar{T}(q_{t+1}^z(q,t), t+1) + 1$ and (15) applies if $\bar{T}(q,t) = \bar{T}(q_{t+1}^z(q,t), t+1)$. Also recall that $\Delta_i^k(q,t) \equiv \sum_{j=i+1}^{T} a_j^z(q,t) - \sum_{j=i+k}^{\bar{T}(q,t)-1} a_j^s(q,t)$. Equation (12) follows from step (3). Noting that $a_t^s(q,t) = a_t^z(q,t) + \Delta_i^1(q,t)$, equations (13) and (14) follow. Also notice that $\bar{T}(q,t) < \bar{T}(q_{t+1}^z(q,t), t+1) + 2$. In words, offering 0 cannot speed up trade (skip one screening stage), because screening already implies that the buyer obtains the smaller share of the gains from trade in the current stage (and the buyer needs to be indifferent between screening and offering 0). Combining (12), (13), (14) and (12), (13), (15), we can derive (8).

The unique sequential equilibrium is given by the screening equilibrium if $R^s(q_H, 1) > R^z(q_H, 1)$ and the zero offer equilibrium if $R^s(q_H, 1) < R^z(q_H, 1)$. If $R^s(q_H, 1) = R^z(q_H, 1)$, the buyer is indifferent between inducing either of the two patterns. We show that $R^s(q_H, 1) > R^z(q_H, 1)$ if T is large. Note that $\bar{T}(q,t)$ is independent of T for fixed t and sufficiently large T. Thus, $\bar{T}(q_H, 1) = \bar{T}(q_t^z(q_H, 1), t)$. Thus, $a_t^z(q_H, 1) = (1-\delta)[\frac{v_L}{p_1^s(q_H,1)}\Delta_t^1(q_H, 1) - \Delta_t^0(q_H, 1)]$ for $t = 2, \ldots, t^*$, where $t^* < T$ is a finite but arbitrarily large number. Moreover, $\frac{v_L}{p_1^s(q_H,1)} > 1$ if $q_H < c_H/v_H$ (otherwise the optimal offer is c_H), see DL (p. 1321). Intuitively, as q becomes lower, the buyer's continuation payoff decreases as long as the offer exceeds v_L and thus the buyer wants to further increase price discrimination (screening). This only changes once the offered price is below v_L, such that a further decrease in q increases the buyers expected payoff. Thus, $a_t^z(q_H, 1)$ is increasing in t and there exists T large enough such that $\sum_{t=1}^{T} a_t^z(q_H, 1) > 1$, which is not possible in equilibrium.

B Online Appendix: Examples of Equilibria with Fairness and Loss Aversion Preferences

To illustrate the impact of fairness and loss aversion, we discuss three theoretical scenarios. The parameter values are chosen in accordance with the elicited fairness and loss aversion parameters.

- *Fairness and Delay.* Let $\beta_{B,L} = \beta_{B,H} = \beta_{S,L} = 0.5$ and $\beta_{S,H} = 0.2$.[28] Following the mean MAO in the fairness task, let $\alpha_B = \alpha_S = 4.7$.[29] We continue to assume loss neutrality. In equilibrium, there are now 7 stages which is the median trading stage with H-types observed in our data. The (rounded) equilibrium price sequence is (844, 875, 1092, 1364, 1706, 2132, 2665), where $2665 = \bar{p}_{S,H}$, and the ex ante acceptance probabilities of the L-type seller are (0.918, 0.008, 0.008, 0.011, 0.018, 0.037, -). The H-type seller accepts the last offer and the L-type accepts in stage 1 with more than 90% probability. This concentration on early acceptance reflects that the buyer's belief to face an H-type seller must be very large in order

[28]The lower value for $\beta_{S,H}$ does not affect the qualitative results. We choose it because it fits well with the data, as H-type sellers rarely insisted on offers as high as 3000.

[29]Note that assuming $\beta_{i,L} = 0.5$, which seems appropriate for the fairness task, a MAO of 16.5 implies $\alpha_i = 4.7$.

for him to be willing to raise his offers.[30]

- *Fairness and Trade Failures.* Keep the parametrization of the first scenario, except that $\beta_{S,L} = 0.75$. The L-type seller now feels entitled to a higher share of the gains from trade ($\overline{p}_{S,L} = 1082$), while the buyer insists on the 50-50 norm ($\overline{p}_{B,L} = 1029$). There is no price for which both parties obtain a positive utility when trading the low quality good. It follows that the high quality good is not traded either due to the presence of adverse selection.

- *Loss Aversion and Delay.* Abstract from fairness preferences. According to the lottery task, on average subjects were indifferent between rejecting and accepting a 50-50 lottery between winning 6 and losing 3.5, which implies $\lambda \approx 1.7$. In this case, the equilibrium price sequence involves 6 offers given by (819.2, 1024, 1280, 1600, 2000, 2500) with corresponding L-type acceptance probabilities (0.092, 0.340, 0.249, 0.162, 0.157, -).

C Online Appendix: Instructions

Instructions Treatment D50

Welcome to this economic experiment. From now on you are not allowed to communicate in any other way than specified in the instructions. Please obey to this rule because otherwise we have to exclude you from the experiment and all earnings you have made will be lost. Please also do not ask questions aloud. If you have a question, raise your hand. A member of the experimenter team will come to you and answer your question in private.

In this experiment you can earn money with the decisions you make. How much you earn depends on your own decisions, the decisions of other participants as well as random events. We will not speak of CHF during the experiment, but rather of experimental points. All your earnings will first be calculated in points. At the end of the experiment the total amount of points you earned will be converted to CHF at the following rate:

$$100 \text{ points} = 0.3 \text{ CHF}$$

In addition, you will receive a show up fee of 10 CHF.

The experiment consists of two parts [note: three parts in some of the sessions] that are independent of one another. For each part you will receive specific instructions. These instructions will explain how you make decisions and how your decisions and the decisions of other participants influence your earnings. Therefore, it is important that you read the instructions carefully.

In case you should make losses, the show up fee of 10 CHF is used to cover for these losses. If you make losses exceeding 10 CHF, you will have the option to leave immediately and earn 0 CHF.

We will now describe the **general setting** you will face during the experiment. At the beginning of the experiment the participants will be divided into buyers and sellers. Half of the participants will be buyers and the other half will be sellers. When you are a buyer (respectively, a seller) you will stay a buyer (respectively, a seller) throughout the experiment. A decision situation (explained below) will be repeated for 10 periods.

[30] It is possible to get a similar screening duration without such a high first-stage acceptance probability. For example if $\alpha_B = \alpha_S = 0.5$ the number of stages is still 7, the price sequence looks similar, but the L-type accepts in the first stage at a price of 762 with a probability of 50%.

In each period a buyer and a seller are randomly matched. In other words, the participants are divided into pairs and each pair consists of one buyer and one seller. You will not get to know the identity of the buyer or seller you are paired with, neither during nor after the experiment. The participant who is paired with you will also not get to know your identity. In each period new pairs will be formed randomly.

The **decision situation** will be the same for all ten periods. We will now describe one such period. After the buyer and the seller have been matched, they face the following situation. The seller can be of two different types: type A or type B. A seller of type A can only produce a high quality good at cost 2500. A seller of type B can only produce a low quality good at cost 0. The buyer's valuation for the high quality good is 3500. The buyer's valuation for the low quality good is 1750.

The seller knows whether she is of type A or type B and therefore also knows how much the good is worth to the buyer. However, the buyer does not know the seller's type and hence, the buyer does neither know whether his valuation for the good is 3500 or 1750 nor whether the cost of the seller to produce the good is 2500 or 0. The type of the seller will be determined randomly according to the following probabilities at the beginning of each period: the probability that the seller is of type A (high cost / high quality good) is 0.4 (40%) and the probability that the seller is of type B (low cost / low quality good) is 0.6 (60%).

To acquire the good, the buyer makes offers to the seller. The offers must be between 0 and 4000 and can be as exact as to the first decimal place. If you enter an offer that is not allowed, the computer will tell you and you will have to change your offer. Upon seeing the buyer's offer, the seller can accept or reject the offer. If the seller accepts the offer, she produces the good and sells it to the buyer at the agreed price. The buyer does not make further offers and the trading pair has to wait until all other pairs have finished their trading process and buyers and sellers are rematched to form new pairs in the next period.

If the seller rejects the offer, the buyer can make a new offer to the seller which can again be accepted or rejected. There can be at most 50 stages, i.e. a buyer can make at most 50 offers to a seller. Likewise, a seller can reject up to 50 offers. If all 50 offers are rejected, the good is not produced (and not traded) and both parties earn 0.

In which stage trade takes place does matter. The buyer and the seller both discount the future at the discount factor $d = 0.8$. This means that a profit (or loss) realized in stage n is discounted according to the given discount factor. For instance, if the buyer makes a profit of x experimental points in stage 1, he earns x experimental points since there is no discounting. If the buyer makes a profit of x experimental points in stage 3, he earns $x * 0.8 * 0.8 = x * 0.8^2$ experimental points.[31] Generally, if an offer is accepted in stage n, the payoffs are determined as follows.

$$\begin{aligned}\text{The buyer's payoff} &= (\text{Valuation of the Good} - \text{Accepted Offer}) * d^{n-1} \\ \text{The seller's payoff} &= (\text{Accepted Offer} - \text{Production Cost}) * d^{n-1}\end{aligned}$$

For convenience the valuations and costs are summarized below:

- Buyer's valuation for the high quality good = 3500
- Buyer's valuation for the low quality good = 1750
- Seller's cost of producing the high quality good = 2500
- Seller's cost of producing the low quality good = 0

[31] Subjects were give a calculator to ensure correct expectations about discounting.

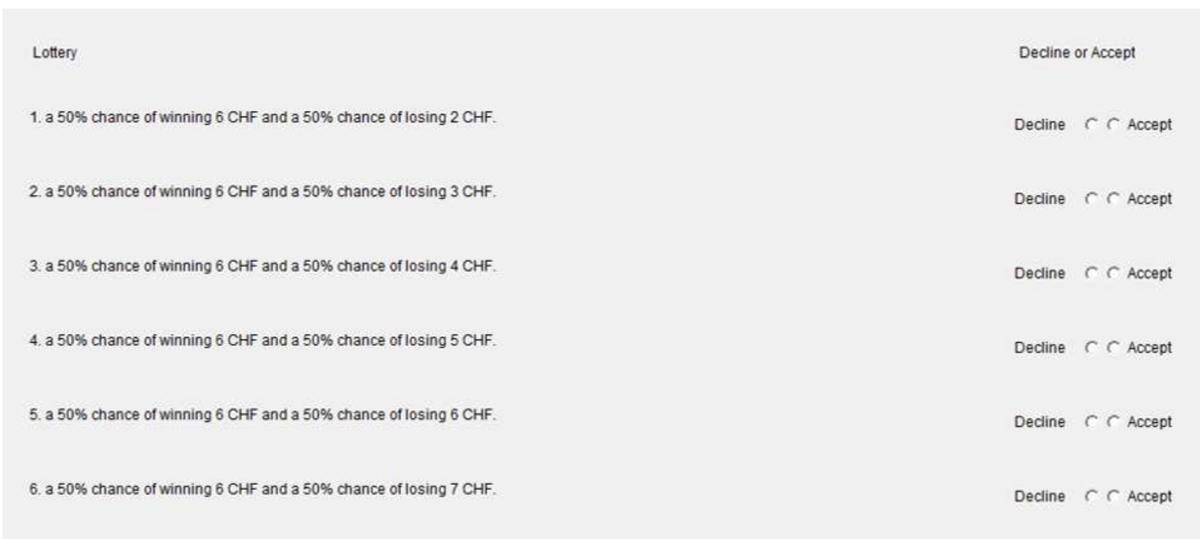
Once all pairs have traded the good at some price or all offers have been rejected, the computer randomly matches buyers and sellers anew and the next period starts. The experiment ends after period 10.

Instructions Lottery Task

In this part of the experiment, you will have the choice to participate in a lottery in which you can win or lose money. Any profits or losses will be added (or subtracted) to your earnings from the previous part of the experiment and paid to you in cash at the end of the experiment.

On the next screen a series of lotteries will be shown. For each lottery, you may choose to accept the lottery or decline the lottery. After you have made a selection for each of the lotteries, one of the lotteries will be randomly selected by the computer. If you chose to decline the selected lottery, nothing happens and your income remains unchanged. If you chose to accept the selected lottery, the computer randomly determines the outcome in this lottery according to the given probabilities (it will be a 50-50 chance for each lottery). If you win the lottery, you earn the corresponding amount. If you lose the lottery, you will lose the corresponding amount.

Figure 5: Lottery Task



Instructions Fairness Task

In this part of the experiment, you will be randomly matched with one other participant in the room.

Both you and the participant you are matched with will then be asked to make two choices. First, you and the other participant will choose how to split 40 experimental points between the two of you. This will be the role of the PROPOSER. Second, you and the other participant will also specify a minimal acceptable amount between 0 and 40. This will be the role of the RESPONDER.

One participant in a pair (either you or the other participant) will then be chosen to be the proposer. For this participant the choice he or she made as a PROPOSER will be relevant. The other participant in the pair is chosen to be the responder. For this participant the choice he or she made as a RESPONDER will be relevant. Which participant in a pair will be in the role of the proposer or the responder is randomly determined, after both participants have made their choices for both roles.

If the share of the 40 experimental points the PROPOSER chose to allocate to the responder is larger than (or equal to) the minimal acceptable amount specified by the RESPONDER, the 40 points are distributed according to the proposer's decision. However, if the amount the PROPOSER offers to the responder does not cover the RESPONDER's minimal acceptable amount, both players in a pair earn 0.

Please use the fields below to tell us what is the offer you will make to the responder and the amount you propose to keep for yourself if allocated the role of the PROPOSER. Recall that the total amount to be distributed between the responder and you is 40.

Your decision as PROPOSER Your share: ______________ Other's share: ______________

Please use the field below to tell us what is the minimum offer you are willing to accept if allocated the role of the RESPONDER. Recall that the proposer will propose how to distribute the 40 points between himself / herself and you.

Your minimal acceptable amount as RESPONDER: ______________

The exchange rate in this part of the experiment is 1:5. That is, each point earned is worth 0.2 CHF.