Competition and Price Transparency in the Market for Lemons: Experimental Evidence∗

Olivier Bochet† Simon Siegenthaler‡

March 26, 2018

Abstract

In markets with adverse selection the price mechanism often fails to allocate goods efficiently. Such inefficiencies can be alleviated through bargaining, where agents engage in repeated interactions and in the process reveal information. We design an experiment to examine the efficiency of bargaining in markets with adverse selection. In line with the theoretical predictions, we find that competition promotes trade of high quality goods and efficiency. Contrary to the predictions, in our main treatments, we find no evidence that price transparency (i.e., the observability of offers among competitors) reduces efficiency. We explore different behavioral explanations for the absence of a transparency effect. Remarkably, asking subjects to make decisions via the strategy method improves their understanding of the strategic opportunities offered by the game, such that price transparency has the predicted effect in these treatments. We also study the role of time frictions and risk aversion.

JEL Classification: C92, C70, D82

Keywords: Adverse Selection, Bargaining, Competition, Information Transmission, Screening, Strategic Complexity

∗We thank Philippe Jehiel, John Wooders, and three anonymous referees for helpful comments. We also thank seminar participants at NYU Abu Dhabi, [NOTE: add other seminars], and the 2018 AEA meeting in Philadelphia.

†Division of Social Science, New York University Abu Dhabi, PO Box 129188, United Arab Emirates. E-mail: olivier.bochet@nyu.edu. Phone: +971 2628 5470

‡Naveen Jindal School of Management, University of Texas at Dallas, Richardson, TX 75080, USA. E-mail: simon.siegenthaler@utdallas.edu. Phone: +1 972-883-5871.
1 Introduction

The presence of informational asymmetries can have a devastating effect on the efficiency of markets. For instance, in situations of adverse selection the presence of low quality goods reduces the buyers’ willingness to pay, thereby eliminating trading opportunities for sellers of high quality goods (Akerlof, 1970). The reason markets collapse under adverse selection is the inability of the price mechanism to convey sufficient information about the quality of the goods: in equilibrium a single market price prevails that cannot accurately reflect the different reservation values of the sellers.

Numerous institutions are potentially impaired by information asymmetries between buyers and sellers; among others trading platforms such as eBay, the market for used cars, the housing market, and asset markets more broadly. Many of these institutions do not fall under Akerlof’s static set-up, because sellers typically have several chances of selling their goods. In a dynamic setting, the alternative to not trading today is to trade in the future. This can have a correcting effect on rates of trade and lead to a partial alleviation of the adverse selection effect. The reason is that delaying agreement is costly—either because of time frictions or because of the risk that no better offers will be made in the future—and hence by rejecting offers a seller can endogenously signal her type (i.e., the quality of the good that she has for sale).

The ability of repeated interactions to promote trade persists across a wide range of trading institutions, including bilateral bargaining (Evans, 1989; Vincent, 1989; Deneckere and Liang, 2006), when several uninformed agents compete for a single seller (Hörner and Vieille, 2009a) or in large decentralized markets where agents meet in pairs and are rematched in each period (Blouin and Serrano, 2001; Moreno and Wooders, 2010, 2016; Virag, 2016). In the presence of competition, however, it turns out that the effectiveness of bargaining as a mechanism to transmit information critically depends on the transparency of offers in a trading institution (Hörner and Vieille, 2009a; Kim, 2015, 2016). Offers are said to be transparent or public if they can be observed among the competing buyers. If offers are private, buyers only know for how long (i.e., for how many time periods) the good has been for sale. For example, online trading platforms often display previous offers but eBay has recently also introduced the possibility for a seller to privately negotiate with a buyer without any information transmitted to other prospective buyers. The housing market serves as another example where sellers can choose whether or not to reveal previous offers.

In this paper, we experimentally examine the efficiency of bargaining in different adverse selection settings. We ask whether the possibility to make repeated offers and delay trade leads to information transmission, and how this depends on the degree of competition and transparency in a market. All offers are made by the uninformed parties (the buyers) and offers can be accepted or rejected by the informed party (the seller). Our design includes three main treatments: (i) exclusive bargaining where there is one buyer and one seller, (ii) competitive bargaining with private offers where three buyers compete for one seller and buyers cannot observe each other’s offers, and (iii) competitive bargaining with private offers where three buyers compete for one seller and buyers observe each other’s offers.

\[1\] It should be noted that while the dynamic set-up tends to increase rates of trade of high quality goods, it also introduces delay as an additional source of inefficiency. Depending on the trading environment, the effect of repeated interactions on efficiency can thus be ambiguous. Samuelson (1984) shows that no mechanism can lead to first-best efficiency if adverse selection is sufficiently strong (moreover, static mechanisms are in fact constrained efficient).
bargaining with public offers where the three buyers can observe each other’s offers. For each of the main treatments, we run a treatment with time frictions, that is, there is an exogenous breakdown probability after each rejected offer, and a treatment without time frictions in which case there is a commonly known number of bargaining stages.

Based on a set of theoretical predictions, we are interested in three main hypotheses. Hypothesis 1: time frictions promote trade of high quality goods. In the presence of time frictions delaying an agreement is costly. Informed agents with potentially high benefits from trade are less willing to postpone agreement (or equivalently, more willing to accept low prices) than agents with lower benefits. This allows uninformed agents to use specific price sequences to screen the different types of the informed agent. As a result, bargaining can lead to trade despite the presence of adverse selection. Intuitively, low quality goods are sold early at a low price and high quality goods are sold late at a higher price.

Hypotheses 2 and 3 focus on the effect of competition and transparency. Hypothesis 2: If offers are private, competition among buyers promotes rates of trade and efficiency compared to exclusive bargaining. If the competing buyers cannot observe each other’s offers, competitive bargaining transmits more information than bilateral bargaining. The reason is that competition drives up prices, thereby speeding up the screening process. However, it is not true that competition is always beneficial for efficiency. Hypothesis 3: If offers are public, competition among buyers reduces rates of trade and efficiency compared to exclusive bargaining. If offers are publicly observable, competition hinders information transmission. This is because buyers have no incentive to overbid their competitors. Such offers would be observed by future buyers and countered by even higher offers. Offers stay low throughout the bargaining process, leading to low rates of trade and welfare levels. Thus, depending on the transparency of price offers, competition has a diametrically opposed effect on market outcomes.

There are several reasons why these theoretical benchmarks warrant an empirical examination. They are based on sophisticated equilibrium reasoning and it is instructive to see if the predictions hold up at least qualitatively. Indeed, it is unclear if the model succeeds at capturing the main determinants of behavior in an actual bargaining situation. An experiment allows us to explore this and can potentially inspire new theories if the predicted effects are not observed or need to be qualified. Note that we are primarily interested in the qualitative features of the equilibria and to a lesser extent in the quantitative predictions. Our experiment also helps us understand real-world markets such as the housing market where it is common that an informed seller faces a series of potential buyers. How does competition on the uninformed side affect bargaining? Are sellers better off revealing information about past offers or should offers remain private? Finally, this article is part of the economics literature on bargaining, which has been successful at combining theoretical and experimental work to generate new insights into human behavior (below we provide a brief literature review). We follow this tradition by experimentally exploring factors—time frictions, competition, and transparency—that have been deemed relevant in the recent theoretical literature.

The experimental results confirm some but not all of our hypotheses. First, we find that exclusive
bargaining leads to screening of low-type sellers, much like the qualitative predictions of the model. In particular, rates of trade with high-type sellers are significantly boosted upwards in the presence of time frictions, while trade failures are common without time frictions. Second, the data confirms that competitive bargaining leads to successful information transmission and high levels of efficiency. Strikingly, competition in conjunction with the possibility to make repeated offers substantially reduces trade failures due to adverse selection. This result holds irrespective of whether offers are private or public. Hence, in contradiction to theory, the transparency of offers does not affect behavior in the experiment. On the one hand, this is good news, because it shows that in dynamic settings competition can alleviate adverse selection effects irrespective of the institutional details. On the other hand, we would like to understand why the predicted differences between the settings with public and private offers are not borne out in the data.

We present a range of robustness checks for the result that the transparency of offers does not affect behavior in our main treatments. The original theoretical result of Hörner and Vieille (2009a) assumed an infinite stream of buyers. We show that the theoretical results continue to hold in our setting with three buyers who take turn in making offers. Nevertheless, it is instructive to see what happens if we bring the experimental setting closer to the original model. To that end, we implemented treatments with six buyers. Behavior remains largely the same as in the 3-Buyer treatments, in particular, the transparency of offers still does not affect subjects’ behavior. We also check whether the way we model time frictions affects behavior. We find that outcomes are the same whether we use an exogenous breakdown probability or discount payoffs realized in later bargaining stages.

Finally, we ran a set of treatments in which subjects make their decisions via the strategy method. Instead of asking buyers to enter their offers stage by stage, all decisions are made at the start of a bargaining game. A decision will be relevant only if the corresponding stage is reached in the actual bargaining game. In the case of public offers, subjects also have to condition their offers for each stage on the different possible values of the offer in the previous stage. Strikingly, we find a strong effect of offer transparency: The rate of trade with high-type sellers in competitive bargaining with public offers decreases to 11%, while it remains at 55% with private offers. The strategy method highlights that current offers can be conditional on past offers and, as it turns out, this is sufficient to bring behavior closer to the theoretical predictions. We link this insight to an equilibrium concept proposed in Jehiel (2005), which is motivated by the observation that agents often use simplified representations of the available strategic opportunities.

It is instructive to compare our results with the findings in Bochet and Siegenthaler (2018). There, we explored exclusive bargaining under adverse selection, in particular, how it fares relative to a take-it-or-leave-it-offer institution. We found that trade with high-type sellers occured substantially later than predicted, leading to low efficiency levels. Where did this delay come from? In Bochet and Siegenthaler (2018) time frictions take the form of discounting. That is, the stakes at play become smaller and the variability of outcomes decreases over time (gains in later stages are smaller, but so are losses). Risk averse bargainers welcome the lower variability and are thus more willing to delay agreement. In the present article, time frictions take the form of a breakdown probability. As a consequence, there is no delay beyond the risk-neutral theoretical predictions. Because the focus of
the present article is on competition and price transparency, the fact that the outcome in exclusive bargaining is in line with theory allows us to use it as a clean benchmark against which we can evaluate the competitive bargaining treatments.²

There is a well-established experimental literature on bargaining with incomplete information.³ Rapoport, Erev and Zwick (1995), Reynolds (2000), and Fanning and Kloosterman (2018) study bargaining games with a focus on the Coase Conjecture. Price sequences in their experiments resemble the theoretically predicted shape, although the authors also find deviations from the comparative statics implied by their models (e.g., the effect of a change in the discount factor). Valuations are independent in these studies, while we focus on case with interdependent valuations where theory predicts trade failures due to adverse selection. Moreover, we focus on competition and the transparency of offers rather than the bilateral setting. Another related experiment is provided by Forsythe, Kennan and Sopher (1991) who test the explanatory power of truth-telling constraints in free-form bargaining (subjects can send hand-written messages for a period of ten minutes). The experiment shows that truth-telling constraints indeed drive the occurrence of trade failures. In our experiment, subjects always face a situation in which, theoretically, inefficiencies are unavoidable due to adverse selection. We explore to what extent bargaining can help improve outcomes and how the answer depends on the specifics of a trading institution.

Our experiment is also relevant for the experimental literature on price setting in decentralized markets with search or discounting costs. Siegenthaler (2017) shows that cheap-talk can be informative in such settings, thus representing an alternative to repeated offers in helping alleviate adverse selection. Cason and Friedman (2003) and Cason and Noussair (2007) examine price dispersion for different matching procedures, e.g., they test the predictions that price offers correspond to the monopoly price if buyer-seller meetings are bilateral and tend to approach Bertrand pricing if a seller meets more than one buyer simultaneously. They find evidence in favor of the theoretical predictions, while the results in Davis and Holt (1996) and Abrams, Sefton and Yavas (2000) suggest that theory fails to predict outcomes. In our setting, the Bertrand price is predicted to occur with private offers, while the monopoly price should be observed when offers are public.

Finally, there is a literature starting with Abreu and Gul (2000) that examines the effects of obstinate or behavioral types in bargaining. Obstinate types commit to a certain behavior (e.g., rejecting any offer below a certain price) at the start of the bargaining process. The presence of such types has interesting implications. In particular, rational players have an incentive to behave as if they were obstinate. Embrey, Fréchette and Lehrer (2015) confirm the existence of such effects experimentally. Fanning (2016) looks at the interaction of deadlines and obstinate types, while Fanning (2014)²

---

²Discounting and using an exogenous breakdown probability both intend to model agents’ impatience. Which approach is preferable depends on the context. The goal in this paper is to study competition and offer transparency and thus we wanted to keep the stakes at play constant across bargaining stages (i.e., no discounting). Another reason we chose to model impatience through a breakdown probability is that we don’t need to specify a maximum number of offers that can be made.

provides a discussion in the context of bargaining under incomplete information. The literature is relevant for us, as it can explain the type of price sequences we observe in our exclusive bargaining treatments.

The remainder of the paper is organized as follows. The next section presents the model. Section 3 presents the experimental design and derives a set of hypotheses that will guide our data analysis. Section 4 provides the main results on exclusive bargaining, competition, and offer transparency. The section also provides a discussion on risk aversion and presents several robustness checks. Finally, Section 5 concludes.

2 Exclusive and Competitive Bargaining

A seller and \( n \geq 1 \) buyers bargain over the price at which a single, indivisible good is traded. The seller can be of two types \( \theta = \{L, H\} \), i.e., the good is either of low (L) or high (H) quality. The reservation costs are \( c_L \) for a low-type seller and \( c_H \) as a high-type seller. The buyers' valuations are \( v_L \) for a low-quality and \( v_H \) for a high-quality good. We assume positive gains from trade for both qualities, i.e., \( v_L > c_L \) and \( v_H > c_H \). The seller’s type is private information. The probability that the seller is of the high type is \( q \in [0, 1] \).

Bargaining takes the following form. All offers are made by the buyers. Buyers queue up to sequentially make offers to the seller. For instance, with three buyers, the game starts with buyer 1 offering a price to the seller. If the seller rejects the offer, buyer 1 joins the end of the queue and buyer 2 is called to make the next offer. If buyer 2’s offer is also rejected, it is buyer 3’s turn. If buyer 3’s offer is rejected, buyer 1 returns to make another offer and so on. The game ends if the seller accepts an offer. If a price offer \( p \) is accepted by a \( \theta \)-type seller, the buyer who made the offer earns \( v_\theta - p \) and the seller earns \( p - c_\theta \). Buyers who do not trade earn 0. The game can also end if the bargaining process breaks down before the seller accepts an offer. Specifically, whenever an offer is rejected, there is a continuation probability \( r \in [0, 1] \) that the next stage is entered. With probability \( 1 - r \) the bargaining process ends, in which case everyone earns 0.

The model reduces to bilateral or exclusive bargaining if \( n = 1 \). If \( n > 1 \), bargaining is said to be competitive. In the presence of competition, the transparency of offers turns out to be an important element of the environment. Offers are said to be private if buyers can only observe their own past offers. Offers are public if the buyer in stage \( t \) can observe the full price sequence that has been offered up to stage \( t - 1 \).

3 Experimental Design

The experiment implements the model presented in the previous section. The treatments vary the degree of competition and whether offers are private or public (transparency). We also study the
Table 1: Experimental Design

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Subjects&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Pr(H-type)</th>
<th>Competition</th>
<th>Transparency</th>
<th>Time Friction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data: Main Experiment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exclusive</td>
<td>48 (8)</td>
<td>$q = 1/3$</td>
<td>1 Buyer</td>
<td>–</td>
<td>$r = 0.9$</td>
</tr>
<tr>
<td>Exclusive T</td>
<td>48 (8)</td>
<td>$q = 1/3$</td>
<td>1 Buyer</td>
<td>–</td>
<td>Known $T$</td>
</tr>
<tr>
<td>Private</td>
<td>84 (7)</td>
<td>$q = 1/3$</td>
<td>3 Buyers</td>
<td>No</td>
<td>$r = 0.9$</td>
</tr>
<tr>
<td>Private T</td>
<td>36 (3)</td>
<td>$q = 1/3$</td>
<td>3 Buyers</td>
<td>No</td>
<td>Known $T$</td>
</tr>
<tr>
<td>Public</td>
<td>84 (7)</td>
<td>$q = 1/3$</td>
<td>3 Buyers</td>
<td>Yes</td>
<td>$r = 0.9$</td>
</tr>
<tr>
<td>Public T</td>
<td>36 (3)</td>
<td>$q = 1/3$</td>
<td>3 Buyers</td>
<td>Yes</td>
<td>Known $T$</td>
</tr>
<tr>
<td>Data: Robustness Checks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private 6B</td>
<td>63 (3)</td>
<td>$q = 1/3$</td>
<td>6 Buyers</td>
<td>No</td>
<td>$r = 0.9$</td>
</tr>
<tr>
<td>Private Strategy&lt;sup&gt;b&lt;/sup&gt;</td>
<td>36 (3)</td>
<td>$q = 1/3$</td>
<td>3 Buyers</td>
<td>No</td>
<td>$r = 0.9$</td>
</tr>
<tr>
<td>Public 6B</td>
<td>63 (3)</td>
<td>$q = 1/3$</td>
<td>6 Buyers</td>
<td>Yes</td>
<td>$r = 0.9$</td>
</tr>
<tr>
<td>Public Strategy&lt;sup&gt;c&lt;/sup&gt;</td>
<td>36 (3)</td>
<td>$q = 1/3$</td>
<td>3 Buyers</td>
<td>Yes</td>
<td>$r = 0.9$</td>
</tr>
</tbody>
</table>

Sessions were run at the labs of the University of Bern (first wave: 264 subjects) and Valencia (second wave: 270 subjects). Payments averaged 30 Euros per subject. (a) Number of independent observations (matching groups) in parentheses. (b) Strategy method: subjects chose offers for bargaining stage $t$ conditional on reaching $t$. (c) Strategy method: subjects chose offers for bargaining stage $t$ conditional on reaching $t$ and the offer in period $t - 1$.

Case without time frictions ($r = 1$) but a finite, commonly-known number of bargaining stages. The remaining parameters are constant across all treatments: the buyers’ valuations are $v_H = 23$ and $v_L = 10$, the seller’s reservation costs are $c_H = 16$ and $c_L = 0$, and the probability of a high-type seller is $q = 1/3$.

3.1 Treatments

Table 1 presents the different treatments. The upper half shows our main treatments. In addition, we ran several control treatments to better understand the experimental results from the first set of treatments. They are shown in the lower half of table 1.

Exclusive Bargaining: In treatment Exclusive, we set $n = 1$ and $r = 0.9$. Hence, there is a single buyer making a sequence of offers to the seller. Offers can be made from the discrete grid $\{0, 0.01, 0.02, \ldots, 23\}$. We do not require offers to be increasing over time. If an offer is rejected, bargaining ends with a probability of 10%. With a probability of 90% bargaining continues and the buyer can make another offer. Treatment Exclusive T is identical to treatment Exclusive, except that the period in which bargaining ends is known. That is, instead of a random breakdown due to $r$, there is a pre-announced stage $T$ after which the bargaining process ends. The number of available bargaining stages follows the same distribution as the realized breakdown stages in treatment Exclusive.<sup>4</sup>

<sup>4</sup>For instance, after session 1 of treatment Exclusive, the stages in which bargaining breakdowns occurred (or would have occurred) were used to determine the pre-announced number of stages $T$ in each bargaining game of session 1 in treatment Exclusive T. This was done separately for each session. The same procedure was used for the competitive bargaining treatments.
Competitive Bargaining with Private Offers: In treatment *Private*, the number of buyers is \( n = 3 \). Whether a buyer is the first, second, or third to make an offer was randomly chosen. The continuation probability remains at \( r = 0.9 \). The three buyers do not observe each other’s offers. Treatment *Private T* removes the time frictions from treatment *Private*, i.e., as in treatment *Exclusive T* there is a pre-announced final stage \( T \). Treatment *Private 6B* is identical to treatment *Private* except that there are six buyers.

Competitive Bargaining with Public Offers: In treatment *Public*, the number of buyers is \( n = 3 \) and the continuation probability is \( r = 0.9 \). In contrast to treatment *Private*, offers are observable, i.e., the three buyers observe each other’s previous offers. In treatment *Public T* there is a pre-announced final stage \( T \). Treatment *Public 6B* is identical to treatment *Public* except that there are six buyers.

Comparing treatments *Exclusive*, *Private*, and *Public* will allow us to examine the effects of competition and offer transparency on efficiency. Comparing each treatment to its counterpart with a known breakdown stage \( T \) will allow us to study the impact of time frictions on bargaining outcomes. The treatments with six buyers highlight that competition is intertemporal, as it much less likely that a buyer will be able to make several offers than in the treatments with three buyers.

In a final set of treatments we elicited participants’ strategies. Treatment *Private Strategy* is identical to treatment *Private* except that buyers and seller made their decisions using the strategy method. For instance, buyers in the first position chose their offers for stages 1, 4, 7, etc. at the start of a bargaining game. Buyers in the second position chose their offers for stages 2, 5, 8, etc., and buyers in the third position chose their offers for stages 3, 6, 9, etc. This procedure allows us to observe the buyers’ offers in stages that are not reached in the actual bargaining game. A seller chose whether to accept/reject offers in all stages, in particular, they chose a minimum acceptable offer for each stage. If the buyer’s offer for a given stage exceeds a seller’s minimum acceptable offer, the buyer’s offer is accepted. Otherwise, the offer is rejected and the game continues to the next stage (or there is a bargaining breakdown). The same procedure was used in treatment *Public Strategy*. However, because past offers are observable in this treatment, buyers and sellers chose their offers (and minimum acceptable offers) for stage \( t \) conditional not only on the stage but also on the offer observed in stage \( t - 1 \).

### 3.2 Hypotheses

This section derives the theoretical benchmarks for each treatment. We should point out that we are less interested in the exact quantitative predictions than the qualitative predictions. The equilibrium

---

5In principle, buyers and sellers could base their choice for stage \( t \) on all previous offers in stages 1, 2, \ldots, \( t - 1 \). In order to be able to implement the strategy method in an comprehensible way, we ask subjects to choose offers and minimum acceptable offers conditional only on the offer in \( t - 1 \). Specifically, we group offers in \( t - 1 \) into 11 bins 0-2, 2.01-4, 4.01-8, 8.01-10, 10.01-12, 12.01-14, 14.01-16, 16.01-18, 18.01-20, and 20.01-23. Notice that the offer in stage 1 is made unconditionally and thus determines which future offers will be relevant, i.e., the first offer determines the starting point for how the bargaining game unfolds.

6We should stress that the theoretical predictions on offer transparency hold if buyers can only observe the offer of the immediately preceding buyer, as is the assumption in the strategy method treatments.
Table 2: Equilibrium Predictions

| Treatment | Pr(Trade|θ = L) | Pr(Trade|θ = H) | Efficiency^a |
|-----------|-----------|---------------|--------------|
| Exclusive | 0.74      | 0.48          | 6.04         |
| Exclusive T | 1         | 0             | 6.66         |
| Private   | 0.78      | 0.63          | 6.66         |
| Private T | 1         | 0.63          | 8.13         |
| Public    | 0.42      | 0             | 2.78         |
| Public T  | 1         | 0             | 6.66         |

(a) Efficiency corresponds to the sum of ex-ante expected payoffs of all market participants.

The concept is Perfect Bayesian Equilibrium as defined in Fudenberg and Tirole (1991), Definition 8.2. The equilibrium rates of trade and efficiency levels are summarized in table 2. Efficiency is measured as the sum of ex-ante expected payoffs of all market participants, i.e., the payoffs of the seller and either one or three buyers. All proofs can be found in the Appendix.

There is a unique equilibrium for treatment Exclusive. Given the parameters used in the experiment, the buyer’s optimal price sequence is (7.7, 5.8, 5.4, 5.2, 5.7, 13, 14.4, 16). The increasing price offers exhaust the low-type seller’s patience before trade with a high-type seller takes place. The corresponding acceptance probabilities of the low-type seller are (0.22, 0.19, 0.19, 0.20, 0.24, 0.32, 1.00, −). High-type sellers accept in stage 8. Trade is reached with both seller types unless there is an exogenous breakdown before the offer of 16 is made.7

In treatment Exclusive T the buyer offers 0 in all stages. The low-type seller accepts the first offer with probability 0.78. The buyer updates his belief to be matched with a high-type seller from 0.33 to 0.70, which makes him indifferent between offering 0 and 16 if he were to make a take-it-or-leave-it offer (on the equilibrium path he never makes the offer of 16, as otherwise the low-type seller would reject in stage 1). The low-type seller rejects all further offers up to stage T − 1 and accepts for sure in stage T. In contrast to treatment Exclusive, high-type sellers don’t trade in Exclusive T, showing that time frictions are essential for trade with high-type sellers. At the same time, as shown in table 2, the rate of trade with low-type sellers is higher in Exclusive T than in Exclusive.8 These observations lead to our first hypothesis:

**Hypothesis 1:** In treatment Exclusive, the buyer uses an increasing price sequence to screen the seller. High-type sellers trade with positive probability. In treatment Exclusive T, only low-type sellers trade although with a larger probability than in Exclusive.

We now turn towards competitive bargaining. In treatment Private, the buyer in stage 1 offers 10 and the offer is accepted by the low-type seller with probability 0.42. The other buyers update their belief

7Stage t is reached with probability 0.9^{t-1}. The ex-ante efficient welfare level is 1/3*7 + 2/3*10 = 9. If the buyer’s ex-ante expected valuation (1/3*23 + 2/3*10 = 14.33) falls short of the high-type seller’s cost, inefficiencies do not disappear as r approaches 1. In fact, the expected welfare with r = 0.9 is 6.04, higher than the welfare of 5.21 if r → 1, see Deneckere and Liang (2006).

8Interestingly, efficiency is predicted to be higher in treatment Exclusive T than in treatment Exclusive. This does, however, not imply that Exclusive T is invariably preferable from a social perspective. In some circumstances, one may want to maximize market liquidity (trading rates) rather than efficiency.
that the seller is a high type from 0.33 to 0.70. The low-type seller’s acceptance probability in stage 1 is chosen to render the buyer indifferent between offering 16 and a “losing offer” that is rejected for sure. All subsequent buyers offer 16 with positive probability, ensuring that the low-type seller was indeed indifferent between accepting and rejecting the offer of 10 in stage 1. Both seller types reject all offers below 16 from period 2 onwards. Notice how competition drives up prices (buyers have an expected profit of 0) such that, as shown in table 2, high-type sellers trade with a higher probability than under exclusive bargaining. In contrast, in treatment Public the buyers offer 0 in all stages. As with private offers, the offer in stage 1 is accepted by the low-type seller with probability 0.42 and the buyers update their beliefs from 0.33 to 0.70. From stage 2 onwards, all offers (on the equilibrium path) are rejected until the bargaining process breaks down. Hence, high-type sellers do not trade and only some low-type sellers trade. As shown in table 2, relative to Exclusive, competition promotes efficiency and rates of trade with both seller types if offers are private but has the opposite effect if offers are public. This leads to the following hypotheses:9

**Hypothesis 2:** Competitive bargaining with private offers increases efficiency and rates of trade with both seller types compared to exclusive bargaining.

**Hypothesis 3:** Competitive bargaining with public offers decreases efficiency and rates of trade with both seller types compared to exclusive bargaining.

Remarkably, whether offers are private or public—seemingly an institutional detail—is predicted to be of first-order importance for the performance of trading environments. Why is there such a stark difference in the equilibrium predictions? Notice that at any equilibrium the offer in stage 1 has to be accepted with a probability strictly between 0 and 1. In other words, the low-type seller needs to be indifferent between accepting and rejecting. Suppose that there is an equilibrium in which buyer 1 offers a price below 10 in stage 1. With private offers, the buyer could always slightly increase the offer such that the low-type seller would accept for sure (other buyers cannot condition their offers on this unobservable deviation). Only at an offer of 10, which is the equilibrium offer in Private, such a deviation is unprofitable. In contrast, when offers are public, any deviation to a higher offer triggers more aggressive offers by the next buyers (the deviation is now observable). As a result, the low-type seller does accept higher offers with a larger probability. Anticipating this, buyers refrains from raising offers above 0. Future competition keeps offers low and the result is that high-type sellers don’t trade.

In the Appendix we show that the effect of competition and offer transparency are independent of time frictions. In particular, Private T leads to the same rate of trade with high-type sellers as Private. Similarly, Public T leads to the same rate of trade with high-type sellers as Public. This highlights that, in contrast to exclusive bargaining, screening and trade with high-type sellers in treatment Private does not occur due to time frictions. Instead screening is caused by the possibility to make repeated offers coupled with competition.10

---

9The ranking of treatments Private ≻ Exclusive ≻ Public in terms of efficiency holds in general if r is sufficiently large.

10The fact that offers are low in treatment Public T shows that the predictions for treatment Public are not due to Diamond Paradox forces. That is, they are not based on the observation that (in complete information environments)
3.3 Procedures

The first wave of data collection took place at the experimental laboratory of the University of Bern with a total of 264 participants. We decided to collect additional data in a second wave to sharpen the results of the first experiments. The second wave was done at the University of Valencia with a total of 270 participants and included treatments with six buyers (instead of three buyers) as well as treatments where decisions were made using the strategy method (see section 3.1). The data from Valencia also includes three matching groups for treatments *Private* and *Public* (72 participants). This allows us to check if there are any differences in behavior in Bern and Valencia. In the Online Appendix we show that behavior does not differ between the two locations. As a side benefit, this also verifies our results on offer transparency for two separate subjects pools. In total 534 students from various fields participated in the experiment. The experiment was programmed in z-Tree (Fischbacher, 2007). Sessions lasted less than 100 minutes and earnings averaged €30, including a show-up fee of €10.

At the start of a session we distributed the instructions of the respective treatment (available in the Online Appendix). Once the participants finished reading the instructions, a member of the experimenter team provided a brief verbal summary. Participants were also asked to answer a set of control questions. There were ten rounds, that is, the bargaining game described above was played ten times. At the start of each round, subjects were randomly assigned the role of a buyer or a seller. Sellers’ types (high or low) were drawn according to the probability \( q = 1/3 \). In each bargaining round, subjects were randomly rematched and this was commonly known. The goal was to minimize repeated game effects.\(^{11}\)

At the end of each session we elicited subjects’ risk preferences. Risk aversion is potentially important, as each offer that exceeds the high-type seller’s reservation cost may also be accepted by a low-type seller. At the end of each session, subjects were presented six lotteries, each of which they could accept or decline. A lottery gave a 50-50 chance between winning €6 or losing an amount of either €2, €3, €4, €5, €6, or €7. One lottery was randomly selected for payment. If the selected lottery was accepted, the earnings/losses were realized. The earnings didn’t change for subjects who declined the selected lottery. The fact that the lotteries may result in a loss is consistent with the bargaining game (if subjects made losses they were subtracted from the show-up fee of €10).

\(^{11}\)The data shows no trends in behavior over the ten bargaining rounds and no endgame effects. This indicates that the random matching successfully induced subjects to treat each bargaining round as a separate game. Moreover, subjects’ behavior was not affected by how many times they were assigned the role of a buyer or seller. The corresponding analysis can be found in the Online Appendix.
4 Results

The discussion of the experimental results is separated into three sections. In section 4.1 we test the main hypotheses on competitive bargaining and offer transparency. Section 4.2 examines the data on the individual level by identifying common price sequences and the effects of risk aversion. Finally, section 4.3 presents robustness checks. All non-parametric tests are based on matching group averages as the unit of observation; table 1 shows the number of matching groups per treatment. We use Wilcoxon-Mann-Whitney tests for between-treatment comparisons and Wilcoxon signed-rank tests for comparisons within treatment. Unless stated otherwise, the analysis will be based on bargaining rounds 3 to 10, that is, we drop the first two rounds in which behavior was slightly more noisy.

4.1 Time Frictions, Competition, and Offer Transparency

Table 3 summarizes the experimental results with the corresponding theoretical predictions in parentheses. We will refer to the table throughout the discussion. We begin with the exclusive bargaining setting:

Result 1: In exclusive bargaining, time frictions promote trade with high-type sellers. That is, the rate of trade with high-type sellers is significantly higher in Exclusive than in Exclusive T. Because introducing time frictions also lowers the rate of trade with low-type sellers, there is no difference in efficiency between the two treatments.

Support: The rate of trade with high-type sellers is 43% in Exclusive and 20% in Exclusive T (p = 0.006). The average trading price in Exclusive is 8.25 with low-type sellers and 17.87 with high-type sellers (p = 0.011), implying that buyers were able to separate the two seller types. Screening was successful in Exclusive: 79% of the trades with low-type sellers occurred at an ex-post individually rational price for the buyer, i.e., at a price of 10 or below, significantly more than the 49% predicted in theory (p = 0.011). The rate of trade for low-type sellers is higher in Exclusive T than in Exclusive (p = 0.004). The efficiency level is 5.63 in Exclusive and 6.43 in Exclusive T, a difference that is insignificant (p = 0.291). Taken together, result 1 is fully in line with hypothesis 1.

Observed outcomes in treatments Exclusive and Exclusive T are close to the theoretical predictions both in terms of efficiency and rates of trade. We use the behavior observed in treatment Exclusive as a benchmark of comparison for the treatments with competition. We next state our main results on competition and offer transparency:

Result 2: Competitive bargaining with private offers promotes efficiency and increases rates of trade compared to exclusive bargaining.

12The prices accepted by low-type sellers in Exclusive T are substantially larger than the predicted offer of 0. This is not surprising given the evidence showing that responders in ultimatum bargaining games are reluctant to accept offers which allocate less than half of the gains of trade to them (see footnote 3).
Table 3: Summary of Outcomes in Main Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seller Type</th>
<th>Trading Rate</th>
<th>Efficiency</th>
<th>Trading Price</th>
<th>Trading Stage</th>
<th>Opening Offer</th>
<th>Buyer Profit</th>
<th>Seller Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exclusive</td>
<td>Overall</td>
<td>0.61 (0.65)</td>
<td>5.63 (6.05)</td>
<td>11.46 (12.64)</td>
<td>5.06 (5.42)</td>
<td>4.97 (7.65)</td>
<td>1.75 (1.05)</td>
<td>3.95 (5.00)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.43 (0.48)</td>
<td>2.98 (3.35)</td>
<td>17.87 (16.00)</td>
<td>7.31 (8)</td>
<td>5.02 (7.65)</td>
<td>2.81 (3.35)</td>
<td>0.37 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.70 (0.74)</td>
<td>6.95 (7.39)</td>
<td>8.25 (10.95)</td>
<td>3.93 (4.14)</td>
<td>4.95 (7.65)</td>
<td>1.21 (-0.10)</td>
<td>5.74 (7.49)</td>
</tr>
<tr>
<td>Exclusive</td>
<td>Overall</td>
<td>0.65 (0.67)</td>
<td>6.34 (6.67)</td>
<td>10.29 (-)</td>
<td>8.23 (-)</td>
<td>4.03 (0.00)</td>
<td>2.68 (6.67)</td>
<td>3.75 (0.00)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.20 (0.00)</td>
<td>1.38 (0.00)</td>
<td>17.96 (-)</td>
<td>9.67 (-)</td>
<td>3.95 (0.00)</td>
<td>1.78 (0.00)</td>
<td>-0.13 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.88 (1.00)</td>
<td>8.83 (10)</td>
<td>6.45 (0.00)</td>
<td>7.51 (10.00)</td>
<td>4.07 (0.00)</td>
<td>3.13 (10.00)</td>
<td>5.70 (0.00)</td>
</tr>
<tr>
<td>Private</td>
<td>Overall</td>
<td>0.77 (0.73)</td>
<td>6.97 (6.67)</td>
<td>13.20 (14.33)</td>
<td>4.10 (4.90)</td>
<td>7.23 (10.00)</td>
<td>0.32 (0.00)</td>
<td>6.03 (6.67)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.73 (0.63)</td>
<td>5.09 (4.38)</td>
<td>17.63 (16.00)</td>
<td>7.00 (6.40)</td>
<td>7.25 (10.00)</td>
<td>1.49 (1.47)</td>
<td>0.71 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.79 (0.78)</td>
<td>7.91 (7.81)</td>
<td>10.99 (13.5)</td>
<td>2.66 (4.15)</td>
<td>7.22 (10.00)</td>
<td>-0.26 (-0.73)</td>
<td>8.69 (10.00)</td>
</tr>
<tr>
<td>Private T</td>
<td>Overall</td>
<td>0.83 (0.88)</td>
<td>7.83 (8.13)</td>
<td>12.92 (12.88)</td>
<td>7.14 (9.48)</td>
<td>6.77 (10.00)</td>
<td>0.43 (0.49)</td>
<td>6.72 (6.67)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.50 (0.63)</td>
<td>3.50 (4.38)</td>
<td>18.32 (16.00)</td>
<td>9.64 (10.00)</td>
<td>6.24 (10.00)</td>
<td>1.45 (1.47)</td>
<td>-0.31 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>1.00 (1.00)</td>
<td>10.00 (10.00)</td>
<td>10.23 (11.31)</td>
<td>5.89 (9.22)</td>
<td>7.03 (10.00)</td>
<td>-0.07 (-0.73)</td>
<td>10.23 (10.02)</td>
</tr>
<tr>
<td>Public</td>
<td>Overall</td>
<td>0.76 (0.28)</td>
<td>6.89 (2.78)</td>
<td>14.09 (-)</td>
<td>3.94 (-)</td>
<td>7.21 (0.00)</td>
<td>0.10 (0.93)</td>
<td>6.62 (0.00)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.75 (0.00)</td>
<td>5.22 (0.00)</td>
<td>18.51 (-)</td>
<td>5.63 (-)</td>
<td>7.41 (0.00)</td>
<td>1.26 (0.00)</td>
<td>1.52 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.77 (0.42)</td>
<td>7.73 (4.17)</td>
<td>11.87 (0.00)</td>
<td>3.09 (1.00)</td>
<td>7.11 (0.00)</td>
<td>-0.48 (1.39)</td>
<td>9.17 (0.00)</td>
</tr>
<tr>
<td>Public T</td>
<td>Overall</td>
<td>0.74 (0.67)</td>
<td>7.11 (6.67)</td>
<td>12.15 (-)</td>
<td>7.97 (-)</td>
<td>6.23 (0.00)</td>
<td>0.40 (2.22)</td>
<td>6.03 (0.00)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>0.25 (0.00)</td>
<td>1.75 (0.00)</td>
<td>17.67 (-)</td>
<td>11.50 (-)</td>
<td>6.03 (0.00)</td>
<td>0.81 (0.00)</td>
<td>-0.27 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.98 (1.00)</td>
<td>9.78 (10.00)</td>
<td>10.15 (0.00)</td>
<td>6.20 (9.22)</td>
<td>6.33 (0.00)</td>
<td>0.20 (3.33)</td>
<td>9.19 (0.00)</td>
</tr>
</tbody>
</table>

The table shows averages across bargaining games by seller type. Overall (high- and low-type sellers) averages are calculated by weighing the observed averages by the theoretical probability of the seller types. Data includes observations from bargaining rounds 3-10. Theoretical predictions are given in parentheses.
Support: The rate of trade with high-type sellers is 73% in Private, which is significantly larger than in Exclusive ($p = 0.017$). The rate of trade with low-type sellers is also larger in Private (79% versus 70%) although the difference is not significant ($p = 0.220$). In terms of efficiency, these observations imply that Private outperforms Exclusive ($p = 0.063$), which is confirmed by the results of the regression model in the last column of table 5. The efficiency levels are similar to the theoretical predictions for both treatments, 6.97 versus 6.67 in Private and 5.63 versus 6.05 in Exclusive. The increased trade frequency with high-type sellers in Private comes at the cost of a higher average trading price with low-type sellers, 10.99 in Private versus 8.25 in Exclusive ($p = 0.003$). However, trading prices in Private are still different for trades with low- and high-type sellers ($p = 0.018$), indicating that screening is an important component of subjects’ behavior: the fraction of trades with low-type sellers occurring at a price below 10 is 69%, higher than the predicted 42% ($p = 0.017$).

Result 2 on private offers is in line with theory and confirms hypothesis 2. What if offers are public?

Result 3: The transparency of offers does not affect rates of trade and efficiency in competitive bargaining. That is, observed outcomes in treatments Public and Private are not significantly different from each other. By extension, efficiency and rates of trade are significantly higher in treatment Public than in treatment Exclusive.

Support: The rate of trade for high-type sellers in Public is 75%, significantly larger than in Exclusive ($p = 0.010$) and not significantly different from treatment Private ($p = 0.796$). Trading rates with low-type sellers are similar across the three treatments. As a consequence, efficiency in Public is significantly higher than in Exclusive ($p = 0.081$), while there is no significant difference between Private and Public ($p = 0.654$). These observations are confirmed by the results of the regression model in the last column of table 5. The observed trading prices also don’t differ between Public and Private ($p > 0.277$ for both seller types). Since non-parametric tests are conservative, we also performed multilevel regressions (with individual and matching group random intercepts) confirming that there are no significant differences between Public and Private, neither for opening offers ($p = 0.625$), trade with high-type sellers ($p = 0.598$), or efficiency ($p = 0.967$). Note that the efficiency level of 6.89 in Public is substantially higher than the predicted level of 2.78 ($p = 0.017$).

Result 3 rejects hypothesis 3: The transparency of offers does not affect behavior, contrary to the theoretical predictions. While we did not expect public offers to fully shut down trading opportunities for high-type sellers, the complete absence of an effect of transparency is puzzling. In section 4.3, we will examine this finding in more detail. We conclude the current section with a result on the effect of time frictions in competitive bargaining:

Result 4: In competitive bargaining, time frictions increase the rate of trade with high-type sellers. Because time frictions also lower trade with low-type sellers, efficiency is not significantly different between Private and Private T, or between Public and Public T.

Support: The difference in the rate of trade for high-type sellers in Public (75%) and Public T (25%) is significant ($p = 0.016$), while the difference between Private (73%) and Private T (50%) is not
significant ($p = 0.168$). However, the latter difference is highly significant in a multilevel regression with individual and session random intercepts (not reported). Pooling the competitive bargaining sessions with time frictions and comparing them to the sessions without time frictions shows that the probability of trade for high-type sellers is significantly higher in the former ($p = 0.003$). On the other hand, rates of trade for low-type sellers are higher in the treatments without time frictions ($p < 0.001$). Taken together, time frictions do not lead to significantly different efficiency levels in competitive bargaining ($p = 0.247$). Hence, the effects of time frictions are similar in the competitive bargaining settings as in the case of exclusive bargaining.

Two main conclusions follow from the above results. First, time frictions enable buyers to use price offers to extract information from sellers, which in turn promotes trade with high-type sellers. This conclusion holds independently of whether bargaining is exclusive or competitive. Recall that the only difference between the treatments with and without time frictions is that the breakdown stage is random when there are time frictions and commonly known otherwise. Buyers seem to understand that the breakdown probability allows for effective screening. The second main insight is that competition promotes rates of trade and efficiency compared to exclusive bargaining, irrespective of the transparency of offers. This was expected for private offers. If offers are public, however, the finding is the exact opposite of what the model predicts.

### 4.2 Price Sequences and Risk Aversion

In this section, we look at the typical price sequences observed in the bargaining games and discuss how risk aversion affects behavior in the different treatments. Figure 1 presents the offers made by the buyers in the main treatments of our experiment (grey circles). The accepted offers are shown as black squares. Price offers follow a steep increase in Private and Public and increase slower in Exclusive. Figure 1 is indicative of the price sequences observed in the experiment. Few offers are between 10 and 16, even in Exclusive where theory predicts that such offers are common. The typical price sequence in all three treatments corresponds to threshold screening: A sequence of offers acceptable only for the low-type seller (i.e., offers between 0 and 10) is followed by a jump to an offer above the high-type seller’s reservation value of 16.

Threshold screening can essentially lead to one of two outcomes. Either the probability of an offer above 16 is sufficiently high such that the majority of price sequences end with a high offer. Alternatively, if buyers are reluctant to make high offers, bargaining breaks down before such an offer is made. Let $y$ denote the maximum offer in a given bargaining game. We assume that the distributions of $y$ is a mixture of two normal distributions. Given that threshold screening was common, we expect that one component of the mixture model has a mean below 10 and another a mean above 16. It is interesting to see how frequent each outcome occurred in each treatment. Table 4 shows the estimates of the corresponding mixture model. In treatment Exclusive 55% of the bargaining games reach a maximum offer centered at 17.34, while 45% have maximum offers centered at 6.38. Competition increases the probability that a bargaining game reaches a maximum offer above 16 to 74% in Private and 79% in Public. The maximum offer in the lower component are centered at 8.33 in Private and
Rejected offers depicted as grey circles. Accepted offers depicted as black squares. Graphs include smoothed values from locally weighted regressions.

9.33 in Public. We can look at the price sequences in the treatments without time frictions in the same way: In Exclusive T the two components of the mixture model are centered around 5.26 and 11.52, i.e., there is no component for offers above 16, in line with the theoretical prediction that time frictions are essential for screening in bilateral bargaining. The component means are centered at 7.04 and 18.31 in Private T and at 8.55 and 17.26 in Public T (in both cases the probability of each component is around 50%).

Threshold screening is in line with the equilibrium predictions in treatment Private. In treatment Exclusive, however, the unique equilibrium is characterized by gradual screening, involving a number of offers between 10 and 16. Can we reconcile threshold screening with equilibrium reasoning? An interesting possibility is the existence of obstinate types (Abreu and Gul, 2000). Obstinate types are committed to never raise offers above a certain threshold. Interestingly, rational players may want to mimic obstinate types, a prediction that has been confirmed in the lab (Embrey et al., 2015). In our setting, assuming the presence of obstinate buyers, there exists an equilibrium in which a rational buyer uses threshold screening. He starts by pretending to be an obstinate type who only makes offers below 10 and switches to a high offer when the belief to be matched with a high-type seller is sufficiently high.13

We have seen that when bargaining is competitive buyers quickly raise price offers. In fact, at equilibrium, buyers’ expected profit equals 0. Table 3 shows that this prediction is born out in the data for the competitive bargaining institutions. This is somewhat surprising. In the lottery task after the main experiment, we find that most subjects are risk averse to different degrees. For risk averse subject, the expected utility is negative for trades with an expected profit of 0. This indicates

---

13The full equilibrium characterization is intricate and beyond the scope of this paper. See Fanning (2014) for a discussion of obstinate types in the presence of incomplete information. An alternative explanation for the flat price sequences in Exclusive is that some subjects fail to correctly update their beliefs towards the high-type seller following a rejection, as argued in the literature on cursed beliefs (e.g., Eyster and Rabin, 2005; Esponda, 2008).
Table 5: Bargaining Institutions and Risk Aversion

| Dependent Variable | Offers | Trade|θ = L | Trade|θ = H | Profit | Efficiency |
|-------------------|--------|------|-------|-------|--------|---------|
| Stage             | 0.807*** | (0.142) |       |       |        |         |
| Private           | 2.095*** | (0.471) | -0.440*** | (0.063) | -0.331*** | (0.103) | -0.691* | (0.381) | 0.991 | 1.307** |
| Public            | 3.240*** | (0.517) | -0.423*** | (0.074) | -0.388*** | (0.104) | -1.21*** | (0.396) | 0.919 | 1.227** |
| Risk Averse (RA)  | -1.112*** | (0.383) | -0.007 | (0.057) | -0.249*** | (0.104) | 0.778** | (0.351) | -0.567 |         |
| Private × RA      | 1.057**  | (0.453) | 0.017 | (0.073) | 0.238* | (0.136) | -1.069*** | (0.366) | 0.557 |         |
| Public × RA       | 0.898**  | (0.457) | -0.030 | (0.101) | 0.375*** | (0.139) | (0.371) | (0.747) |         |         |
| Constant          | 4.442*** | (0.456) | 0.737*** | (0.064) | 0.613*** | (0.108) | 0.939** | (0.384) | 5.710 | 5.269*** |

Period Dummies ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
Observations 4623 788 403 1191 1191 519
Individuals 216 216 190 216 216 190

Linear multilevel models with individual and session random intercept. Standard errors clustered on independent observations (22 matching groups) in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01. All dependent variables refer to outcomes for buyers. The reference group is treatment Exclusive and RA = 0 (low risk aversion).

that risk aversion has no bite in the competitive bargaining settings. Table 5 presents multilevel regressions for the following dependent variables: buyers’ offer choices, their probability of trade with low-type and high-type sellers, buyers’ profits, and efficiency. The main explanatory variables are the treatments and buyers’ risk aversion. Risk aversion is captured by the dummy Risk Averse (RA), which is constructed based on the risk elicitation task described in section 3.3.14 Remarkably, risk aversion is an important determinant of behavior in exclusive bargaining but, as hinted above, the effects of risk aversion disappear in the presence of competition:

**Result 5:** Risk aversion reduces buyers’ offers and slows down trade in treatment Exclusive but has no impact on behavior in treatments Private and Public.

**Support:** Column 1 in table 5 shows that offers are higher under competitive bargaining than under exclusive bargaining. Interestingly, the effect is stronger when offers are observable (p = 0.012), i.e., offer transparency seems to reinforce competition, the opposite of the theoretical predictions. Risk aversion as a negative impact on offers in Exclusive. This is intuitive. Postponing agreement allows for better screening, thereby reducing the risk of offering a high price to a low-type seller. As a consequence, as shown in column 3, risk averse buyers are less likely to trade with high-type sellers. In contrast, risk aversion does not lead to lower offers or efficiency in competitive bargaining. In fact, in treatment Public the probability of trade with a high-type seller is larger for risk averse buyers

---

14Almost all subjects (97%) have a unique switching point from accepting less risky to rejecting more risky lotteries. Thus, we use the switching point as the risk aversion measure. The risk aversion dummy is created by splitting subjects into two equally large groups. The regression results are robust to using as our risk measure the switching point in the lottery task (i.e., integers 0 to 6) instead of a dummy variable.
than their less risk averse counterparts ($p = 0.067$). The last column on efficiency confirms a previous result that the competitive bargaining treatments are more efficient than treatment Exclusive. The second-to-last column reveals that competitive bargaining is more efficient than exclusive bargaining for the set of subjects characterized by a comparably low degree of risk aversion, although the effect is not significant. The difference is significant once we look at the group of comparably more risk averse subjects ($p = 0.040$ for Private and $p = 0.067$ for Public).

### 4.3 Price Transparency: Robustness Checks and An Explanation

The main deviation from theory in our data is the failure of hypothesis 3: high-type sellers trade with a high probability in treatment Public while theory predicts a rate of trade of 0. Table 3 shows that trading rates, efficiency, trading prices, trading stages, opening offers, and profits of buyers and sellers are virtually identical in Public and Private.\textsuperscript{15} In this section, we explore several factors that may help explain these observations.

In Hörner and Vieille (2009a) there is an infinite stream of buyers who sequentially meet the seller to make an offer. If an offer is rejected, the respective buyer leaves the market and never comes back to make another offer. In our environment, competition is also sequential but the three buyers take turns in making offers. In the Appendix, we show that the detrimental effect of public offers persists in our environment. Behaviorally, however, the possibility that a buyer may come back to make another offer may matter, for instance, because competition is interpreted as being simultaneous rather than sequential. The lab doesn’t allow us to implement an infinite stream of buyers. But we can look at the case with six buyers, where it is much less likely that a given buyer will be able to make multiple offers. Table 6 reports the results for the treatments with six buyers, Private 6B and Public 6B. Rates of trade and efficiency levels are similar in Private 6B and Public 6B, and also similar to the respective three-buyers treatments. In fact, competition is slightly stronger when offers are observable. This is best seen when looking at the trading prices with low-type sellers, which are higher in Public 6B than in Private 6B ($p = 0.049$). We conclude that the number of buyers isn’t responsible for the absence of an effect of offer transparency.

Another possible concern is that offer transparency interacts with how one models time frictions. In three sessions of treatments Private, Private 6B, Public, and Public 6B, after the main experiment had been completed, we asked subjects to play five additional bargaining rounds in which we used discounting instead of a breakdown probability.\textsuperscript{16} Efficiency levels in the rounds with discounting are 6.09 in Private, 6.66 in Private 6B, 6.22 in Public, and 6.63 in Public 6B. The differences are insignificant. We cannot exclude that participants’ behavior is affected by the fact that we ran the discounting rounds after the main experiment. Given this limitation, however, our data shows that behavior in competitive bargaining is unaffected by whether time frictions take the form of a...

\textsuperscript{15}We can exclude the possibility that the absence of an effect of offer transparency is due to subjects not paying enough attention to the history of offers. The history of offers was explicitly discussed in the experimental instructions and prominently displayed on the subjects’ computer screens during the experiment.

\textsuperscript{16}In the main part of the experiment, subjects knew that there will be a second part but they didn’t know the details of it.
Table 6: Summary of Outcomes in 6-Buyers and Strategy Method Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seller Type</th>
<th>Trading Rate</th>
<th>Efficiency</th>
<th>Trading Price</th>
<th>Trading Stage</th>
<th>Opening Offer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private 6B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>High</td>
<td>0.75 (0.73)</td>
<td>6.89 (6.67)</td>
<td>13.49 (14.33)</td>
<td>3.93 (4.90)</td>
<td>8.13 (10.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.59 (0.63)</td>
<td>4.13 (4.38)</td>
<td>18.65 (16.00)</td>
<td>6.54 (6.40)</td>
<td>8.12 (10.00)</td>
</tr>
<tr>
<td><strong>Private Strategy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>High</td>
<td>0.72 (0.73)</td>
<td>6.64 (6.67)</td>
<td>14.08 (14.33)</td>
<td>3.12 (4.90)</td>
<td>8.88 (10.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.55 (0.63)</td>
<td>3.82 (4.38)</td>
<td>18.09 (16.00)</td>
<td>5.25 (6.40)</td>
<td>8.17 (10.00)</td>
</tr>
<tr>
<td><strong>Public 6B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>High</td>
<td>0.78 (0.28)</td>
<td>7.04 (2.78)</td>
<td>15.56 (–)</td>
<td>3.56 (–)</td>
<td>8.66 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.72 (0.00)</td>
<td>5.04 (0.00)</td>
<td>18.54 (–)</td>
<td>5.28 (–)</td>
<td>8.69 (0.00)</td>
</tr>
<tr>
<td><strong>Public Strategy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>High</td>
<td>0.54 (0.28)</td>
<td>5.33 (2.78)</td>
<td>13.18 (–)</td>
<td>4.76 (–)</td>
<td>7.36 (0.00)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0.11 (0.00)</td>
<td>0.78 (0.00)</td>
<td>19.25 (–)</td>
<td>8.50 (–)</td>
<td>7.14 (0.00)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.76 (0.42)</td>
<td>7.61 (4.17)</td>
<td>10.15 (0.00)</td>
<td>2.89 (1.00)</td>
<td>7.46 (0.00)</td>
</tr>
</tbody>
</table>

The table shows averages across bargaining games by seller type. Overall (high- and low-type sellers) averages are calculated by weighing the observed averages by the theoretical probability of the seller types. Data includes observations from bargaining rounds 3-10. Theoretical predictions are given in parentheses.

Our final set of treatments Private Strategy and Public Strategy use the strategy method to learn more about the buyers' choices for different bargaining histories. In Private Strategy, we ask buyers to make conditional offers of the form: suppose that stage $t$ is reached and it is your turn to make an offer, what will your offer be? In Public Strategy, buyers’ offers are made conditional not only on the number of previous stages but also on the previously made offers. Because there is a large number of possible histories, we ask buyers for their choices in stage $t$ conditional on the offer observed in stage $t - 1$ but not conditional on offers made in earlier stages. The motivation for using the strategy method was to check if at least some buyers in Public Strategy play according to the equilibrium predictions (i.e., if they choose low offers conditional on observing low previous offers). Strikingly, asking participants to make offers via the strategy method had more far-reaching effects than we anticipated:

**Result 6:** Price offers and the rate of trade for high-type sellers are substantially lower in treatment Public Strategy than in treatment Private Strategy.

**Support:** Behavior in Private Strategy is similar to the one observed in treatment Private. In contrast, the transparency of offers now has a strong effect. Opening offers and as a consequence the rate of trade with high-type sellers are significantly lower in treatment Public Strategy than in treatment Private Strategy (non-parametric tests $p = 0.049$, multilevel regressions $p < 0.016$). The rate of trade for high-type sellers is reduced to just 11% in Public Strategy and thus close to the breakdown probability or discounting.

---

$^{17}$See the experimental design section and the instructions in the Online Appendix for more details on how we implemented the strategy method. Notice that subjects choices are incentivised as in the original treatments: In stage 1, offers cannot be conditional (there is no history) and thus the first offer determines which choices will be relevant for payment in all future stages.
theoretical prediction of 0. Two-component mixture models (similar to the ones presented in table 4) show that only 27% of all price sequences involve an offer above 16 in Public Strategy while the majority of the price sequences are centered around a maximum offer of 8.94. In Private Strategy, 69% of all price sequences reach an offer which exceeds 16.

Thus, implementing the bargaining game via the strategy method reveals results that are in line with hypothesis 3. That is, compared to the bilateral bargaining setting, adverse selection effects are mitigated by competition if offers are private but reinforced if offers are public. This begs the question why subjects behave differently in treatment Public than in treatment Private.

The equilibrium construction in the competitive bargaining setting with public offers requires buyers to use conditional reasoning of the form: “If I keep my current offer low, the next buyer will do so as well; but if I raise my current offer, the next buyer will react by offering an even higher expected offer.” The results in treatment Public show that buyers typically do not behave like this. However, the strategy method makes explicit the importance of conditional reasoning. As a result, observed behavior is closer to the equilibrium predictions. Jehiel (2005) proposes an equilibrium concept that is motivated by the observation that in complex situations agents use simplified representations to learn how their environment may react. In particular, players pool together several contingencies in which the other players must move. Applied to our setting, a buyer may believe that other buyers take into account the current length of the bargaining process (i.e., in which stage they are) but not, or not sufficiently often, what the previous offers were. Buyers doubt each other’s ability to react “correctly” to past offers. In our main treatments, the consequence is that the environment with public offers essentially reduces to the one with private offers. Using the strategy method, on the other hand, helps buyers realize the strategic richness of the environment with public offers.

5 Conclusion

We conduct an experiment examining the efficiency properties of different bargaining institutions in the presence of adverse selection. Our choice of institutions is rooted in the theoretical literature, which shows that whether or not bargaining—defined as the possibility to make repeated offers—can successfully transmit information and thus promote trade depends on the presence of time frictions, the level of competition, and the transparency of offers (i.e., whether or not offers are observable among competitors).

The experimental results are qualitatively in line with the theoretical predictions for most treatments. The possibility to bargain leads to increased rates of trade for high-type sellers and, in line with theory, time frictions are shown to be important for this result. Competition between buyers (the uninformed parties) leads to consistently high efficiency levels in our markets, independently of whether offers are private or public. The latter observation that the transparency of offers does not affect efficiency is not in line with theory. We explore this finding in more detail. Remarkably, when we implement the bargaining games via the strategy method, we observe the predicted negative effects of public offers.
That is, making explicit the strategic opportunities linked to public offers enables us to reconcile behavior in the experiment with the theoretical predictions.

Hörner and Vieille (2009b) theoretically explore the consequences of assuming that a seller is myopic with some probability. A myopic seller accepts any offer that exceeds her production costs. As a result, buyers gradually update their beliefs until at some point trade with high-type sellers must occur. This model is consistent with our data in some respects. In particular, low-type sellers do accept offers below 10 with positive probability also after stage 1. However, the presence of myopic sellers cannot explain the complete absence of a difference in behavior between treatments Private and Public. In fact, Hörner and Vieille (2009b) show that if the probability of a seller to be myopic is small the equilibrium is close to the rational one. Another possible explanation comes from the behavioral economics literature on fairness. Intention-based fairness models in the spirit of Rabin (1993) can explain why trade with high-type sellers occurs in treatment Public. The reason is that low-type sellers reject offers below, say, a price of 5, but receive a positive utility for offers slightly above 5. If low-type sellers obtain a positive utility in some stage, the bargaining game must eventually lead to offers above 16. However, fairness models are not in line with the observation that opening offers are substantially above 5 and that the seller extracts almost 100% of the gains from trade. Finally, difficulties related to mixed strategy equilibria (e.g., Ochs, 1995) do also not seem to explain our results. Randomizing offers is equally important in treatment Private, where buyers behave in line with the theoretical predictions.

Our results carry a positive message for the performance of markets with adverse selection. The welfare-enhancing effects of competitive bargaining are substantial and, in our main treatments, robust to the information buyers have about their competitors’ behavior. The theoretical literature on adverse selection has demonstrated the importance of time frictions, competition, and price transparency. Our experiment confirms that these factors are important determinants of market outcomes. At the same time, our results challenge the existing theories to better explain the interaction of risk aversion and competition and calls for a more precise modeling of how agents’ perceive a trading environment, that is, which strategic opportunities they focus on and which parts they ignore. The continuing interplay between theory and experiments is a promising avenue to improve our understanding of how to best design markets in the presence of adverse selection.
References


A Proofs