Bargaining or Searching for a Better Price? - An Experimental Study

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Abstract

This experimental study investigates two bargaining games with two-sided incomplete information between a seller and a buyer. In the first game with no outside options a majority of subjects do not use the incomplete information to their advantage as predicted. The second game gives the buyer the option to buy via search or return to bargaining. Here many buyers choose a bargaining agreement when a search outcome is predicted. For those who opt out, search outcomes are overall efficient and behavior is relatively close to the optimal search policy.

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JEL Classification: C91, C78, D83, D82

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1 Introduction

Suppose a buyer meets a seller who offers to sell him a particular item he has been looking for. They start to bargain over the price, each of them uncertain about the other's valuation for the item. While the seller currently has no other potential clients, the buyer can quit negotiations and search for better alternatives, but he can also return to the seller at any time. Information and outside options are two crucial strategic factors in a bargaining setting. This paper investigates how they influence bargaining behavior in an experiment.

The extensive literature on bargaining experiments has brought substantial insight into people's motivation, in particular, when observed behavior departs from the theoretical prediction. Starting with Güth et al. (1982), many ultimatum games experiments showed that most subjects prefer “fair”, i.e. more equitable outcomes to the extreme predictions. Gantner et al. (2001) find that subjects differ in equity types when various equity standards are applicable. Experiments on alternating-offers bargaining (e.g., Hoffman and Spitzer 1982, 1985) offer somewhat contradictory evidence: “Fair” allocations are observed when players are randomly assigned their roles; when positions are earned in a preliminary game, however, the winning player receives a larger payoff, and asymmetric payoffs seem to be more acceptable. When a fixed *outside option* is introduced, the experiments by Binmore et al. (1989, 1998) showed that this makes the threat of ending negotiations credible, and earnings increase for the player who has the outside option. When the outside option is high, but still smaller than the size of the bargaining cake, the proportion of conflicts increases. In the presence of *incomplete information*, experimental results also tend towards more competitive bargaining: In a simultaneous-demand bargaining experiment by Hoggatt et al. (1978), only about one quarter of all agreements are equal splits; subjects learned to avoid low initial demands over time. Kuon (1994) finds that in a bargaining experiment with incomplete information about the opponent's outside option, subjects bargain more competitively with higher outside option values and with increasing experience. Weak players (those with a low outside option) pretend to be strong.

The Chatterjee and Samuelson (1987) model of alternating-offers bargaining with two-sided incomplete information is a major contribution to the theory of bargaining with incomplete information. When offers are restricted, the model predicts a unique equilibrium in which the first mover may use the incomplete information to conceal his type and thus receive a larger share of the total surplus.[1] In an extension of this bargaining setting, Gantner (2007) adds an outside option

[1] The asymmetry in the gains from trade is also maintained when the restriction of the offer set is relaxed, as shown in a subsequent study by Chatterjee and Samuelson (1988). Despite the existence of multiple equilibria in this model, there is only one equilibrium with plausible beliefs, and it has the same features as the unique equilibrium in the restricted offers model.

for the buyer, modeled as a sequential search process with non-negotiable prices. The theoretical analysis shows that despite the option to switch between the bargaining and search process repeatedly, a bargaining agreement may be achieved without delay, and an agent who starts search will never return to bargaining when both agents know the value of search. These two models shall be tested in an experiment to answer some simple questions about subjects' behavior in a more complex bargaining environment: Do they use the incomplete information to their advantage? When do they bargain and when search? The search option supports a more selfish bargaining behavior, but at the same time the possibility of choosing a bargaining agreement with benefits for both players over a risky search outcome in which the partner is left with empty hands may affect behavior.

Two previous experiments that allow for an uncertain outside option in a bargaining setting are Zwick and Lee (1999) and Carpenter and McAndrew (2003). Both use complete information bargaining, in which search consists of a single random draw. Zwick and Lee allow only for one-shot bargaining, while Carpenter and McAndrew allow for exactly one renegotiation, which follows ultimatum bargaining rules. The results show that agents with the outside option reject generous offers during bargaining. In Zwick and Lee (1999) this leads to lower profits due to overly high search rates. In Carpenter and McAndrew (2003), agents respond conciliatory when returning to bargaining. Note that, in comparison, our approach allows for an unlimited time horizon in both bargaining and search, and outcomes can thus not be compared directly.

Two major findings from the experimental literature on sequential search shall be pointed out. One is that search is highly efficient in terms of earnings (Schotter and Braunstein 1981, Hey 1987, Kogut 1990, Sonnemans 1998). The other finding is that subjects tend to search too little compared to the optimal rule (Cox and Oaxaca 1989, Schotter and Braunstein 1981). This may point towards risk-averse behavior: subjects prefer an offer located from search over the "lottery" of continuing search that yields a better expected outcome. In a series of experiments, Cox and Oaxaca (1989, 1992, 2000) provide a systematic exploration of theoretical predictions of finite search models. They find that a model assuming risk averse behavior performs well in the experimental test.

The rest of the paper is organized as follows: Section 2 theoretically describes the two models of the bargaining games with and without outside option. Section 3 describes the three treatments that were tested in the experiment, section 4 reports the experimental results and section 5 concludes.

2 Two Bargaining Models

In this experiment we investigate two games. *Game 1* is a bargaining game between a seller and a buyer with two-sided incomplete information and restricted offers. *Game 2* has an additional outside option, which is to search for a better price. The two games are presented in detail in the following subsections.

2.1 Bargaining without Outside Option

Game 1 is a restricted-offers bargaining game with two-sided incomplete information as analyzed by Chatterjee and Samuelson (1987). Seller S and buyer B bargain over the price p of an indivisible good. They are imperfectly informed about each other's valuation for the good. Each agent can be one of two possible types: B's valuation (BV) can be either high or low: $BV \in \{HV, LV\}$; similarly, S's cost (SC) can be either high or low: $SC \in \{HC, LC\}$. Let $LC \leq LV < HC \leq HV$. At time 0, B's prior belief that he faces a low-cost S is π_S^0, and S's prior belief that he faces a high-value B is π_B^0. The priors are exogenously given and are common knowledge. Agents update their beliefs according to Bayes' rule. Price offers p are restricted to a high-price offer $p_h = HC$ and a low-price offer $p_l = LV$. Bargaining between B and S proceeds as follows: In period 1, S makes an offer, and B responds with one of three choices: he can accept S's offer, or reject and make a counteroffer, or quit. If B accepts or quits, the game is over. If B makes a counteroffer, agents enter period 2, in which S decides whether to accept B's offer, or reject and make a counteroffer, or quit. If S accepts or quits, the game is over. If S makes a counteroffer, it is B's turn in period 2. There are no exogenous restrictions on the length of bargaining, but a discount factor $\delta < 1$ is applied to future payoffs. The payoffs are $p - SC$ for S and $BV - p$ for B in case of trade, otherwise they are zero.

It is clear from the setup of the model that the only acceptable price for a high-cost S is p_h and for a low-value B it is p_l, otherwise these agents would make losses; they shall thus be called inflexible agents. Mutually beneficial trade between two inflexible types is not possible. On the other hand, a high-value B and a low-cost S can accept either offer without making losses; they shall thus be called flexible agents. Flexible agents may have a strategic incentive to conceal their type in order to make higher profits.

As Chatterjee and Samuelson (1987) show, bargaining proceeds only for a finite but endogenously determined number of periods. An equilibrium in which both flexible agents reveal their type in $t = 1$ exists if demanding p_l and thus receiving $LV - LC$ in round 1 is better for S than demanding p_h, when B will accept p_h in round 1 with probability π_B^0, and with probability $1 - \pi_B^0$ the game continues to the next round:

$$\pi_B^0(p_h - LC) + \delta(1 - \pi_B^0)(p_l - LC) \leq p_l - LC \tag{1}$$

which gives the boundary value for π_B^0:

$$\pi_B^0 \leq \frac{(p_l - LC)(1 - \delta)}{p_h - LC - \delta(p_l - LC)} \equiv \bar{\pi}_B. \tag{2}$$

In this case, a buyer will infer from an offer of p_h that he faces an inflexible S. Then a flexible B accepts p_h; an inflexible B quits.

An equilibrium in which a flexible S conceals his type, i.e. he offers p_h, thus only exists if his belief that B is flexible is sufficiently high ($\pi_B^0 > \bar{\pi}_B$). Then B will reveal his type before S if

$$\delta\pi_S^0(HV - p_l) + \delta(1 - \pi_S^0)(HV - p_h) \leq HV - p_h \tag{3}$$

that is, if B's prior that S is flexible is sufficiently low:

$$\pi_S \leq \frac{(HV - p_h)(1 - \delta)}{\delta(p_h - p_l)} \equiv \bar{\pi}_S. \tag{4}$$

Since delay is costly, this would happen in round 1. Then the best response for a flexible S is to accept p_l in $t = 2$, since S must conclude that he faces an inflexible buyer if he is offered the low price in round 1 when $\pi_S \leq \bar{\pi}_S$.

If neither condition (2) nor (4) are satisfied, the equilibrium is in mixed strategies.[2] As Chatterjee and Samuelson show, this game has a unique sequential equilibrium:

Proposition 1. *The bargaining game with two-sided incomplete information (Game 1) has a unique Nash equilibrium in which a flexible S offers p_l in $t = 1$ if $\pi_B^0 \leq \bar{\pi}_B$. A flexible B accepts p_h in $t = 1$ if $\pi_B^0 > \bar{\pi}_B$ and $\pi_S \leq \bar{\pi}_S$. If none of the conditions hold, the equilibrium is in mixed strategies.*

2.2 Bargaining with Search as Outside Option

In *Game 2*, bargaining process, information about the types and parameters are as described in *Game 1*. The only difference is that instead of quitting, B can now choose to opt out and buy via search. Figure 1 shows the move-structure of the bargaining-search game. During the search phase, B receives a non-negotiable offer each period. Upon receipt, he can accept this offer, or reject and continue search, or renegotiate with S. For simplicity, we consider a discrete-time model in which outside offers y are random draws from a discrete uniform distribution on

[2] As the parameters of the experiment will be chosen such that there exists an equilibrium in pure strategies, we shall not go into details of the mixed strategy equilibrium.

the interval $[0, \bar{y}]$, where $\bar{y} \in \mathbb{N}$. B and S have identical information about the distribution of the outside offers.

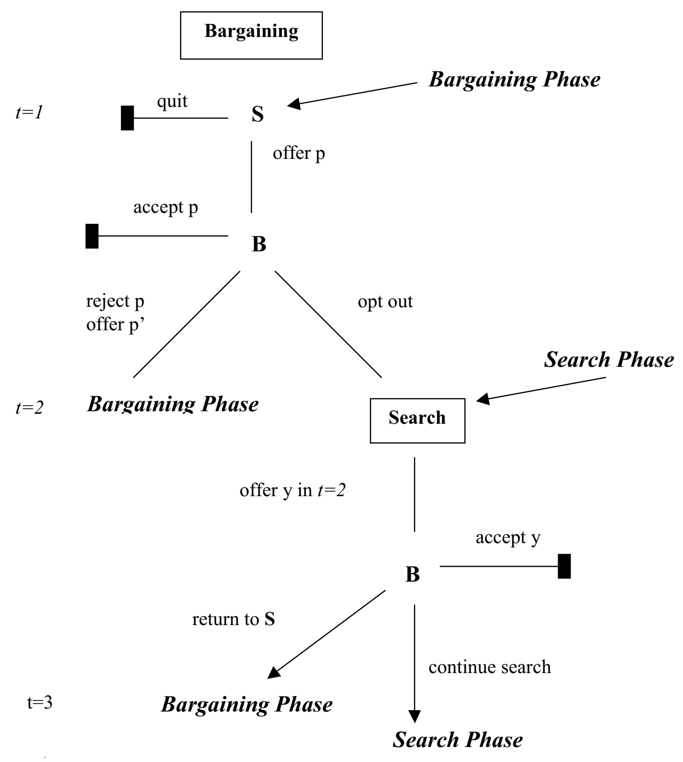

Figure 1: The Bargaining and Search Game

To find the equilibrium strategies for this bargaining and search game, we need to know how good the search option is compared to the bargaining alternative. The value of search is determined by the optimal reservation price y^*, which is the price at which B is just indifferent between continuing search for one more period and accepting the current search offer. This reservation price depends on B's valuation V. B is said to follow the reservation price policy if he rejects all outside offers $y > y^*$ and accepts any $y \leq y^*$. Since we have a discrete uniform distribution of outside offers, y^* is the solution to:

$$V - y^* = \delta \left[\frac{1}{\bar{y}+1} \sum_{y=0}^{y^*} (V - y) + \frac{\bar{y} - y^*}{\bar{y}+1} (V - y^*) \right] \qquad (5)$$

Gantner (2007) describes the equilibrium of this game with a continuous-time search process in which verifiable outside offers come from a Poisson distribution. The analysis is adapted to the simpler setting of the present game, in which exactly one outside offer drawn from a discrete uniform distribution is available in each period of search, and furthermore B loses the outside offer if he decides to return to S. Since the reservation price is increasing in the valuation, there is no separation of types in which only the inflexible B would bargain. We thus confine our attention to the flexible buyer's reservation price y^*_{HV}, as it drives the bargaining results. The bargaining-search equilibrium of this game is characterized by the following proposition:

Proposition 2. *In the bargaining-search game with two-sided incomplete information and symmetric information about the outside option, the flexible B opts out in $t = 1$ and follows the reservation price policy if $y^*_{HV} < p_l$. If $y^*_{HV} \geq p_l$, then two flexible agents agree on p_l in $t = 1$ if at least one of the following conditions holds: (i) $y^*_{HV} \leq p^h$; (ii) $\pi^0_B \leq \bar{\pi}_B$. If neither condition holds, then two flexible agents agree on p_h in $t = 1$ if $\pi^0_S \leq \bar{\pi}_S$. Otherwise, there is no equilibrium in pure strategies.*

Condition (i) thus identifies a "good" outside option for B, and it gives the flexible S the incentive to reveal his type. Condition (ii) is already known from the pure bargaining game. Since it is known at time zero whether the conditions stated in Proposition 2 are met, and future payoffs are discounted, a flexible S will reveal his type immediately if (i) or (ii) are satisfied. It thus follows that B only starts search with the intention to accept an offer from search, but never to induce S to lower his offer.

Corollary 1. *On the equilibrium path of the bargaining-search game with symmetric information about the outside option, the buyer never returns to bargaining.*

The proofs are omitted since they are direct applications of Gantner's (2007) model. For an experimental test of the described models, we can thus identify some clear predictions. In *Game 1* the obvious question is whether the high surplus is assigned to the "right" player. If parameters are chosen such that S has a strategic advantage in *Game 1*, we would expect to see this advantage vanish in *Game 2* when search parameters for B are chosen appropriately. We can thus test whether games in *Game 2* end in the bargaining or search phase as predicted, how long agents search and whether they return to bargaining.

3 Experimental Setup

3.1 Treatments

Three treatments (`NOO`, `GOO`, `BOO`) were designed to test the predictions of the models described above. The theoretical predictions described for each treatment rely on the standard assumptions that agents care only about their own monetary payoff and that they are risk-neutral.

Treatment NOO ("No Outside Option") refers to *Game 1*. The seller cost is either $LC = 3$ or $HC = 22$ with equal probability. The buyer value is either $HV = 37$ or $LV = 18$ with equal probability. Offers are restricted to a high price offer $p_H = 23$ or a low price offer $p_L = 17$.[3] Future payoffs are discounted by a factor of $\delta = 0.8$ for each bargaining period. When two flexible agents are matched, the theoretical prediction assigns the high surplus to the seller according to Proposition 1: $\pi_B^0 = .5$ exceeds the critical value $\overline{\pi}_B^0 = .32$ calculated from (2), thus a flexible S should conceal his type in $t = 1$. At the same time, B's belief $\pi_S^0 = 0.5$ is below the critical value $\overline{\pi}_S^0 = 0.83$ calculated from (4), thus a flexible B should immediately accept p_h. The respective column in Table 1 summarizes the theoretical predictions for all possible pairs of agents in this treatment.

Pair	Treatment NOO	Treatment GOO	Treatment BOO
LC-HV	**agree** on p_h in t=1	**search** for $y \leq 16.1$	**agree** on p_l in t=1
	S gets 20, B gets 14	S gets 0, B gets 20.9	S gets 14, B gets 20
LC-LV	**agree** on p_l in t=2	**search** for $y \leq 9.9$	**search** for $y \leq 12.1$
	S gets 11.2, B gets 0.8	S gets 0, B gets 8.1	S gets 0, B gets 5.9
HC-HV	**agree** on p_h in t=1	**search** for $y \leq 16.1$	**search** for $y \leq 20.3$
	S gets 1, B gets 14	S gets 0, B gets 20.9	S gets 0, B gets 16.7
HC-LV	**disagree** (quit)	**search** for $y \leq 9.9$	**search** for $y \leq 12.1$
	S gets 0, B gets 0	S gets 0, B gets 8.1	S gets 0, B gets 5.9

Table 1: Theoretical Predictions for all Treatments

In treatments GOO ("Good Outside Option") and BOO ("Bad Outside Option") subjects played the bargaining-search game *(Game 2)* with varying quality of the search option. An offer from search was a random draw from a discrete uniform distribution with support $\{0, 0.1, 0.2, ..., \bar{y} - 0.1, \bar{y}\}$. In GOO we set $\bar{y} = 25$, while in BOO $\bar{y} = 50$, thus BOO had the worse outside option. All parameters of the bargaining process were identical with those of NOO. The reservation prices for the two types of B can be calculated from (5). In GOO, we have $y_{HV}^* = 16.1$ and $y_{LV}^* = 9.9$ and thus, according to Proposition 2, all games should end in the search phase since the reservation prices are below p_l; Table 1 lists the predictions for all possible matches in this treatment. Note that the payoffs from search are in expected terms. For BOO, reservation prices are $y_{HV}^* = 20.3$ and $y_{LV}^* = 12.1$. Since $p_l < y_{HV}^* < p_h$, Proposition 2 predicts that a low-cost S reveals his type in $t = 1$. A

[3] In the Chatterjee-Samuelson (1987) model, offers come from the set {LV, HC }, i.e., the low-value B (high-cost S) gets zero from accepting the low (high) price, and he also gets zero from quitting. In order to avoid the situation of indifference between these two payoffs, we deviate from the original model and let the offers be $\{LV - \epsilon, HC + \epsilon\}$, where we set $\epsilon = 1$. This does not affect the theoretical solution of the original model.

high-value B accepts if offered p_l and searches if offered p_h. A low-value B always searches since $y^*_{LV} < p_l$. The last column in Table 1 lists the predictions for all possible pairs in this treatment.

3.2 Experimental Procedure

The experiment was conducted at the University of California, Santa Barbara (USA) in 2002 and at Simon Fraser University (Canada) in 2003 using the software *z-tree* (Fischbacher 2007).

Subjects. A total of 144 participants were recruited amongst undergraduate students of any major. Each subject participated in one treatment only.

Treatments. Each of the three treatments was tested in 4 sessions and 48 subjects per treatment. A session consisted of 20 games of the respective treatment with an unrestricted number of periods.[4] While their role as a buyer or seller was fixed throughout the session, subjects played different types of their role, i.e. at the start of each game a random draw decided whether a subject was a flexible or inflexible type in the current game.[5]

Instructions and Matching. Play was anonymous via computers, and subjects were informed that their bargaining partners would change in each game, but there was some chance that they might face the same partner more than once.[6] Subjects were given written instructions for both roles as buyer and seller, and they played two trial games in order to become familiar with the basic rules of the game and the computer interface.[7] At each stage of the game the computer screen displayed the period, the subject's own cost or valuation, his available choices (including the current offer from bargaining or search) and the (discounted) profit in case of acceptance of the current offer. In `GOO` and `BOO` sellers were informed when their partner was searching. At the end of each game, subjects were informed about their profits in that game.

Payoffs. Each subject received a show-up fee of \$7. Additionally, two games were drawn at random at the end of each session and subjects were paid off the profits they made in these two games at a rate of 1:1. The average payoff was \$22, each session lasted for at most 2 hours.

[4] There were two exceptions: one session had 12 games and one had only 10 games.

[5] By experiencing the change in their own type, the given prior probabilities of 0.5 for each type should be more credible.

[6] Each matching group consisted of 3 buyers and 3 sellers, thus a subject played the same partner more than once, but never in two subsequent games. Additionally, since each player's type was randomly drawn for each new game, chances were high that at least one player's type was different from the last time they played each other.

[7] The complete set of instructions can be found in the appendix.

4 Experimental Results

4.1 Bargaining with No Outside Option

We shall start by looking at outcomes. Later on, we will investigate how they emerged by investigating subjects' strategies more closely. In the following, we use the pooled data from the two experimental locations; we did not find significant differences in first-period decisions between the two locations for all types of agents.

Agreements: Figure 2 shows the distribution of agreements and conflicts for `NOO`. All pairs in which two flexible types were matched (LC-HV), and thus a total surplus of 34 was available, reached an agreement. When a flexible and an inflexible type were matched, we find agreements in 88% for LC-LV and in 87% for HC-HV pairs. The maximal total surplus available for these pairs is 15, assigning a profit of 1 to the inflexible agent. Theory predicts an agreement for all three types of pairs, however, in the experimental data the proportion of agreements in these pairs are significantly different (χ^2, $p < 0.005$). If only LC-LV and HC-HV pairs are compared, i.e. pairs in which the size of the total surplus is identical, the proportion of agreements are not significantly different. We thus conclude that, in contrast to the theoretical prediction, agreements are not independent of the size of the bargaining surplus. Finally, we find 2% agreements in all pairs in which two inflexible types were matched (HC-LV), i.e. where mutually beneficial trade was not possible. This is not significantly different from the predicted rate of zero.

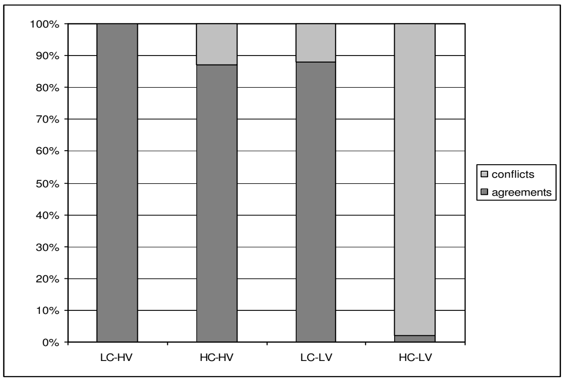

Figure 2: Agreements and Conflicts in Treatment `NOO`

Surplus allocation: When two flexible agents are matched (LC-HV), standard theory predicts S to receive the high surplus $s = 20$ in period 1, B thus gets the low surplus $s = 14$. Figure 3 displays the observed surplus allocations for all pairs. In LC-HV pairs we find that B, i.e. the "wrong" player, gets the high surplus in 59%. This certainly does not support the theoretical prediction of the surplus allocation. The Wilcoxon matched-pairs signed-ranks test cannot reject the null hypothesis that B and S make the same profits in LC-HV pairs (mean profits are 16.07 for S and 17.08 for B). The two-sided sign test rejects the null of equality of medians at a 10% level.

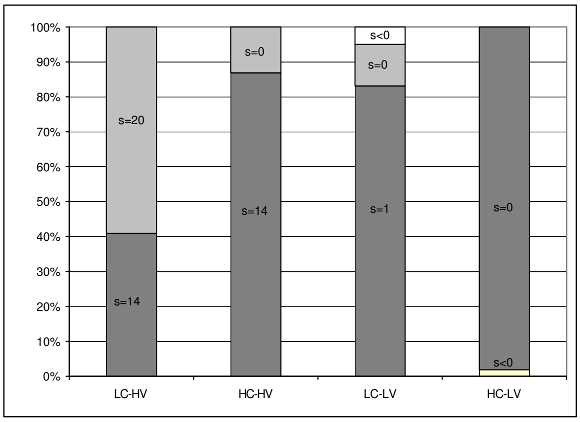

Figure 3: Buyers' Surplus in Treatment `NOO`

For pairs in which a flexible and an inflexible agent are matched (HC-HV and LC-LV), the predicted outcome assigns $s = 14$ to the flexible and $s = 1$ to the inflexible agent. It is the only possible agreement in which no agent makes losses. The distribution of allocations here matches the theoretical prediction in over 80% in both types of pairs. However, even though all agents can make some positive profit through an agreement, we find breakdowns ($s = 0$) in about 12% in both types of pairs. 5% of buyers in LC-LV pairs make losses ($s < 0$), while no losses are observed in HC-HV.

Bargaining length: For flexible agents a trade-off exists between reaching an early agreement and hiding information. Figure 4 considers only agreements whose surplus allocation is consistent with the theoretical prediction and shows how many of these occurred in the "right" period. For 88% of LC-HV pairs in which the flexible S received the high surplus, the game ended in period 1 as predicted. This looks convincing regarding the accuracy of theory prediction, however, as already seen, the predicted *allocation* was only observed in 40% of LC-HV pairs. For LC-LV pairs, Figure 4 shows that only about 50% achieve an agreement in $t = 2$ as predicted, while about 40% find an agreement already in $t = 1$. The latter implies that sellers offered the low price immediately. For HC-HV pairs, 80% of the agreements that correspond to the predicted outcome occur in period 1 as predicted. This implies that these buyers immediately accepted the high price.

Table 2 displays the proportion of all agreements that were achieved within the first two periods, independently of whether or not they match the theoretical prediction. 83% of all agreements between two flexible agents occurred in period 1,

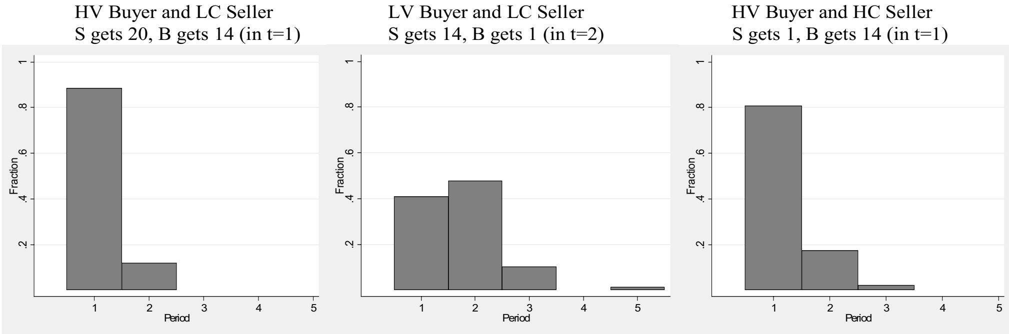

Figure 4: Predicted Allocations and Time in Treatment NOO

and by period 2 all pairs have reached agreements. For HC-HV pairs, we find 81% of all agreements occurred in period 1, while in LC-LV pairs, the rate of immediate agreements is only half as high. The theoretical prediction, however, would have implied that there are no agreements in $t = 1$ in LC-LV pairs. Overall, the timing pattern shows that most agreements were reached by period 2, independent of the surplus allocation. As for LV-HC pairs, no agreement is expected. The prediction regarding the timing of a disagreement is not very strong, as agents should just choose between a payoff of zero now or zero later. The experimental results are shown in Figure 5. There is a considerable number of subjects still bargaining after period 3, thus giving the bargaining partner a repeated chance to come to an agreement. The Mann-Whitney test corroborates the hypothesis that HC-LV pairs bargain significantly longer than all other pairs ($p < 0.001$).

Table 2: Time of Agreements in Treatment NOO

Pair	# agreements	in $t = 1$	in $t \leq 2$
LC-HV	104	91 (0.83)	104 (1.00)
HC-HV	104	84 (0.81)	102 (0.98)
LC-LV	93	36 (0.39)	83 (0.89)

Overall, these observations regarding surplus allocation and timing indicate three things: First, subjects seem to have well understood that delay is costly when gains from trade exist. Second, a significant proportion of low-cost sellers did not conceal their type in an attempt to get the high surplus as predicted. Third, a high proportion of high-value buyers did reveal their type immediately, as predicted. It thus seems that the reason why sellers fail to get the high surplus in LC-HV pairs is mainly due to their own behavior (possibly including wrong expectations about buyers' behavior). This shall be further investigated by checking subjects' behavior.

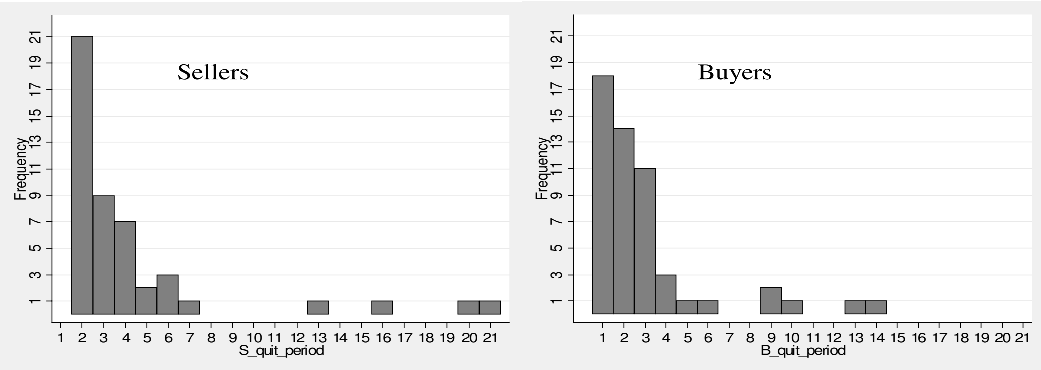

Figure 5: Quitting when Trade is Not Beneficial

Behavior and Learning: Table 3 shows that only 54% of all low-cost sellers ask the high price in period 1. Why do not more sellers attempt to get the high surplus? Many experiments, e.g. with ultimatum and dictator games, have shown that bargainers are concerned not only with their own monetary payoff when they evaluate bargaining outcomes, but they may be willing to give up some of their profit in order to attain a more symmetric outcome, or to punish the partner for being greedy. More recent models of preferences consider these experimental results that are not in line with standard theory predictions.[8] As Roth (1995) points out, it is not the case that bargainers are primarily trying to *be* fair, but notions of fairness respond to strategic considerations. But strategic considerations in the experiment are based on subjects' understanding and their goal in the given situation. The claim that sellers had a strategic advantage relies not only on the assumption that agents are risk-neutral and maximize their own monetary payoffs, but it also requires correct expectations about the other player's behavior and the capability of calculating expected payoffs (or at least having a sufficiently good estimate thereof). Having found a significant number of observations that are not consistent with predicted behavior in this situation, it shall be checked which possible alternative assumptions on behavior are consistent with the data.

The design of this experiment does not allow for symmetric outcomes that are also efficient when gains from trade exist. Bargainers in LC-HV pairs who want to realize gains from trade only have the choice between claiming the high surplus for themselves or leaving it to the bargaining partner. The only way to avoid an asymmetric outcome is to quit, which is very costly for both players in LC-HV. We do not observe any disagreement in LC-HV pairs and conclude therefrom that subjects do not choose to avoid asymmetric payoffs when the forgone profits are relatively high. On the other hand, for pairs in which a flexible and an inflexible

[8]See e.g. the contributions of Bolton and Ockenfels (2000), Charness and Rabin (2000), and Fehr and Schmidt (1999).

Table 3: Initial Offers in Treatment NOO

Type		**high price**	**low price**
LC Sellers	offer	0.54	0.46
HC Sellers	offer	0.99	0.01
HV Buyers	accept	0.71	1.0
	reject	0.29	0
	quit	0	0
LV Buyers	accept	0	0.72
	reject	0.89	0.22
	quit	0.11	0.06

agent are matched and thus highly asymmetric gains from trade exist, the inefficient outcome of a disagreement was chosen in 12%. The inflexible agent, whose foregone profit is at most 1, initiates the disagreement in almost all cases, and mostly without giving the opponent the chance to revise their initial offer: in LC-LV, buyers quit in period 1, and in HC-HV, sellers quit in period 2. Even though the latter is consistent with a high-cost seller's equilibrium strategy, the former is not and thus suggests that there are other reasons for this behavior. In both cases, the inflexible agent has nothing to lose, but possibly a small profit to win, if he continues the game. The disagreements thus may have been chosen in order to avoid strongly asymmetric outcomes at a small cost, or just because the potential profit is so small that it does not seem worthwhile to continue the game even if an agreement is possible, or even for the reason that the opponent, if flexible, should be punished for his greed. In any case, a disagreement here is initiated when the foregone profit of the opponent was relatively high.

It is possible that subjects in the role of a seller only learn with experience that they have a strategic advantage. In this case, behavior may converge over time towards the theory prediction. Consider the first 5 games and last 5 games as representing decisions of inexperienced and experienced subjects. Here we find that inexperienced low-cost sellers offer the high price in 65% while experienced offer it in 35%. This difference is significant, (χ^2, $p < 0.05$), but the direction of change is opposite of what would be expected if subjects' behavior converged to the theory prediction. This raises the question whether the change in sellers' behavior is an adjustment in response to an initially unexpected buyers' behavior. We thus need to consider how buyers responded to high price offers in early games. If a sufficient number of buyers is expected to reject the high price, it becomes optimal for low-cost sellers to ask the low price immediately.

We are not able to identify an adjustment of sellers' expectations on an individual level, but we may check whether subjects' *aggregate behavior* is consistent with such an explanation. In early games, the rejection rate for high prices offered by flexible sellers is 0.66. According to condition (2), a flexible seller is better off revealing his type if his belief that the buyer rejects the high price is at least $1 - \bar{\pi}_B = 0.68$.[9] Thus, the proportion of high-price offers that were rejected is very close to the critical value that would make a low price the optimal strategy for a flexible seller. Note that we do not claim that individual sellers had sufficient information to revise and recalculate their beliefs correctly. But on an aggregate level, sellers' behavior in later games is consistent with expectations that include their experience from earlier games, thus explaining the decrease of strategic offers over time. To understand how *individual behavior* changes over time, we compare subsequent offers of a subject in the role of the flexible seller. We find that the proportion of flexible sellers who stick to the high price decreases from 72% in the first 5 games to 42% in the last 5 games, while the proportion of sellers who repeat the low price offer increases from 28% in the first 5 games to 58% in the last 5 games (χ^2, $p < 0.1$). Furthermore, the hypothesis that a change in a flexible seller's initial offer is independent of the surplus he received last time he was in the same position and offered the high price is rejected (χ^2, $p < 0.1$): while 25% of sellers switch to the low-price offer after having received the surplus of 14 last time they asked the high price, only 11% switch to the low price offer after having received 20. Many sellers seem to get discouraged quickly when they fail to get the high surplus and switch to the conservative strategy.

Other assumptions on behavior that are consistent with flexible sellers' revealed preference for a sure profit of 14 over the chance of getting 20, which includes the risk of a rejection, are risk-aversion and satisficing. Subjects' understanding of the no-delay rule would induce a sufficiently risk-averse low-cost S to reveal his type immediately. On the other hand, subjects could simply be satisfied with a profit of 14 and not even attempt to get more, independent of discount factor and probability of facing a low-value B. But as will be shown in the next section, buyers do not seem to follow such a simple satisficing rule as they strongly respond to changes in the outside option. Risk aversion in bargaining behavior, on the other hand, would be consistent with observations in all treatments.

4.2 Bargaining with Search as Outside Option

In treatments `GOO` and `BOO`, an outside option consisting of search was introduced for buyers. Recall that all games in `GOO` should end in the search phase (see Table 1). In `BOO`, theory predicts a bargaining agreement on p_l for HV-LC, while for all other pairs the game should end in the search phase.

[9] This is not an equilibrium belief, but may serve as a plausible behavioral rule.

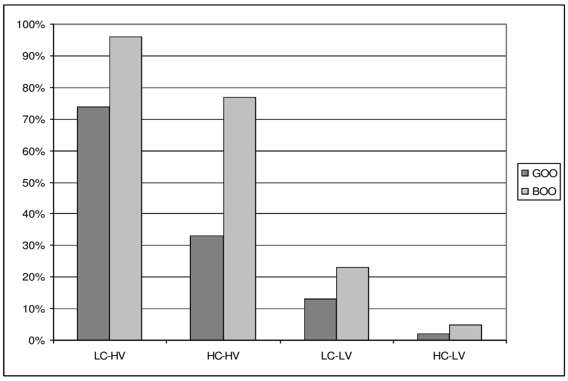

Figure 6: Bargaining vs. Search: Games Ending in Bargaining Phase

Agreements: Figure 6 displays the proportion of games that ended in the bargaining phase for the various pairs in both treatments.[10] The only observations that correspond to the predictions are the high proportion (96%) of agreements between two flexible agents (LC-HV) in BOO and almost no agreements between two inflexible agents in both treatments (2% and 5%, resp.). For all other pairs, we find bargaining agreements where search was predicted. But despite the fact that search rates were overall lower than predicted, Figure 6 shows that monetary incentives of the outside option do matter: The better the outside option compared to the expected bargaining outcome, the higher the proportion of games that end in the search phase. Consider the outcomes in GOO: Buyers have the lowest incentive to search in games between LC-HV, as they can make a profit of 20 from bargaining and 20.9 (in expectation) from search. Here only 26% of the games ended in the search phase. Search becomes more attractive for buyers in HC-HV pairs, as they can get only 14 from bargaining, and we observe 67% of these games ending in the search phase. LV buyers paired with LC sellers can get at most 1 from bargaining but can expect 8.1 from search, and we find 87% who take the outside offer in this case, whereas in HC-LV pairs, no gains are to be expected from bargaining and we have 98% of the buyers searching. The results are similar for BOO, but the proportion of bargaining agreements here is significantly higher than in GOO for each type of pairs (χ^2, $p < .001$).

Bargaining behavior: As in NOO, we want to see which alternative explanations are consistent with subjects' behavior when it diverges from pure payoff-maximization. A simple satisficing rule does not seem plausible, since the differences across all pairs between the two search treatments indicate that, in general, buyers strongly consider the opportunity cost of a given outcome. Figure 7 shows in more detail the allocation of the bargaining surplus for both search treatments

[10]These numbers include games that ended in a disagreement initiated by a seller, since we want to separate bargaining from search. Figure 7 contains more information about the disagreements.

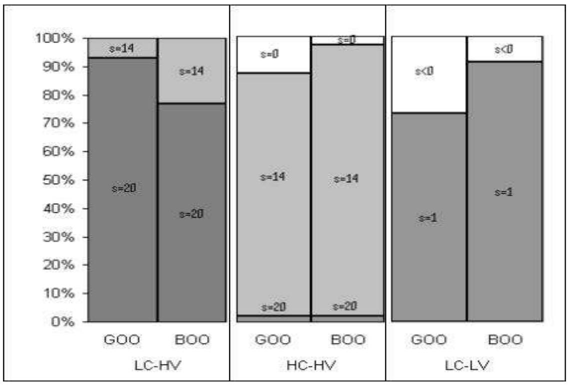

Figure 7: Buyers' Surplus from Bargaining in Treatments `GOO` and `BOO`

from B's perspective, given that the game ended in the bargaining phase. In `GOO`, 93% of those HV buyers who reached an agreement with LC sellers received the high surplus, thus rejecting a search option that offers only slightly more. In `BOO`, 23% of the HV buyers that did not opt out even accept the low surplus from LC sellers. In HC-HV pairs, where S can only offer p_h or quit without making losses, we find that p_h was accepted by over 85% of HV buyers who did not opt out in `GOO` and 95% in `BOO`. This corresponds to 30% of *all* HV buyers in `GOO` who accept p_h when offered, thus preferring the certain surplus of 14 over the expected 20.9, while in `BOO` 73% prefer the sure 14 over the expected 16.7 from search.

A preference for more equitable outcomes is certainly a possible explanation for this behavior. However, note that this may be prevalent only in a rather small fraction of subjects: First, we find that 45% of all HV buyers in `GOO` choose to search, thus revealing little concern for the bargaining partner who is left with a zero payoff in this case. Of the 55% who remain at the bargaining table, we cannot distinguish whether they do it out of a concern for the partner's payoff or because of risk aversion. When the outside option is much worse in `BOO`, the proportion of buyers who opt out drops to 13%, but this comparison between the two treatments shows that observed behavior strongly considers the opportunity cost in the decision problem, and thus equitable outcomes do not seem to be the decisive factor in decision making here. On the other hand, risk aversion is a plausible explanation when bargaining is preferred over search as well as when the bargaining surplus is lower than expected. Recall that also in the pure bargaining treatment `NOO`, we observed that the bargaining surplus for the first mover with the strategic advantage was lower than expected, when the bargaining partner was not at risk to receive zero. Therefore, we think that risk aversion is a plausible explanation for bargaining behavior in all three treatments. Of course, the possibility of calculation errors in all treatments should be seriously considered, but it is noteworthy that in this case, subjects in a bargaining situation would systematically underestimate the risky option.

As for LV buyers' behavior, we observe disagreements in 87% of LC-LV pairs in GOO and 77% in BOO, i.e. the vast majority of LV buyers prefer to opt out even though this implies that their bargaining partner receives zero. This is particularly notable when S offers p_l and thus reveals his type. Then B knows that an agreement with S is possible, and with his decision to opt out S foregoes a profit of 14. In GOO, of the 116 LC-LV pairs we find 81 low-cost sellers who offer p_l immediately and 71 buyers responded with the decision to search. One may argue that these buyers dislike the asymmetric outcome that yields a much higher profit for the bargaining partner and thus they started search. But a comparison with the pure bargaining treatment GOO, in which LC-LV pairs mostly reached agreements, shows that LV buyers' behavior is primarily driven by the concern for their own payoff: when there is a better alternative, they take it without regard for the bargaining partner's cost.

Most games that end in a bargaining agreement are very time efficient. Over 90% of the agreements are achieved in the first period of bargaining. These results do not depend on experience, as we see about one half of the agreements occur in games 10-20. The obvious question now is whether buyers who went for the risky option of search did better on average, as predicted in the theoretical model. This implies, of course, that their search behavior was efficient, which shall be investigated in the next subsection.

Table 4: Outside Offers Accepted by HV and LV Buyers*

Type	**Accepted Outside Offers**					
	# Obs.	Pred.Mean	Obs.Mean	Std.Dev.	Min	Max
HV Buyers	108	8.1	8.9	5.7	.1	23.1
	27	10.2	10.6	6.3	.8	22.4
LV Buyer	222	5.0	6.6	4.3	.2	17.8
	173	6.1	8.7	6.7	.1	47.8

* observations for GOO are reported in upper left, for BOO in lower right of each cell

Search Outcomes: Table 4 shows the accepted outside options for each type of buyer in both treatments, as well as the predicted means. The latter are derived from the optimal reservation prices, i.e. if the optimal stopping rule prescribes for HV buyers to accept a price of 16.1 or less in GOO, then one would predict the mean of all accepted outside offers to be 8.1, since all search offers are equally likely. In fact, we observe a mean of 8.9 in GOO. In BOO it is 10.6 when 10.2 was predicted. For LV buyers, the mean accepted outside offers are less close to the predictions: 6.6 in GOO when the prediction was 5.0, and 8.7 in BOO when the prediction was

Table 5: Buyers' Profits by Types*

Game End	Pair	Profits			
		# Obs.	Pred.Mean	Obs.Mean	Std.Dev.
Bargaining	HV-LC	87	20	19.4	1.7
		99	20	18.2	2.6
	HV-HC	46	14	12.1	4.9
		90	14	13.2	3.2
	LV-LC	15	1	-.3	2.2
		21	1	.4	1.5
	LV-HC	2	-	-1.1	3.0
		9	-	-.7	1.3
Search	all HV	108	20.9	20.0	5.3
		27	16.7	14.1	7.8
	all LV	222	8.1	7.5	5.3
		173	5.9	5.0	4.2

* observations for GOO are reported in upper left, for BOO in lower right of each cell

6.1. Significant differences between the mean accepted outside offers are thus found between HV and LV buyers (MWU test for GOO: $p < .001$, BOO: $p < .08$), while a test of difference between treatments is only significant for LV buyers (MWU: $p < .002$).[11]

All mean accepted outside options are far below p_l, which seems to suggest that profits from search are higher than profits from bargaining. However, the discount factor of .8 causes a sharp decrease in actual profits when they are earned in a later period, thus realized profits shall be considered in Table 5. In GOO, all HV buyers could be pooled from a theoretical point of view, since they are all predicted to search; their mean profit from bargaining of 17.3 is lower than the mean profit from search of 20.0 (two-sample Wilcoxon rank-sum test, $p < .001$). However, if we consider them separately in LC-HV pairs and HC-HV pairs, the former do not attain a significantly higher profit from search compared to bargaining (20.0 vs. 19.5), while the latter do (20.0 vs. 12.1, $p < .000$, MWU). Not surprisingly, also LV buyers' profits from bargaining are significantly lower than those from search, as they can make at most a profit of 1 from bargaining, and given individual rationality, search thus must yield higher profits.

In BOO, theory predicts that HV buyers' behavior depends on who they are paired with: They should have reached an agreement with LC sellers, and we observe most HV buyers did just this, however, not always on the predicted p_l. As Table 5 shows, the average profit from bargaining is only 18.2, when 20 is expected.

[11] Note that for BOO we have few HV buyers who search; this might be the reason why the difference in mean accepted outside offers is visible but not significant.

On the other hand, they should have opted out when paired with HC sellers, as the expected profit from search is higher than from bargaining. We find less than one quarter of these buyers searching. On average, they were no worse off accepting p_l from bargaining than trying their luck with search. The average profit of 14.1 from search is not significantly higher than the profit of 13.2 from bargaining, and quite below the expected profit from search of 16.1. These numbers point towards a suboptimal search strategy in `BOO`, however one also has to consider that the number of observations in this class is small. Buyers' search behavior shall be investigated in the next subsection.

Search Behavior: Buyers' search behavior was more successful than accepting a random outside offer: Significant differences are found when comparing the mean profits from the accepted outside options to the mean profit from all drawn outside options (Wilcoxon, $p < .001$ for both buyer types and both treatments). This is also true when we compare the actual profits to the profit they would have made if they had accepted the first outside offer they received. The search profits for all buyers in `GOO` as well all those for LV buyers in `BOO` are actually rather close to the expected profits from search. Thus, search behavior *per se* was, if not optimal, then at least quite successful in terms of payoff efficiency. This result does not vary significantly over experience levels of players and is consistent with previous search experiments.

As for the length of search, Figure 8 shows the periods in which buyers search for both treatments. While in `GOO` only about 10% of the HV buyers searched for more than 2 periods, 25% of the LV buyers do so. The median search length for HV buyers is less than for LV buyers (Kruskal-Wallis, $p < .01$). This result is in line with the lower optimal reservation price for LV buyers, assuming that both types display a similar risk attitude. In `BOO`, about 50% of both HV and LV buyers search for more than two periods, and period 8 is reached when about 90% of both HV and LV buyers have ended search. As already noted, more HV buyers in `BOO` than LV buyers rejected offers below the optimal reservation price, and the median search length for the two buyer types is not significantly different in this treatment.

To check search behavior, we compare each search decision to the optimal stopping rule. Overall, a proportion of 85% of HV buyers in `GOO` display a behavior during search that is consistent with the exact optimal stopping rule. Table 6 describes the two possible directions of violation of this rule. The behavior of HV and LV buyers with respect to violation of the reservation price policy is not significantly different in `GOO`, we observe more violations of the optimal stopping rule when the outside offer is above the reservation price then when the offer is below. This is consistent with the "too little search" results found in previous experiments. 26% of HV buyers accept an outside option when they should have rejected, and 9% reject when they should have accepted. The former case of viola-

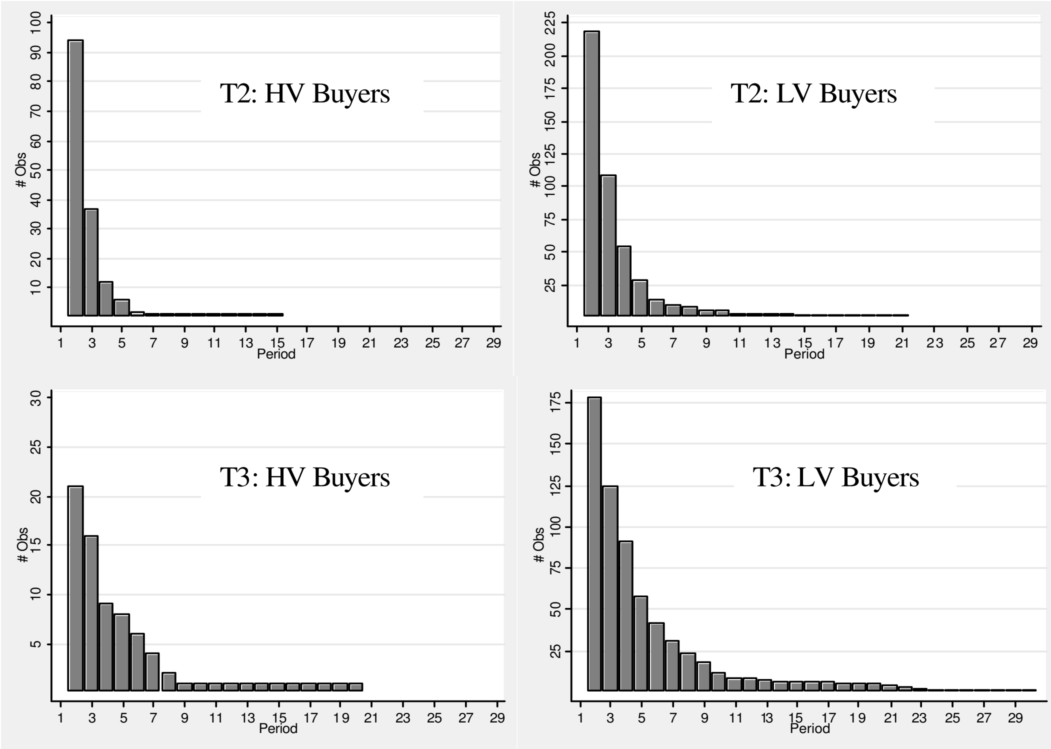

Figure 8: How long do Buyers Search?

tions of the optimal stopping rule includes risk-aversion as possible explanation for the observed behavior and is stronger than the latter which includes risk-seeking behavior (Pearson χ^2, $p = .006$, Fisher exact test: $p = .007$). As for LV buyers in GOO, we find that about 15% reject the outside option when they should have accepted, while 20% accept when they should have rejected. This result is only weakly significant (Pearson χ^2, $p = .1$, Fisher exact $p = .11$). The pattern of searching too little rather than too much can also be found if we consider decisions in early games (games 1-5) and late games (games 16-20).

In BOO, 83% of HV buyers who search are in line with the exact optimal stopping rule. As for the two directions of violation, we find a different picture here: They search too much. Only 3% of HV buyers accept an outside offer when they should have rejected, wile 38% reject an offer when they should have accepted. This difference is highly significant (Pearson χ^2, $p = .001$) and is consistent with a risk-seeking attitude. For LV buyers, 15% reject when the outside offer is below the reservation price and 9% accept when it is above the reservation price. Also this difference is significant (Pearson χ^2, $p = .003$). Moreover, HV buyers' rejection rate of a low outside offer is significantly higher than LV buyers (χ^2, $p = .001$) and is thus responsible for the low average search profit of HV buyers in BOO. A closer

Table 6: Violations of Optimal Stopping Rule*

Type	$p > p^*$		$p \leq p^*$	
	# Obs.	accepted	# Obs.	rejected
HV Buyers	53	0.26	104	0.09
	59	0.03	39	0.39
LV Buyer	284	0.20	192	0.15
	494	0.09	150	0.15

* obs for GOO are reported in upper left, for BOO in lower right of each cell

look at buyers' search decisions over time reveals that no HV buyer rejected an offer below the reservation price in games 1-5 and games 15-20, but almost all violations are found in games 10-15. The high proportion of violations below the reserve price therefore does not persist. For LV buyers, we find significantly less rejections of offers below y^* in later games: 38% in games 1-5 and 3% in games 15-20 (χ^2, $p < .001$). We thus believe that searching too much is not a persistent pattern in this experiment. These results also support for Sonnemans' (1998) hypothesis that subjects who follow stopping rules that imply too little search perform rather well, while those using stopping rules that imply too much search obtain poor results. The latter are thus more likely to be revised downwards, so on average subjects search too little.

Overall, the results confirm what we already found in the analysis of the search outcomes: Buyers search quite efficiently. The high number of observations and the observed efficiency for search behavior suggests that despite the relatively complex situation with uncertainty, subjects are able to make very good decisions.

Return to Bargaining: Recall that for both treatments, theory predicts that buyers will never return to bargaining after they left S, i.e. in equilibrium, a bargaining-search game with the option to return and a game without such option are identical. We find that for inexperienced players (games 1-5), in less than 5% of the games a buyer returns to S to continue bargaining in GOO. In BOO, return to bargaining is observed in 22% of games 1-5. Some subjects return more than once to their bargaining partner. When players are more experienced (games 16-20), this inefficient behavior disappears completely and is in line with the theoretical prediction.

5 Conclusion

This paper reports on an experimental study of two games: a bargaining game with no outside option and one with search as an outside option. For the pure bargaining game we implement the Chatterjee and Samuelson (1987) model with two-sided incomplete information, in which the low-cost seller can pretend he has high cost and can thus try to get the highest possible surplus. We find some evidence for concealing offers in the experiment, however, more than one half of the subjects in this position prefer to reveal their type, thus renouncing to the high surplus. Even though most high-value buyers accept the high price immediately as predicted, low-cost sellers seem to get discouraged quickly from unsuccessful trials of asking the high price, and even less strategic behavior is observed with experience.

In the bargaining and search game, in which an outside option for the buyers is introduced to the original bargaining game, we varied the quality of the outside option. In the treatment with a good outside option, we found that many high-value buyers prefer a sure profit to search with a higher expected value. When the outside option is bad, acceptance for the low surplus from bargaining further increases. Overall, we find for both treatments and for all combinations of types that many more bargaining agreements are reached when search is predicted to be optimal. We believe that risk aversion is more important than social preferences to explain this divergence of prediction and observations, as it would also be consistent with behavior observed in the pure bargaining game. Search behavior is very efficient and on average never leads to worse outcomes than bargaining. Over 80% of the buyers' behavior is consistent with the exact optimal stopping rule for search. While we do not assume that subjects consciously follow this rule, the observation suggests that they have a good intuition when dealing with uncertainty in simple random draws, and they fully understand the no-delay rule.

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7 Appendix

7.1 Instructions for Treatment NOO

General Information

In this experiment you will face a decision problem involving two people. The decision problem will subsequently be denoted as "game", and the people participating in it will be denoted as "players". One of the two players in a game is always a "Seller" and the other one a "Buyer". You will bargain over a price for an object. The bargaining proceeds via computer. No verbal communication is possible.

Participants in this experiment are divided into two groups, the group of Sellers and the group of Buyers. Whether you are a Seller or a Buyer will be determined in the beginning of the first game, and you will keep this role for the entire experiment.

You will play 20 games in this experiment. In each game, you will be randomly matched with another participant in this room. He/she will remain anonymous and will change from one game to another. It is possible that you encounter the same partner again. Your partner will only be informed about your decision, but not about your name or your participation number, i.e., **your decision will be completely anonymous**. Each player will be informed about his/her own payoff in each game, but not about the partner's payoff.

After a game is finished, you will be randomly matched with another person to play a new game. **At the end of the experiment, two games will be drawn at random, and each participant will receive his/her payoffs from these two games in real money.**

The Game

In each of the 20 games, you will bargain over the price of a (fictitious) object, which you can buy if you are a Buyer, or sell if you are a Seller. Each game consists of several rounds. You will keep the same partner for all rounds of a game. Once a new game starts, you will be matched with a different partner. **All participants receive the same information about the game.**

The Sellers
Each Seller has a certain cost of selling the object. At the beginning of a game, each Seller will be informed about his/her cost, which is determined by a random draw of the computer:

- There is a 50 % chance that a Seller has a **low cost of $3**.
- There is a 50 % chance that a Seller has a **high cost of $22**.

Only these two cost levels are possible. A Seller's cost remains the same in all rounds of a game. Once a new game starts, there is a new random draw with a 50-50 chance for each Seller of having a high or low cost.

The Seller's profit
If a Seller and a Buyer come to an agreement over the price, the Seller's profit is calculated in the following way:

Seller's profit = accepted price offer ─ Seller's cost

Thus, if the Seller and the Buyer agree on a price that is above the Seller's cost, the Seller will make a profit. If the price is below the Seller's cost, he will make a loss. If they don't agree on a price, both Seller and Buyer get a profit of zero.

The Buyers
Each Buyer has a certain valuation for the object. At the beginning of a game, each Buyer will be informed about his/her valuation, which is determined by a random draw of the computer:

- There is a 50 % chance that a Buyer has a **high valuation of $37**.
- There is a 50 % chance that a Buyer has a **low valuation of $18**.

Only these two valuations are possible. A Buyer's valuation remains the same in all rounds of a game. Once a new game starts, there is a new random draw with a 50-50 chance for each Buyer of having a high or low valuation.

The Buyer's valuation and the Seller's cost are randomly determined and independent from each other.

The Buyer's profit
If a Seller and a Buyer come to an agreement over the price, the Buyer's profit is calculated in the following way:

Buyer's profit = Buyer's valuation − accepted price offer

Thus, if they agree on a price that is below the Buyer's valuation, the Buyer will make a profit. If the price is above the Buyer's valuation, he will make a loss. If they don't agree on a price, both Seller and Buyer get a profit of zero.

The Bargaining

Round 1

In Round 1, the Seller will start by making an offer to the Buyer. **This offer can be either $17 or $23. No other offers are possible**. The Buyer will be informed about the Seller's decision and will then be asked to choose between one of the following three options:

The Buyer's options:
- He can accept the Seller's offer (**"accept"**). In this case, the game is over and the profits of each player are calculated according to the profit rules described above.
- He can reject the Seller's offer and quit the game (**"reject and quit"**). In this case, the game is over and both players receive a payoff of zero.
- He can reject the Seller's offer and make a counteroffer (**"reject and make counteroffer"**). If the Seller offered $17 ($23, respectively.) and the Buyer rejects this offer and makes a counteroffer, this counteroffer will automatically be $23 ($17, resp.). The game proceeds to the next round.

After the Buyer made his decision in Round 1, the game either ends (if he decided to "accept" or if he decided to "reject and quit"), or the game proceeds to Round 2 (if he decided to "reject and make counteroffer").

Round 2

If the game continues in Round 2, the Seller will be asked to respond to the Buyer's offer from the previous round. He has the following three options:

The Seller's options:
- He can accept the Buyer's offer (**"accept"**). In this case, the game is over and the profits of each player are calculated according to the profit rules described above.

- He can reject the Buyer’s offer and quit the game (**"reject and quit"**). In this case, the game is over and both players receive a payoff of zero.
- He can reject the Buyer’s offer and make a counteroffer (**"reject and make counteroffer"**). If the Buyer offered \$17 (\$23, resp.) in Round 1, and the Seller rejects this offer and makes a counteroffer, this counteroffer will automatically be \$23 (\$17, resp.).

After the Seller has made his decision in Round 2, the game either ends (if he decided to "accept" or if he decided to "reject and quit"), or the Buyer will be asked to respond to his offer (if the Seller decided to "reject and make counteroffer") . Again, like in Round 1, the Buyer can choose between one of the three options:

- accept
- reject and quit
- reject and make counteroffer

as described in "The Buyer’s options" above. If the Buyer decides to reject and make a counteroffer, the game will proceed to Round 3. The rules in Round 3 are identical with those of Round 2, i.e. Round 3 starts again with the Seller's decision as described in "The Seller's options".

In each round, each player can choose whether to terminate or to continue the game. **The game continues until either an agreement is reached (one player accepts the other player's offer) or one player quits the game**. There is no limit on the number of rounds you and your partner can play.

The Payoffs

The payoff of a game depends on the round in which the agreement has been reached. If an agreement is reached in Round 1, the payoffs will be the full profits the players made, i.e.

Buyer’s payoff = Buyer’s valuation ─ accepted price offer
Seller’s payoff = accepted price offer ─ Seller’s cost

If an agreement is reached in a later round, the profits of both Buyer and Seller are multiplied by a factor of .8 with each round after Round 1. That is, if an agreement is reached in Round 2, each dollar profit is paid off only 80 cents. If an agreement is reached in Round 3, each dollar profit is paid off (.8)(.8) = .64 cents. In Round 4, a dollar profit is worth (.8)(.8)(.8) = .51 cents. And so on for further rounds.

Example: Suppose you reached an agreement in Round 4, where you made a profit of \$10. Your payoff would then be (.8)(.8)(.8) (\$10) = (.51)(\$10) = \$5.10. You would be paid off \$5.10 in real money for this game if it is one of the two games selected at the end of the experiment. If you made a loss in one of these two games, we will subtract at most \$2 from the \$7 that you earned for showing up. All other losses are forgiven. Remember that you can always choose to quit and avoid losses.

Remember:

Each player will know only his/her own cost/valuation, but not their partner's. For each player, there is a 50 percent chance of having a high or low cost/valuation. Whether your own cost/valuation is high or low is completely independent of your partner's cost/valuation.

7.2 Instructions for Treatment BOO[12]

General Information

In this experiment you will face a decision problem involving two people. The decision problem will subsequently be denoted as "game", and the people participating in it will be denoted as "players". One of the two players in a game is always a "Seller" and the other one a "Buyer". They can *bargain* over a price for an object, but the Buyer can also *search* for another price offer by leaving the Seller. The bargaining and the search proceed via computer. No verbal communication is possible.

Participants in this experiment are divided into two groups, the group of Sellers and the group of Buyers. Whether you are a Seller or a Buyer will be determined in the beginning of the first game, and you will keep this role for the entire experiment.

You will play 20 games in this experiment. In each game, you will be randomly matched with another participant in this room. He/she will remain anonymous and will change from one game to another. It is possible that you encounter the same partner again. Your partner will only be informed about your decision, but not about your name or your participation number, i.e., **your decision will be completely anonymous**. Each player will be informed about his/her own payoff in each game, but not about the partner's payoff.

After a game is finished, you will be randomly matched with another person to play a new game. **At the end of the experiment, two games will be drawn at random, and each participant will receive his/her payoffs from these two games in real money.**

The Game

In each of the 20 games, you can bargain over the price of a (fictitious) object, which you can buy if you are a Buyer, or sell if you are a Seller. The Buyer can also leave the Seller and search for another price. Each game consists of several rounds. You will keep the same partner for all rounds of a game. Once a new game starts, you will be matched with a different partner. **All participants receive the same information about the game.**

A game can either be in the **Bargaining Phase** or in the **Search Phase**. In the Bargaining Phase, the Seller and the Buyer bargain over the price for the object. In the Search Phase, the Buyer searches for other price offers, while the Seller has to wait. The Buyer can return to the Seller and continue bargaining, or accept an offer he found from search.

The Sellers

Each Seller has a certain cost of selling the object. At the beginning of a game, each Seller will be informed about his/her cost, which is determined by a random draw of the computer:

- There is a 50 % chance that a Seller has a **low cost of $3**.
- There is a 50 % chance that a Seller has a **high cost of $22**.

Only these two cost levels are possible. A Seller’s cost remains the same in all rounds of a game. Once a new game starts, there is a new random draw with a 50-50 chance for each Seller of having a high or low cost.

The Seller’s profit

• if the game ends in the Bargaining Phase

If a Seller and a Buyer come to an agreement over the price, the Seller’s profit is calculated in the following way:

[12] Instructions for GOO are identical except for the random draw.

Seller’s profit = accepted price offer ─ Seller’s cost

Thus, if the Seller and the Buyer agree on a price that is above the Seller’s cost, the Seller will make a profit. If the price is below the Seller’s cost, he will make a loss. If they don’t agree on a price, the Seller’s profit is zero.

• if the game ends in the Search Phase
If the Buyer accepts a price he found in the search phase, the **Seller’s profit is zero**.

The Buyers

Each Buyer has a certain valuation for the object. At the beginning of a game, each Buyer will be informed about his/her valuation, which is determined by a random draw of the computer:

- There is a 50 % chance that a Buyer has a **high valuation of $37**.
- There is a 50 % chance that a Buyer has a **low valuation of $18**.

Only these two valuations are possible. A Buyer’s valuation remains the same in all rounds of a game. Once a new game starts, there is a new random draw with a 50-50 chance for each Buyer of having a high or low valuation.

The Buyer’s valuation and the Seller’s cost are randomly determined and independent from each other.

The Buyer’s profit
• if the game ends in the Bargaining Phase
If a Seller and a Buyer come to an agreement over the price, the Buyer’s profit is calculated in the following way:

Buyer’s profit = Buyer’s valuation ─ accepted price offer

Thus, if they agree on a price that is below the Buyer’s valuation, the Buyer will make a profit. If the price is above the Buyer’s valuation, he will make a loss.

• if the game ends in the Search Phase
If the Buyer accepts an offer he found in the search phase, his profit is

Buyer’s profit = Buyer’s valuation ─ accepted offer from search

Bargaining and Searching

Round 1

A game always starts in the Bargaining Phase. In Round 1, the Seller starts by making an offer to the Buyer. **This offer can be either $17 or $23. No other offers are possible**. The Buyer will be informed about the Seller's decision and will then be asked to choose between one of the following three options:

The Buyer’s options in the Bargaining Phase:

- He can accept the Seller's offer (**"accept"**). In this case, the game ends in the Bargaining Phase and the profits of each player are calculated according to the profit rules described above.
- He can reject the Seller's offer and start search (**"reject and start search"**). In this case, the Search Phase starts, which is described below.

- He can reject the Seller's offer and make a counteroffer (**"reject and make counteroffer"**). If the Seller offered $17 ($23, respectively) and the Buyer rejects this offer and makes a counteroffer, this counteroffer will automatically be $23 ($17, resp.). The game proceeds to the next round in the Bargaining Phase.

After the Buyer made his decision in Round 1, the game either ends (if he decided to "accept"), or the game proceeds to Round 2. **In Round 2, the game is either in the Search Phase** (if the Buyer decided to "reject and start search") **or in the Bargaining Phase** (if the Buyer decided to “reject and make counteroffer”).

Continuing in the Bargaining Phase
If the game in the next round continues in the Bargaining Phase, the Seller will be asked to respond to the Buyer’s offer from the previous round. He has the following three options:

The Seller's options:
- He can accept the Buyer’s offer (**"accept"**). In this case, the game ends in the Bargaining Phase and the profits of each player are calculated according to the profit rules described above.
- He can reject the Buyer’s offer and quit the game (**"reject and quit"**). In this case, the Seller receives a payoff of zero. The Buyer continues in the Search Phase and cannot return to the Seller anymore.
- He can reject the Buyer’s offer and make a counteroffer (**"reject and make counteroffer"**). If the Buyer offered $17 ($23, resp.) in Round 1, and the Seller rejects this offer and makes a counteroffer, this counteroffer will automatically be $23 ($17, resp.).

After the Seller has made his decision in this round, the game either ends for the Seller (if he decided to "accept" or if he decided to "reject and quit"), or the Buyer will be asked to respond to his offer (if the Seller decided to "reject and make counteroffer"). Again, as in Round 1, the Buyer can choose between one of the three options:
- accept
- reject and start search
- reject and make counteroffer

as described in "The Buyer’s options in the Bargaining Phase" above. If the Buyer decides to reject and start search, the game will proceed to the next round in the *Search Phase*. If the Buyer decides to reject and make a counteroffer, the game will proceed to the next round and will remain in the *Bargaining Phase*.

Continuing in the Search Phase
If the Buyer decided to "reject and start search" in any round, the Search Phase begins in the next round. **The Seller has to wait as long as the Buyer is searching**. The Buyer will receive a random number between 0 and 50, where all numbers are equally likely to be drawn. This will be the price offer he found from search in this round. Then he can choose between one of the following three options:

The Buyer’s options in the Search Phase:
- He can accept the offer he found from search (**"accept offer from search"**). In this case, the game ends in the Search Phase and the profits are calculated as described above.

- He can reject the offer he found from search and continue search (**"reject and continue search"**). In this case, a new random number between 0 and 50 will be drawn in the next round for the Buyer, while the Seller has to wait.
- He can reject the offer he found from search and return to bargaining with the Seller (**"reject and return to bargaining"**). In this case, the Seller makes a new offer in the next round, which can be either 17 or 23. He can change his previous offer.

After the Buyer has made his decision, the game either ends (if he chose to "accept offer from search") or the game proceeds to the next round. As long as the Seller has not quit the game, the next round will be either in the Search Phase (if the Buyer chose to "reject and continue search") or in the Bargaining Phase (if the Buyer chose to "reject and return to Seller"). If the Seller has quit the game, the Buyer can only search. Then the game ends as soon as the Buyer accepts an offer he found from search.

The Payoffs

The payoff of a game depends on the round in which the agreement has been reached. If an agreement is reached in Round 1, the payoffs will be the full profits the players made.
If an agreement is reached in a later round, the profits of both Buyer and Seller are multiplied by a factor of .8 with each round after Round 1. That is, if an agreement is reached in Round 2, each dollar profit is paid off only 80 cents. If an agreement is reached in Round 3, each dollar profit is paid off (.8)(.8) = .64 cents. In Round 4, a dollar profit is worth (.8)(.8)(.8) = .51 cents. And so on for further rounds.

Example 1: Suppose the game ended in the Bargaining Phase in Round 4, where you made a profit of $10. Your payoff would then be (.8)(.8)(.8) ($10) = (.51)($10) = $5.10. You would be paid off $5.10 in real money for this game if it is one of the two games selected at the end of the experiment. If you made a loss in one of these two games, we will subtract at most $2 from the $7 that you earned for showing up. All other losses are forgiven.

Example 2: Suppose the game ended in the Search Phase in Round 4, where the Buyer accepted an offer from search and made a profit of $10. His payoff would then be (.8)(.8)(.8) ($10) = (.51)($10) = $5.10, and the Seller's payoff would be zero.

Remember:

Each player will know only his/her own cost/valuation, but not their partner's. For each player, there is a 50 percent chance of having a high or low cost/valuation. Whether your own cost/valuation is high or low is completely independent of your partner's cost/valuation.