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Beyond Dividing the Pie: Multi-Issue Bargaining in the Laboratory

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Keywords: Negotiation scope, asymmetric information, bundling, alternating offers, value creation
JEL Classification: C72, C78, C91, D82

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July 7, 2022

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1 Introduction

Many bargaining situations involve negotiations along multiple dimensions or issues. For instance, an employer and a prospective hire may negotiate the salary, the duration of the contract, employee perks, a non-compete clause, and more. Negotiations between firms require agreement on the price and the range of services the seller provides to the buyer (e.g., Davis and Hyndman, 2018; Hughes and Ertel, 2020). Representatives in boards and delegations also often face bargaining problems with flexible scopes; climate change negotiations provide a noteworthy example (e.g., Nordhaus, 2015).[1] Though the case where negotiations revolve around the price of a single issue provides a vital theoretical benchmark (e.g., Rubinstein, 1982; Cramton, 1991; Deneckere and Liang, 2006), the multi-issue context introduces unique questions that call for a thorough investigation.[2]

Let us consider the following example to underscore the distinctiveness of multi-issue negotiations (Hughes and Ertel, 2020). A semiconductor company negotiates with its suppliers on technology licensing (significant gains from trade), maintenance services (smaller gains from trade), and subsequent contracts (no gains from trade). When considering each issue separately—which corresponds to the single-issue case—economic theory would predict that firms clinch an agreement on technology licensing but fail to realize the surplus on maintenance services due to incentive constraints (e.g. Myerson and Satterthwaite, 1983). In a multi-issue negotiation, there is hope that firms can overcome this inefficiency as they can link issues to achieve a joint deal on technology licensing and maintenance services. However, parties must discover both the trading prices *and* the optimal scope, the set of issues maximizing the total surplus. Identifying the optimal scope is not easy because both sides may have an incentive to misrepresent their benefits and costs.

The multi-issue case thus gives rise to under-explored considerations about information structures and types of price offers that characterize a bargaining environment. In terms of information structures, bargaining parties can possess or lack information about the surplus or the scope of an agreement. It is well-known that informational asymmetries about the surplus can stand in the way of beneficial exchange (e.g., Ausubel et al., 2002). However, little is known about the consequences of incomplete information on the optimal agreement scope. In terms of types of price offers, multiple issues introduce the possibility of issue-bundling. Parties may negotiate each issue separately, but they may also choose to link issues by making price offers on a bundle of goods or services. While different literatures in

[1]The central issue is a harmonized carbon price, but many have argued for expanding the scope to facilitate progress (e.g., Cramton et al., 2017). Other examples include legislative bargaining (e.g., Christiansen et al., 2014; Baranski et al., 2020) and tariff negotiations (e.g., Bagwell et al., 2020).

[2]One reason for the focus of the literature on single-issue bargaining is the rich environment it already provides. For example, there is no known complete characterization of equilibria for the incomplete information case (e.g., Ausubel et al., 2002), and pinning down trading prices is surprisingly tricky.

economics point to the importance of bundling for efficient exchange—consider multi-unit auctions (e.g., Klemperer, 2002; Goeree and Lindsay, 2020), monopoly pricing (e.g., Stigler, 1963; Crawford and Yurukoglu, 2012), and management (e.g., Fisher et al., 1981; Susskind, 2014)—few studies have looked at it in the context of bargaining.

We address the following key questions to understand how information and bargaining protocols shape multi-issue negotiations. First, does lack of information about the optimal agreement scope hamper beneficial exchange and agreements? The theoretical answer depends on whether negotiators can bundle price offers across different issues. Our second question is thus: Are integrated negotiations (bundling) critical for reaching beneficial agreements in multi-issue bargaining? In the semiconductor company example, uncertainty about the optimal scope leads to inefficiency when separating technology licensing and maintenance services negotiations. Remarkably, more integrated negotiations allow specific price offers on bundles of issues such that we predict negotiators to achieve an efficient joint deal. Integrated negotiations also contribute to a different mindset for negotiations, one of problem-solving (identifying agreement scopes) rather than the mere surplus division. Indeed, the behavioral norms individuals adopt are a critical aspect of all bargaining environments. We want to understand how bargaining conventions arise and how individual traits of the negotiators representing the two firms affect bargaining outcomes. Put differently: What are the main features of the bargaining process when there are multiple issues?

We design a series of multi-issue bargaining lab experiments to examine these questions. Subjects interact through computer terminals in an unstructured bargaining environment with three issues that we call "items". They continuously make, accept and reject price offers. In expectation, 50% of the items contain a positive surplus such that bargainers must figure out which items they should or should not trade. We consider the following information structures. In the No Information condition, players know neither the total surplus nor the optimal scope of an agreement. In the Intermediate Information condition, players learn the total surplus but remain uncertain about the optimal scope. In the Complete Information condition, players know both the total surplus and the optimal scope. In such a case, negotiations are only about how to distribute the gains from trade. We also vary the bargaining protocol: Bundling, where price offers can be made on any combination of items, and thus negotiations are integrated, versus Item-by-Item, where the price offers can only be made separately for each item. Lastly, we elicit bargainers' risk and fairness preferences.

Our theoretical hypotheses build on the existing bargaining literature. It is well-known that a lack of information can preclude efficiency because incentive constraints cause trade failures for small-surplus items (e.g., Myerson and Satterthwaite, 1983; Chatterjee and

Samuelson, 1983; Jackson and Sonnenschein, 2007). Theoretically, trade failures should be mitigated under complete information, although our data reveal that improved information can also backfire. We base the predictions for the intermediate information structure on recent insights by Jackson et al. (2020). They find that, remarkably, uncertainty about the scope of an agreement does not preclude efficiency. However, achieving efficiency (i.e., all weak Perfect Bayesian equilibria are efficient) does require a sufficiently rich bargaining protocol, such as the one implemented in our bundling conditions.

Our main empirical findings both support and qualify the theoretical predictions. We find that bargaining outcomes under intermediate information are (i) nearly equivalent to those observed under complete information when bundling is possible but (ii) nearly equivalent to those observed under no information when price offers are restricted to item-by-item. Revealing information about the aggregate surplus rather than more specific information about the individual issues can therefore go a long way in alleviating trade failures typical of asymmetric information. The beneficial effect of surplus information on agreement rates only materializes when bundling is possible, as it helps negotiators identify optimal agreement scopes. This finding demonstrates the importance of integrated negotiations. Indeed, we find that going from no information to intermediate information leads to *fewer* agreements when bundling is *not* possible. A suitable bargaining protocol is thus crucial for information about the deal's total surplus to be meaningful. Another takeaway from our study is that too much information (complete information) may backfire. On the one hand, giving bargainers access to more information boosts agreement rates in small-surplus negotiations; on the other hand, it triggers increased risk-taking and conflicting fairness preferences in large-surplus negotiations.

To explain why more information can backfire, we note that the data reveal two leading causes of disagreement. One cause is the predicted trade failures due to information asymmetry. The second cause relates to behavioral factors, particularly conflicting views on a 50-50 division norm and differences in risk preferences. Better information conditions (i.e., complete information or intermediate information with bundling) help avoid trade failures salient in the no information case. This effect mainly occurs for small-surplus aspects where incentive constraints preclude trade. However, in large-surplus negotiations, better information has a detrimental effect on trade as it causes brinkmanship, an insistence on one's bargaining terms by delaying agreement in the face of a possible negotiation breakdown. Better information also activates fairness preferences, which play no role in the no information condition. This evidence links to a familiar idea in the negotiation literature: parties should focus on value creation or problem-solving rather than value claiming or distributional concerns (e.g., Fisher et al., 1981; Susskind, 2014). We show that improved information about the aggregate surplus shifts the focus from problem-solving to one where parties become only concerned about relative surplus shares. We also provide counterfactual estimations that show these behavioral preferences are the critical hurdle preventing efficiency under intermediate and complete information.

In addition to the main results discussed above, we examine the bargaining strategies employed by the subjects in the experiment. We find that the subjects use bundles often and successfully, but we also find significant differences compared with the theoretical predictions caused by the price discovery process. Subjects tend to start negotiating with offers on individual items, while bundles only come into play later. The attempt to integrate negotiations also results in more aggressive offers on bundles than individual items. Bundled offers correspond to the theoretical equilibrium only after a period of back-and-forth negotiations. These observations have two important implications. First, negotiators should avoid a natural tendency to "start simple" by first trying to agree on particular, easy-to-agree-on issues. Early agreement on a subset of the possible scope can complicate negotiations and limit the ability to negotiate holistically. Second, since reaching a compromise takes the longest for negotiations on bundles, bargaining institutions should allow for repeated offers.[3]

Finally, we uncover a compelling congruence with the empirical bargaining literature. In two recent studies, Backus et al. (2020) and Keniston et al. (2021) identify a pervasive bargaining pattern, ranging from eBay to used-car bargaining and from housing to trade tariff negotiations. This pattern is a split-the-difference approach to bargaining, where a negotiator's offer falls halfway between their own and the other side's most recent offer. Such price offers do not necessarily constitute a fair split of the surplus but reflect a fairness convention about the bargaining process. We find that meeting the other's offer halfway is also the dominant pattern in our data. The pattern exists for offers on individual items and bundles and across the different information structures. We also relax the conditions required to observe the pattern. In contrast to Backus et al. (2020) and Keniston et al. (2021), offers in our unstructured bargaining setting can be made in any order. We accordingly observe an endogenous emergence of an alternating-offer bargaining institution necessary for reaching an agreement through split-the-difference offers. Our findings thus also lend support to the salience of the alternating offer game (Stahl, 1972; Rubinstein, 1982) as the dominant bargaining protocol studied in the literature.

Our experimental results may serve as a guidepost for expected negotiation outcomes. Recall the semiconductor company example. In the no information case, bargaining should end with an agreement on technology licensing but a failure on maintenance services. In the intermediate information case, where parties accurately estimate the total surplus, only

[3]For example, the commonly studied ultimatum game structure (Güth et al., 1982), adjusted for multiple items, is not flexible enough for bundling to make a difference. We show in online Appendix B.1 that bundling is hindered in an ultimatum game setting.

bundled negotiations can alleviate informational asymmetries. Bundled negotiations are successful because a specific set of offers allows bargaining parties to identify the optimal agreement scope.[4] Without bundled offers, a deal on maintenance services is still not in reach because information about the total surplus does not resolve the uncertainty about the distribution of the gains from trade across items. Finally, the intermediate and complete information structures introduce trade failures due to heterogeneity in fairness and risk preferences. Better information conditions thus bear the risk of stalling compromise when negotiators focus too much on relative gains.

We organize the remainder of the paper as follows. Section 2 embeds the article in the literature. Section 3 discusses the theoretical background. Section 4 presents the experimental design. Section 5 discusses the empirical results. Finally, Section 6 concludes.

2 Related Literature

Intermediate information relaxes the complete information assumption frequently invoked in single-issue bargaining by introducing uncertainty about the optimal scope. The labor literature, for instance, often relies on the assumption that employer-employee negotiations take place under complete information (e.g., Manning, 2021). However, as stressed in Hall and Mueller (2018), preferences for non-wage job components such as commuting time or employee perks are heterogeneous. The intermediate information structure captures such preference heterogeneity through uncertainty about *which* non-wage components should enter an agreement, retaining the assumption that the aggregate surplus is approximately known.[5] Therefore, the intermediate information structure describes cases that in a single-issue model would come close to complete information, but for which the analyst deems it essential to allow for a flexible agreement scope. It also closes a gap between the economics and the less formal negotiation literature. The latter has long emphasized the importance of flexible agreement scopes (e.g., Fisher et al., 1981; Bazerman and Neale, 1993; Susskind,

[4] Suppose the total surplus is \$30 million. Further, the semiconductor company believes it has more bargaining power and wants to claim two-thirds of the surplus. Without giving away information, the company can make a set of price offers that generates \$20 million in expected gains. Price offers are higher on bundles than individual items because bundles have a higher value. Specifically, it ensures that the semiconductor company's share of the total surplus is constant across the different bundles. Hence, the best offer for the suppliers is the one on the bundle that maximizes total surplus. The efficient scope of agreement is realized, i.e., technology licensing and maintenance services.

[5] Another familiar example of the intermediate information structure is when a dean negotiates an offer with a prospective faculty hire. Both parties typically have a common understanding of the value created when the relationship forms. Nevertheless, asymmetry of information prevails. The researcher is unaware of the dean's ability to adjust the offer on different issues, e.g., salary, teaching load, or competitive benefits. The dean is unaware of the desirability of each of these issues to the researcher. It is also apparent why bundling can be a useful negotiation tool: It allows parties to connect, for instance, a salary-related request with another issue such as the teaching load.

2014; Hughes and Ertel, 2020).

Another motivation for the intermediate information structure comes from the bargaining literature on incomplete information. There, the key mechanism revealing information is the delay of agreement and the associated signal about the willingness to incur opportunity costs (e.g., Fudenberg and Tirole, 1983; Cramton, 1991; Fanning, 2016; Bochet and Siegenthaler, 2018). Alternatively, delay is beneficial because of public information that can arrive exogenously (e.g., Daley and Green, 2012) or endogenously (e.g., Hörner and Vieille, 2009) during the bargaining process. Both types of information revelation concern the agreement surplus. However they are uninformative about the optimal scope. One can thus interpret intermediate information as a situation where delay has already revealed information about the surplus but where the agreement scope remains uncertain.

We find that intermediate and complete information reduce trade failures for small-surplus items. This is in line with a large experimental literature on one-sided (e.g., Forsythe et al., 1991; Cason and Reynolds, 2005; Camerer et al., 2019) and two-sided (e.g., Valley et al., 2002; Ellingsen et al., 2009) incomplete information bargaining. More surprisingly, we show that better information can also negatively affect trade due to excessive risk-taking and conflicting fairness views in large-surplus negotiations. Experiments on single-issue bargaining have documented extensively the relevance of behavioral factors such as fairness or strategic sophistication, see e.g. Roth (1995), Cooper and Kagel (2016), Fehr and Schmidt (1999), Bolton and Ockenfels (2000), Andreoni and Miller (2002), Embrey et al. (2015), Fanning and Kloosterman (2019) and Bochet and Siegenthaler (2021). Closely related to us are Babcock et al. (1995), who document that an increased surplus can affect agreement rates negatively under complete information, and Huang et al. (2020), who show in an ultimatum bargaining context that fairness concerns are more pronounced when information is complete than when it is incomplete. See also Crawford (1982) for a related theoretical analysis and Karagözoğlu and Urhan (2017) for a review of experiments on stake size. Overall, our multi-issue experiment is a natural next step in the literature, building on the co-evolution of bargaining theory and experiments in the past four decades.

Though there are obvious differences between multi-item bargaining and multi-unit auctions, a common question is whether bundling can improve performance. Goeree and Lindsay (2020) demonstrate the benefits of package bidding in double auctions when there is an exposure problem, i.e., when more than two agents interact and only a series of risky trades achieves the optimal assignment of objects. The authors also implement bargaining treatments, showing that bargainers' ability to form good trading packages hinges on favorable information conditions. Other related studies on multi-unit auctions and bundling include Klemperer (2002), Engelmann and Grimm (2009), Brunner et al. (2010), Goeree and Holt (2010), Lindsay (2018), and Matoušek and Cingl (2018). Inderst (2000) and Lang and Rosenthal (2001) consider bundling in an agenda-setting context. Concurrently to our study, Jackson et al. (2020) also conducted an experiment on multi-issue bargaining that allows for bundling, focusing on a setting where participants can infer the aggregate surplus from the distribution of valuations and costs. Finally, the monopoly pricing literature (e.g., Stigler, 1963; Bakos and Brynjolfsson, 1999; Crawford and Yurukoglu, 2012) stresses another benefit of bundling, which is that it improves a firm's ability to engage in price discrimination.

In the introduction, we describe a similarity between the dominant bargaining institution we identify in the experiment—one where negotiators alternate offers and meet each other's demands halfway—and the empirical literature on bargaining processes (Backus et al., 2020; Keniston et al., 2021). There is another connection worth mentioning. Larsen (2020) studies bargaining in the wholesale used-car industry. The author estimates bounds on agents' valuations by exploiting auction outcomes that occur before bargaining. This allows him to conclude that the leading cause of inefficiency in his setting are behavioral factors, just like in our complete information treatments. Additionally, we show that when there is less information, the magnitude of inefficiency remains the same but the source changes from risk and fairness preferences to binding informational incentive constraints—see also Ambrus et al. (2018) who use a historical data set of captives ransomed from North African pirates to estimate the valuations of the negotiators.

Finally, the negotiation literature has long emphasized that determining the right agreement scope is a primary component of almost all real-world negotiations (e.g., Fisher et al., 1981; Bazerman and Neale, 1993; Susskind, 2014; Hughes and Ertel, 2020). The goal often lies in improving a relationship by creating instead of claiming value and engaging in explorative rather than distributive bargaining. This literature is informal such that there are no precise predictions on how information or bundling might affect agreement rates. One interpretation of our study is thus that it represents a formal and testable approach to value creation. Other studies like Frankel (1998), Bac (2001), Baranski (2016) and Baranski (2019) also provide models of value creation, but they think of the problem in terms of public good provision rather than discovering the scope of an agreement.

3 Theoretical Background

We consider bargaining between two agents, a buyer and a seller, who negotiate a deal involving a set of items $N = \{1, 2, \ldots, n\}$. The buyer has a valuation v_i for each item $i \in N$, drawn from a finite set $V \subset \mathbb{R}$ according to a probability mass function f. The seller has a reservation cost c_i for each item $i \in N$, also drawn from f for simplicity.

Time advances in discrete periods $t \in \{0, 1, \ldots\}$. In each period, the proposer offers a finite number of offers. An offer (K, p_K) consists of a set of items $K \subseteq N$ and a corresponding price p_K at which the set of items trades if the offer is accepted. If bundling is possible, an offer can include all possible subsets of items; if bundling is not possible, an offer is for a single item, i.e., $|K| = 1$. The responder observes all offers and chooses which ones to accept, with the obvious restriction that two offers containing the same item cannot both be accepted.

There are time frictions. After any period, the next period is entered with probability $\delta \in [0, 1)$, otherwise the bargaining process stops. Let $\mathcal{K}$ be the set of accepted offers when the bargaining process stops. For a given offer (K, p_K), let $v_K = \sum_{i \in K} v_i$ and $c_K = \sum_{i \in K} c_i$, respectively, be the sum of the buyer's valuations and the seller's reservation costs over the items in K. The payoffs realized when bargaining concludes are $\Pi_B = \sum_{K \in \mathcal{K}} (v_K - p_K)$ for the buyer and $\Pi_S = \sum_{K \in \mathcal{K}} (p_K - c_K)$ for the seller.

Multiple items introduce information structures that lie between the interim (private values) and ex-post (complete information) stage. In particular, agents can be informed about the total surplus of an agreement while remaining uncertain about the agreement scope (i.e., there can still be significant uncertainty about valuations and costs for individual items). Let the possible surplus from item i be denoted by $S_i = \max(v_i - c_i, 0)$. The aggregate or *total surplus* over all items is then $TS \equiv \sum_{i \in N} S_i$. The following theorem due to Jackson et al. (2020) states a key prediction for our experiment.

Theorem 1 *Consider a multi-issue bargaining problem with a commonly known total surplus $TS > 0$: (i) if bundling is possible, then in all weak perfect Bayesian equilibria*[6]*, agreement happens immediately and the whole surplus is realized. Moreover, the distribution of surplus is the same as in complete information bargaining; (ii) if bundling is not possible, then all equilibria are inefficient.*

Theorem 1 predicts that the value of information about the total surplus in promoting agreement rates depends on the availability of bundling. We did not specify whether the initial proposer is the buyer or the seller and how proposer roles change over time. The theorem holds for all cases. For example, if the total surplus is commonly known, bundling is possible, and the buyer is the proposer in all periods, then an immediate agreement allocates the entire surplus to the buyer. If players alternate in making offers, the initial proposer's payoff equals $\frac{TS}{1+\delta}$ and the responder's payoff equals $\frac{\delta TS}{1+\delta}$, equivalent to the outcome predicted in complete information alternating offers bargaining (Rubinstein, 1982). If the first player makes a take-it-or-leave-it offer (i.e., $\delta = 0$), the proposer's payoff equals TS, and the responder's payoff equals 0.

[6] A weak perfect Bayesian equilibrium is a strategy profile and a consistent belief system for which the strategy satisfies sequential rationality. A belief system is consistent if beliefs are generated from the strategy profile through Bayes' rule whenever possible (i.e., for any history reached with positive probability).

We present an example to demonstrate the roles of bundling and a commonly known total surplus in multi-issue bargaining.

Example 1 *There are three items: A, B and C. For each item, the buyer's valuation and the seller's cost are drawn from the uniform distribution on* $[0, 1]$. *The buyer makes a set of take-it-or-leave-it offers to the seller, i.e.,* $\delta = 0$. *Suppose the buyer's realized valuations are* $(v_A, v_B, v_C) = (0.5, 0.5, 0.5)$ *and the seller's reservation costs are* $(c_A, c_B, c_C) = (0.4, 0.9, 0.4)$. *The total surplus of $TS = 0.2$ is realized when items A and C are traded and item B is not traded.*

(i) Item-by-Item & Unknown Total Surplus: *When bundling is not possible and the total surplus is not known, the buyer's maximization problem is given by* $\max_{p_i} Prob[c_i \leq p_i] \times (v_i - p_i) = \max_{p_i} p_i(v_i - p_i)$ *for each item i. This corresponds to three separate single-issue problems, as bundling is not possible and no aggregated information is available. The solution is $p_i^* = v_i/2$, which in our example implies that the optimal set of offers is* $(\{A\}, 0.25)$, $(\{B\}, 0.25)$, $(\{C\}, 0.25)$. *Note that the seller will not accept any of these offers. Bargaining is inefficient.*

(ii) Bundling & Unknown Total Surplus: *The buyer's optimal set of offers when bundling is possible but the surplus is unknown is given by* $(\{A\}, 0.25)$, $(\{B\}, 0.25)$, $(\{C\}, 0.25)$, $(\{A, B\}, 0.67)$, $(\{A, C\}, 0.67)$, $(\{B, C\}, 0.67)$, *and* $(\{A, B, C\}, 1.12)$. *The optimal offers follow the same logic as in case (i) except that the buyer can also offer bundles.*[7] *The offered price for the efficient bundle $\{A, C\}$ of 0.67 falls short of the seller's reservation cost of 0.8. Bargaining is again inefficient. However, if the reservation costs of the seller were lower, e.g., $c_A = c_C = 0.3$, then the efficient bundle would be traded in case (ii), while the offers on single items in case (i) would still be too low to generate trade. That is, bundling can potentially promote efficiency.*

(iii) Item-by-Item & Known Total Surplus: *If the surplus is known but bundles cannot be offered, the only set of offers that would guarantee an efficient outcome for all realizations of the reservation costs of the seller is* $(\{A\}, 0.5)$, $(\{B\}, 0.5)$, $(\{C\}, 0.5)$. *This cannot be optimal as it implies a payoff of 0 for the buyer. Therefore, bargaining is inefficient even when TS is commonly known. Note that the buyer's offer for each item i must be at least $v_i - TS = 0.3$ because lower offers would always fall short of the seller's reservation cost. Offering* $(\{A\}, 0.3)$, $(\{B\}, 0.3)$, $(\{C\}, 0.3)$ *would lead to an efficient outcome if the entire surplus is concentrated on a single item (but not otherwise), thus potentially promoting efficiency compared to case (i).*[8]

[7] For each bundle K the buyer maximizes $Prob[c_K \leq p_K] \times (v_K - p_K)$ where c_K is distributed according to the Irwin-Hall distribution $\frac{1}{n!}\sum_{i=0}^{\lfloor p_K \rfloor}(-1)^i\binom{n}{i}(p_K - i)^n$, the cumulative distribution function of a sum of n continuous uniform random variables on the interval $[0, 1]$.

[8] Characterizing optimal offers is a difficult problem in (*iii*). Information about the surplus changes the

(iv) Bundling & Known Total Surplus: *If bundling is possible and the surplus is commonly known, the buyer's optimal set of offers is* $(\{A\}, 0.3)$, $(\{B\}, 0.3)$, $(\{C\}, 0.3)$, $(\{A, B\}, 0.8)$, $(\{A, C\}, 0.8)$, $(\{B, C\}, 0.8)$, *and* $(\{A, B, C\}, 1.3)$. *The offers are constructed by summing the buyer's valuations over the items contained in an offer and subtracting* TS. *The seller's best response is to accept* $(\{A, C\}, 0.8)$ *and earn a payoff of 0 (or* ϵ*); all other offers imply a negative payoff for the seller. The buyer receives the entire total surplus (as* $\delta = 0$*) and bargaining is fully efficient.*

Case (*iv*) shows that bargaining is efficient when the total surplus is known and bundling is allowed. Importantly, this result does not depend on the particular parameters of the problem. It holds for all distributions and realizations of valuations and reservation costs, as implied by Theorem 1. If $\delta > 0$, equilibria follow a similar idea as with take-it-or-leave-it offers, and efficiency is still guaranteed. The difference is that the initial proposer would only demand a fraction of the surplus due to the possibility of counteroffers.

Cases (*i*) to (*iii*) demonstrate that without information about the total surplus or the possibility of bundling (or both), bargaining is, in general, inefficient. It does not come as a surprise that the presence of asymmetric information causes inefficiencies (e.g., Chatterjee, 1982; Myerson and Satterthwaite, 1983). Interestingly, bundling of issues is also critical for reaching efficiency, as it helps bargainers identify the optimal scope of an agreement.

4 Experiment Design

We implement six main treatments in an unstructured bargaining setting.[9] The treatments vary the offer protocol (*Item-by-Item* versus *Bundling*) and the information structure (*No Information*, *Intermediate Information* and *Complete Information*). We implement additional treatments to study multi-issue ultimatum games and a situation when the surplus is known only approximately.

4.1 Items, Valuations, and Costs

In each experiment round, subjects are randomly matched into pairs and assume the role of the buyer or seller. They then negotiate to strike a deal on up to three items: A, B, and C. For each item i, the buyer's valuation v_i and the seller's reservation cost c_i are drawn

buyer's belief about the seller's reservation costs, and the updating is conditional on the buyer's valuations for the different items. It is sufficient to know that all offers must be in the range $[0.3, 0.5)$ and hence inefficiency is unavoidable.

[9] Recently, the experimental literature on bargaining has returned to unstructured bargaining protocols, as in many instances unstructured interaction is believed to mirror real-world negotiation environments better than a protocol with fixed proposer-responder rules (e.g., Gächter and Riedl, 2005; Bolton and Karagözoğlu, 2016; Camerer et al., 2019; Karagözoğlu, 2019; Embrey et al., 2021).

Table 1: Treatments

Treatments	Subjects
Unstructured Bargaining	
1. *No Information & Item-by-Item*	70 (7)
2. *No Information & Bundling*	100 (10)
3. *Intermediate Information & Item-by-Item*	70 (7)
4. *Intermediate Information & Bundling*	100 (10)
5. *Complete Information & Item-by-Item*	70 (7)
6. *Complete Information & Bundling*	100 (10)
Additional Treatments	
Treatments 1-6 but with take-it-or-leave-it offers (multi-issue ultimatum game)	240 (24)
Treatments 2,4,6 but with noisy information about valuations and costs	180 (18)

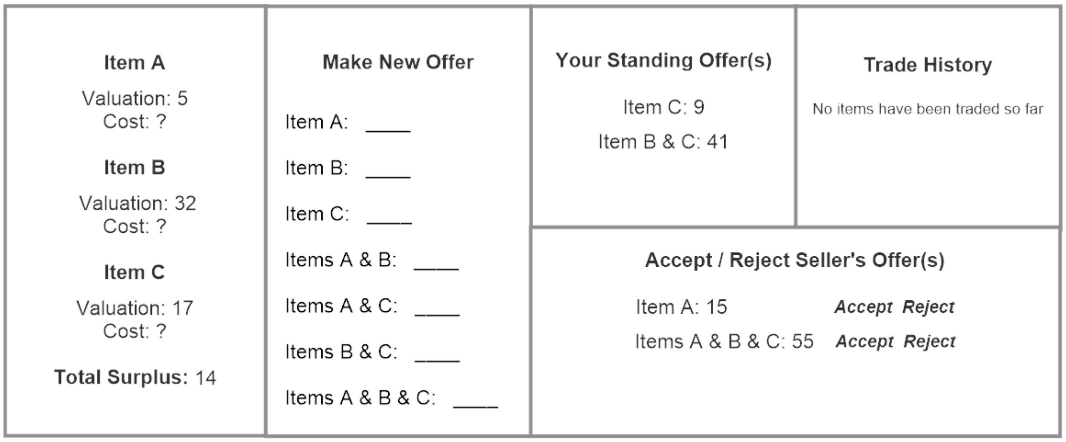
Sessions were run at the Laboratory for Research in Behavioural Experimental Economics (LINEEX) at the University of Valencia in June 2016, May 2017, and November 2020. The total number of participants is 930. The number of independent matching groups is given in parentheses.

from the discrete uniform distribution $\mathcal{U}\{0,33\}$. Thus, in expectation, half of the items contain a positive surplus and should be traded. The maximum total surplus is $3 \times 33 = 99$, which occurs if $v_i = 33$ and $c_i = 0$ for each item. The minimum total surplus is 0, which occurs if $v_i \leq c_i$ for each item. The expected surplus per item is 5.66; thus, the expected total surplus across the three items is 16.98. If an offer on a set of items K at price p_K is accepted, the buyer earns $v_K - p_K$ and the seller earns $p_K - c_K$, where $v_K = \sum_{i \in K} v_i$ and $c_K = \sum_{i \in K} c_i$.

4.2 Information Structures

We consider three information structures. The buyer and seller are informed about their valuations or reservation costs in all cases. In *No Information*, bargainers only know the distribution from which the valuations and reservation costs of the other party are drawn (discrete uniform between 0 and 33) but do not receive any information about the realized values. In *Intermediate Information*, players are also informed about the total surplus, given by $TS = \sum_{i \in \{A,B,C\}} \max(v_i - c_i, 0)$. Finally, in *Complete Information*, each player is in addition informed about the other party's valuation or reservation cost for each item. Bargainers can infer the total surplus from the information about individual items under complete information. However, we also explicitly inform the participants about the value of TS to guarantee that complete information is strictly more informative than intermediate information.

Figure 1: Diagram of Decision Screen



Notes: Example of buyer's decision interface with bundling and intermediate information. The left panel shows the buyer's valuations and the total surplus; the seller's reservation costs are unknown to the buyer. In panel 'Make New Offer', the buyer can make offers for single items and bundles. Own offers that have not yet been accepted or rejected are shown in panel 'Your Standing Offer(s)'. Offers from the seller can be accepted or rejected in the 'Accept/Reject Seller's Offer(s)' panel. All accepted offers are listed under 'Trade History'. The interface looks similar under no information, except that the total surplus is unknown. Under complete information, the seller's costs are known additionally.

4.3 Offer Protocol

The offer protocol plays an essential role in the predicted equilibrium outcomes. In particular, bargainers' ability to make offers on bundles of items can be necessary for reaching efficiency. We consider *Item-by-Item* bargaining, where only offers on individual items A, B, and C are possible and compare it to the *Bundling* protocol, where bargainers can make offers on all possible combinations of items. In particular, there are 7 combinations of items: each item A, B and C as well as the bundles $\{A, B\}$, $\{A, C\}$, $\{B, C\}$ and $\{A, B, C\}$.

4.4 Negotiation Interface

Figure 1 illustrates the experimental interface for the intermediate information treatment (the total surplus is known) in which the offer protocol allows for bundling. In the item-by-item bargaining protocol, the four bottom rows in the panel 'Make New Offer' would be unavailable. The information conditions vary the information given in the panel on the left of the interface.

We study unstructured bargaining. At any point in time, both bargainers can (i) make offers on untraded items, (ii) accept or reject the other party's standing offers, and (iii) cancel their standing but unaccepted offers. We impose no structure on the bargaining process except that it is anonymous and all interactions occur through price offers, i.e., there is no chat or face-to-face communication. Naturally, an item can be traded only once. For example, if the proposer offers a price for item A and a price for bundle $\{A, B\}$, the other party can accept only one of these offers. On the other hand, an offer for item A and an offer for bundle $\{B, C\}$ can both be accepted. The game ends if all items trade, both sides independently agree to end the negotiation, or there is a bargaining breakdown. We allow for an initial minute without the risk of experiencing a bargaining breakdown to give subjects time to negotiate and form expectations. After the first minute, the breakdown occurs with a probability of 4% every 10 seconds.[10]

4.5 Behavioral Hypotheses

Our hypotheses are grounded in the theoretical bargaining literature. Incomplete information is a well-known source of inefficiency. Myerson and Satterthwaite (1983) and Chatterjee and Samuelson (1983) show that even under an optimal trading mechanism, small-surplus items will not change hands due to incentive constraints. Case (i) in Example 1 also illustrates this point. Hence, we expect that in our *No Information* setting, it will be difficult for subjects to trade small-surplus items, which for our distribution of valuations and costs are items with a surplus of 8 or less.

Hypothesis 1 (Agreement Failures in No Information) *Agreement rates under complete information are higher than under no information. Trade failures for small-surplus items ($S \leq 8$) drive this difference.*

The second and third hypotheses are specific to the multi-issue context and follow Theorem 1.

Hypothesis 2 (Value of Intermediate Information) *Agreement rates under intermediate information & bundling are similar to those under complete information and higher than those under no information.*

Hypothesis 3 (Richness Condition) *Agreement rates under intermediate information are higher for the bundling than the item-by-item offer protocol.*

A key strength of Theorem 1 is its applicability to a wide range of bargaining institutions including take-it-or-leave-it offers, alternating-offer bargaining, when one side makes offers repeatedly, or any mixture of these. It is thus an appropriate theoretical benchmark for our unstructured bargaining environment. It is worth noting that Theorem 1 also makes

[10] The breakdown probability after the first minute induces moderate pressure to reach an agreement. Subjects knew the breakdown probability. We also explained that bargaining lasts at least 1 minute, continues beyond 2 minutes with a chance of 78% (according to the breakdown probability), beyond 3 minutes with a chance of 61%, and so on. The game ends for sure after 12 minutes, but this point was never reached.

predictions about the distribution of surplus, in addition to those on agreement rates. We do not include distributional predictions in Hypotheses 2 and 3 because proposer power is not varied across our treatments.

4.6 Procedures

We ran the experiment at The Laboratory for Research in Behavioural Experimental Economics (LINEEX) at the University of Valencia between 2016 and 2020. We programmed the software in z-Tree (Fischbacher, 2007). As shown in Table 1, there are six main treatments with unstructured bargaining. We also ran treatments on multi-issue ultimatum bargaining and with noisy information. We report the results in online Appendix B. The total number of participants is 930. For our main treatments, we gathered data from 100 subjects in 10 independent matching groups or 70 subjects in 7 independent matching groups, implemented in 3 separate sessions per treatment. Each subject participated in one treatment only. Payments were made privately in cash at the end of a session. Average earnings were €28 per subject, including a show-up fee of €5. Sessions lasted on average 120 minutes, and the maximum duration was 150 minutes.

At the start of a session, we distributed written instructions. They are available in online Appendix C. The instructions explained the bargaining setting, how valuations and costs are generated, and how subjects' payoffs are computed. All subjects completed a comprehension test. Subjects were randomly assigned the role of a buyer or a seller (which remained fixed) and divided into matching groups of size 10. Each session had 10 periods of the bargaining game. In each period, subjects in a matching group were randomly rematched into pairs. There were no identifiers. At the end of a period, subjects received feedback about valuations, reservation costs, and earnings. We paid for all periods.

4.7 Elicitation of Risk and Fairness Attitudes

At the end of a session, subjects also had to complete two further tasks. We randomly selected one of the tasks to be paid.

In the risk elicitation task, subjects had to choose one lottery among the following six: 80% chance of winning €2, 70% chance of winning €3, 60% chance of winning €4, 50% chance of winning €5, 40% chance of winning €6, and 30% chance of winning €7. Each subject then received the selected amount with the corresponding probability. The lottery choices order subjects by risk preference, with the first lottery revealing the greatest risk aversion and the last one being the most risk-loving choice. The median choice was lottery 3 (60% chance of winning €4), and 94% of the subjects chose lottery 2, 3, 4, or 5. There are no significant differences in the distribution of lottery choices across treatments

(Kruskal–Wallis test, $p = 0.726$), with the median choice always being 3, the mean choice being between 3.11 and 3.39, and the standard deviation being between 1.08 and 1.17. We use the lottery choice to proxy a subject's risk tolerance.

In the fairness elicitation task, subjects had to play the following ultimatum bargaining game. Person A had to distribute €5 between herself and person B. Person B had to specify a minimum offer they are willing to accept before knowing Person A's proposed split. If Person A's proposed split covers Person B's minimum acceptable offer, the split was implemented. Otherwise, both earned 0. Both subjects in a pair made decisions in both roles. Pairs were randomly matched in a session.

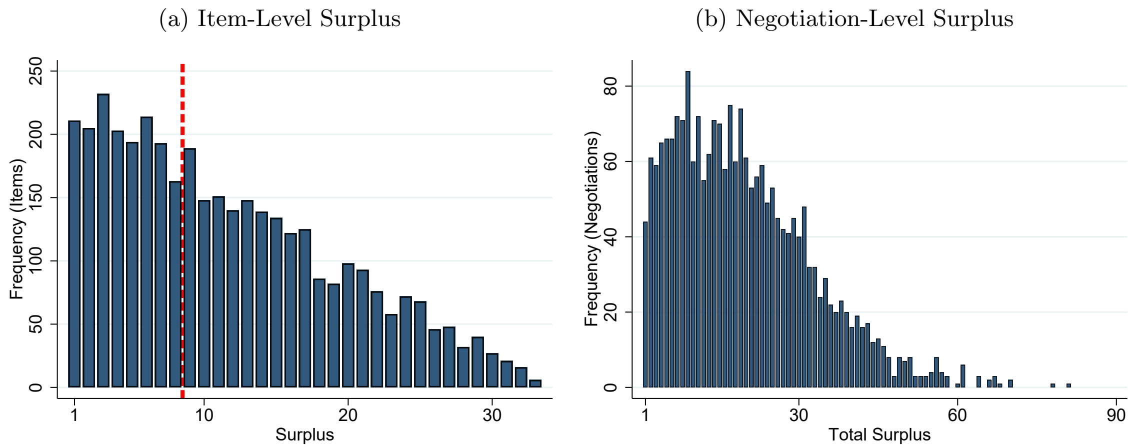
For each subject, we observe two pieces of fairness-related information. First, the minimum offer a subject is willing to accept captures a subject's inequality aversion. Interestingly, 56% of the subjects chose a minimum acceptable offer of exactly 10. These subjects insist on a norm of 50-50 division (e.g., Andreoni and Bernheim, 2009). Most other subjects (32%) chose minimum acceptable offers of less than 10. They are willing to grant the proposer a higher share. Second, we observe a subject's proposed split. It depends on the subject's conformity to the 50-50 norm and her beliefs about the other person's minimum acceptable offer. About 64% of the subjects proposed a split that allocates exactly 10 to themselves and the other person. These subjects thus want to follow the 50-50 norm or believe the other subject insists on the 50-50 split. Most other subjects (30%) propose a split that allocates more than half to themselves. Such behavior constitutes a violation of the 50-50 division norm. We thus define a dummy *Violates 50-50 Norm* equal to 1 if a subject proposed a split that, if accepted, gives more than half of the pie to herself. The dummy captures the idea that deviations from the 50-50 split likely have a non-continuous interpretation given the concentration on equal splits.[11]

5 Results

Section 5.1 contains the main results and hypotheses tests. Section 5.2 provides an analysis of the bargaining process.

[11]Note that the proposed split cannot decrease the other side's acceptance threshold as Person B did not observe Person A's proposed split when choosing her minimum acceptable offer. A low proposed split thus cannot be used to signal an aggressive bargaining stance. Instead, the proposed split depends only on a subject's internalized preference for the 50-50 division norm or social expectations about the 50-50 norm. The proposed split may depend on risk preferences. However, there is no significant correlation between the proposed split in the ultimatum game and the risk measure from the lottery task: Spearman's rho equals 0.051. The null hypothesis that the lottery choice and the proposed split are independent cannot be rejected ($p = .244$). In addition, our regressions will control for risk preferences.

Figure 2: Surplus Histograms



Notes: ***(a)*** Frequency of item surplus (S) conditional on $S > 0$. Items to the left of the vertical dashed line ($S \leq 8$) are not traded in the optimal trading mechanism. ***(b)*** Frequency of total surplus (TS) for the three items in a negotiation conditional on $TS > 0$.

5.1 Empirical Test of Hypotheses

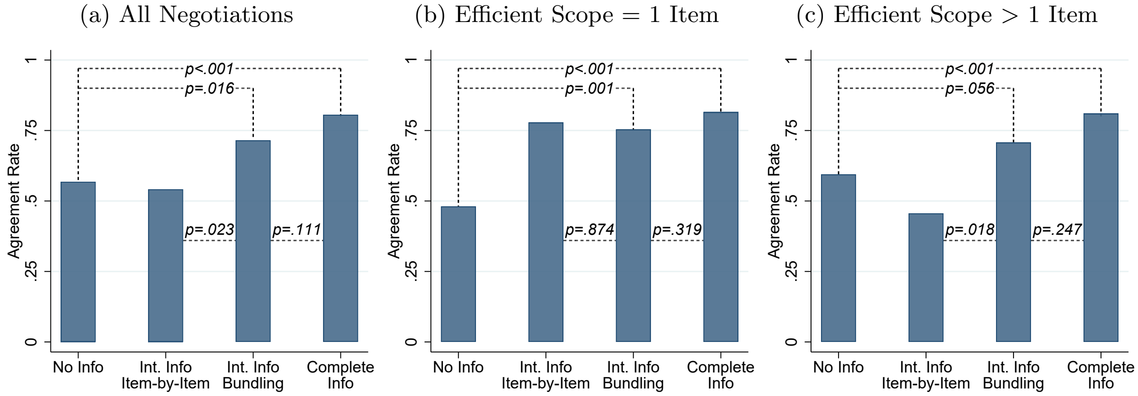
Figure 2a shows the distribution of item surplus conditional on an item having a positive surplus, $S > 0$. Items to the left of the dashed line contain a surplus of eight or less, i.e., $S \leq 8$. We refer to them as *small-surplus* items. Small-surplus items are not traded in theory under the optimal mechanism when bargainers have incomplete information. In other words, theory predicts trade failures of small-surplus items in the No Information treatments and Intermediate Information & Item-by-Item. On the other hand, theory predicts that small-surplus items trade in Intermediate Information & Bundling and both Complete Information treatments.

5.1.1 Agreement Rates

Figure 3a shows the empirical agreement rates for small-surplus items. The agreement rate is the number of positive-surplus items that trade divided by the total number of positive-surplus items. The p-values stem from two-sided Wilcoxon rank-sum tests.[12] For the intermediate information structure, we show the Bundling and Item-by-Item treatments

[12] We use two-sided Wilcoxon rank-sum tests for all non-parametric treatment comparisons. The unit of observation for these tests is the average outcome in an independent matching group. That is, the statistical tests between No Info and Complete Info in Figure 3 use 34 matching groups (17 per information condition). The comparison between Intermediate Info & Bundling and Complete Info uses 27 matching groups (10 and 17, respectively). The comparison between Intermediate Info & Item-by-Item and Intermediate Info & Bundling uses 17 matching groups (7 and 10, respectively). All p-values could be divided by 2 to reflect that our hypotheses are directional, but we use the more conservative approach and report two-sided test values.

Figure 3: Agreement Rates for Small-Surplus Items



Notes: Agreement rate for small-surplus items ($0 < S \leq 8$) for ***(a)*** all negotiations, ***(b)*** when only one item has a positive surplus, ***(c)*** when two or three items have a positive surplus. P-values stem from two-sided Wilcoxon rank-sum tests for average outcomes across the independent matching groups.

separately. We pool the Bundling and Item-by-Item treatments for the no information and complete Information structures. This is consistent with the hypotheses developed in Section 4.5, as they distinguish between offer protocol only for the intermediate information structure.[13]

Figures 3b and 3c, respectively, show the agreement rates for small-surplus items for the subset of negotiations with an efficient scope of one (i.e., one positive-surplus item) or greater than one (i.e., two or three positive-surplus items). This is a helpful way of slicing the data because, theoretically, the availability of bundling is essential only when bargainers need to exchange multiple items.

We find clear support for Hypothesis 1. The agreement rate for small-surplus items is 57% in No Info and 81% in Complete Info ($p < .001$), see Figure 3a. The result also holds separately when the efficient scope equals one ($p < .001$) or is bigger than one ($p < .001$). Thus, in line with the theoretical predictions, private information renders efficient bargaining more difficult when the surplus of an item is small. However, bargainers still traded about half of the small-surplus items despite private information. We summarize these findings in the following result.[14]

[13]We will confirm in Table 2 that there are no significant differences between the bundling and item-by-item treatments in No Info and Complete Info.

[14]We also report the following alternative statistical approach. Suppose we set the theoretical hypotheses aside. We wish to test if there are significant treatment differences between any of the categories considered in Figure 3a, adjusting for multiple comparisons. We implement a Dunn's test. First, a Kruskal–Wallis test rejects equality of trade rates for small-surplus items between all treatments ($p < .001$). For the pairwise comparison, using the Holm adjustment to correct for multiple comparisons, the p-values are $p = .317$ (No Info versus Int. Info & Item-by-Item), $p = .043$ (No Info versus Int. Info & Bundling), $p < .001$ (No Info

Result 1 *The agreement rate for small-surplus items ($S \leq 8$) is significantly higher in the Complete Information treatments than in the No Information treatments.*

The data also support Hypothesis 2 on the equivalence of Intermediate Info & Bundling and Complete Info. The agreement rate for small-surplus items is 72% in Intermediate Info & Bundling and 81% in Complete Info ($p = .111$). Hence, while small-surplus items are traded more often under complete information than under intermediate information with bundling, the difference is relatively small and insignificant at the 10% level. We will confirm the similarity of outcomes in these bargaining environments through the regressions presented in Table 2. The result again holds independently of the efficient scope, as can be confirmed in Figures 3b and 3c. The data also support the second part of Hypothesis 2, which states that agreement rates in Intermediate Info & Bundling should exceed those under no information. We find that agreement rates for small-surplus items are indeed significantly higher in Intermediate Info & Bundling than in No Info ($p = .016$). We summarize these findings in the following result.

Result 2 *The agreement rate for small-surplus items in Intermediate Information & Bundling is not significantly different from the Complete Information treatments, and is significantly higher than in the No Information treatments.*

Finally, we find clear support for Hypothesis 3. The agreement rate for small-surplus items is 72% in Intermediate Info & Bundling and 54% in Intermediate Info & Item-by-Item ($p = .023$). Hence, the availability of bundling is crucial for the efficient exchange of small-surplus items when bargainers have intermediate information. As can be seen in Figure 3b ($p = .874$) and Figure 3c ($p = .018$), this effect stems entirely from negotiations with more than one positive-surplus item. We summarize this observation in the following result.

Result 3 *The agreement rate for small-surplus items in Intermediate Information & Bundling is significantly higher than in Intermediate Information & Item-by-Item. The effect is driven entirely by negotiations for which efficiency requires exchanging multiple items.*

We further examine the hypotheses using logistic regressions. This allows us to observe the effect of item surplus when varying it continuously. In Figure 4, we provide the predicted agreement probabilities from the logistic regressions depending on item surplus. Figure 4a confirms that No Info and Intermediate Info & Item-by-Item have a significantly lower agreement probability for small-surplus items than Intermediate Info & Bundling and Complete

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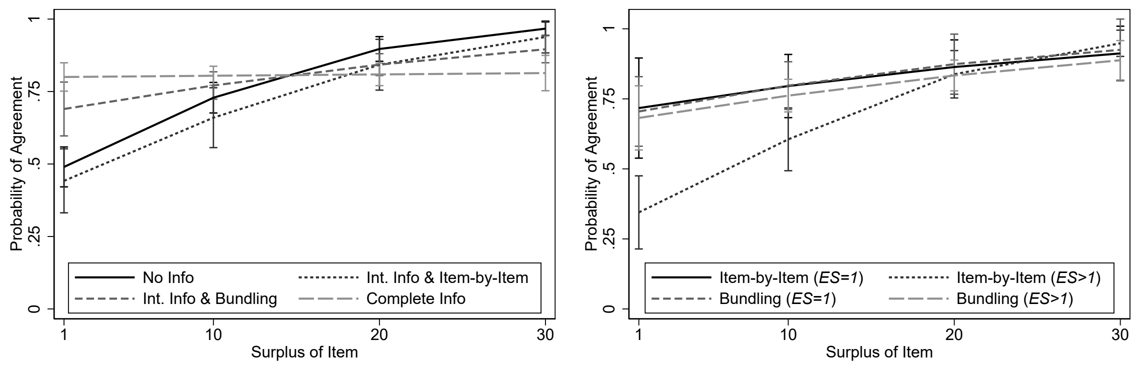
versus Complete Info), $p = .056$ (Int. Info & Item-by-Item versus Int. Info & Bundling), $p < .001$ (Int. Info & Item-by-Item versus Complete Info), $p = .169$ (Int. Info & Bundling versus Complete Info). Using the Benjamini–Hochberg adjustment instead, we obtain (p-values in same order): $p = .317$, $p = .021$, $p < .001$, $p < .028$, $p < .001$, $p < .101$. The results are very similar to the ones reported in Figure 3a.

Figure 4: Probability of Agreement over Surplus

(a) All Treatments (b) Intermediate Info by Efficient Scope



Notes: Probability of agreement depending on item surplus for ***(a)*** all treatments and ***(b)*** Intermediate Info & Item-by-Item and Intermediate Info & Bundling separated by efficient scope (ES) equal to or greater than one. Predicted probabilities and 95% confidence intervals are from random effects logistic regressions with period dummies and with standard errors clustered on matching groups.

Info. Predicted agreement probabilities are not significantly different between Intermediate Info & Bundling and Complete Info. Figure 4b focuses on the effect of the efficient scope in the intermediate information structure. It nicely complements the non-parametric analysis. The increase in agreement probability thanks to bundling is entirely driven by negotiations with multiple positive-surplus items ($ES > 1$). These findings provide further support for Hypotheses 1 to 3.

Let us now look at Table 2 to further separate treatments and include additional control variables. Columns (1) to (3) of Table 2 report the results. Model (1) includes all negotiations, model (2) includes negotiations with an efficient scope of one, and model (3) includes negotiations with an efficient scope greater than one. The variable *Risk Tolerance* corresponds to a subject's lottery choice in the task we implemented after the main experiment. Lotteries range from one to six, indicating increasing risk tolerance. The variable *Violates 50-50 Norm* would equal 1 if a subject proposed a distribution that allocates strictly more than half of the pie to herself in the fairness elicitation task. It equals 0 otherwise (see Section 4.6 for a detailed explanation).[15] The treatment effect (relative to the reference group No Info & Bundling) at any surplus size $S \geq 1$ is the non-interacted treatment coefficient

[15]The reason we focus on the Violates 50-50 Norm dummy rather than the minimum acceptable offer elicited in the fairness elicitation task is that there is no proposer advantage in our unstructured environment. Expressing a minimum acceptable offer of one-half of the pie will likely cause trade failures in an ultimatum game or other games with asymmetric bargaining power. However, there is no tension between the inequality aversion and bargaining power in our setting. On the other hand, subjects that insist on getting *more* than half in the ultimatum game—those with a Violates 50-50 Norm dummy of 1—may cause disagreement.

Table 2: Regressions—Probability of Agreement and Efficiency

	(1) Prob. of Agreement	(2) Prob(Agr.) if $ES = 1$	(3) Prob(Agr.) if $ES > 1$	(4) Realized Surplus	(5) Efficiency
Int. Info & Bundling	2.751***	3.829***	2.497**	-0.300	0.151***
	(0.925)	(1.761)	(1.030)	(0.668)	(0.0454)
Com. Info & Bundling	3.661***	6.604***	3.267***	-0.304	0.175***
	(1.058)	(3.525)	(1.116)	(0.624)	(0.0489)
No Info & Item-by-Item	0.964	1.015	0.940	0.690	-0.0105
	(0.274)	(0.515)	(0.306)	(0.644)	(0.0889)
Int. Info & Item-by-Item	0.857	4.538***	0.432**	-0.661	0.206***
	(0.291)	(2.617)	(0.171)	(0.979)	(0.0711)
Com. Info & Item-by-Item	8.677***	8.304***	9.300***	0.265	0.328***
	(2.953)	(4.248)	(4.768)	(0.861)	(0.0523)
Surplus (S)	1.129***	1.129***	1.131***		
	(0.0242)	(0.0379)	(0.0256)		
Total Surplus (TS)				0.883***	0.0115***
				(0.0219)	(0.00164)
Int. Info & Bundling ∗ S or TS	0.934***	0.935	0.933**		-0.00586***
	(0.0240)	(0.0432)	(0.0289)		(0.00196)
Com. Info & Bundling ∗ S or TS	0.910***	0.873***	0.918***		-0.00692***
	(0.0216)	(0.0404)	(0.0231)		(0.00194)
No Info & Item-by-Item ∗ S or TS	1.013	1.001	1.019		0.000400
	(0.0295)	(0.0513)	(0.0443)		(0.00293)
Int. Info & Item-by-Item ∗ S or TS	0.990	0.928*	1.021		-0.00862***
	(0.0266)	(0.0390)	(0.0310)		(0.00226)
Com. Info & Item-by-Item ∗ S or TS	0.865***	0.864***	0.865***		-0.0116***
	(0.0203)	(0.0342)	(0.0297)		(0.00216)
Risk Tolerance	0.899**	0.867*	0.907*	-0.187	-0.00839
	(0.0401)	(0.0699)	(0.0508)	(0.173)	(0.00863)
Violates 50-50 Norm	0.685***	0.834	0.643***	-0.937**	-0.0515***
	(0.0740)	(0.135)	(0.0887)	(0.409)	(0.0187)
Period	0.946*	0.958	0.945	0.0221	-0.00387
	(0.0316)	(0.0484)	(0.0364)	(0.101)	(0.00543)
Constant	2.153**	1.013	2.744**	-1.182	0.513***
	(0.782)	(0.590)	(1.089)	(1.222)	(0.0766)
Items	3,039	766	2,273	3,039	3,039
Negotiations	1,777	766	1,011	1,777	1,777
Matching Groups	51	51	51	51	51

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Random effects regression for the probability of agreement (logistic) and realized surplus (linear) with standard errors clustered on matching group level in parentheses. For models (1) to (3), reported coefficients are odds ratios. Risk Tolerance and Violates 50-50 Norm are taken from the buyer in a negotiation (results are similar for sellers). All regressions control for item valuations. Reference group: No Info & Bundling. Data includes items (or negotiations) with a surplus (or total surplus) greater than 0.

(first five variables) plus S multiplied by the appropriate interacted coefficient.

Model (1) in Table 2 again confirms Results 1 to 3. In particular, for small-surplus items, agreement rates are higher for the two Complete Info treatments and for Intermediate Info & Bundling compared to the reference group, No Info & Bundling. To see this, observe that the odds ratios attached to each of these three treatments (the non-interacted coefficients) are significantly greater than 1 and therefore show a positive treatment effect compared to No Info & Bundling. Controlling for the effect of the item surpluses is nevertheless important. The higher performance of the Complete Info treatments and Intermediate Info & Bundling is confirmed for small-surplus items. Yet, the odds ratios of the interaction terms with item surplus (S) that are significantly below 1 show that the advantage of the Complete Info treatments and Intermediate Info & Bundling shrinks as we move from small surplus items to larger ones.[16] This is in line with the evidence displayed in Figure 4a.

Models (2) and (3) confirm that the difference between Intermediate Info & Bundling and Intermediate Info & Item-by-Item stems from negotiations with an efficient scope greater than one. Note in particular the odds ratio of 0.432 in model (3), showing that surplus information can have a detrimental effect on agreement rates in the absence of bundling. Moreover, the regression results in Table 2 confirm that agreement probabilities and their dependence on item surplus are similar between the bundling and item-by-item treatments for both the no information and the complete information structure. The pooling of treatments in Figures 3 and 4a, which was motivated by the theoretical predictions, is thus also empirically justified.

Finally, Table 2 shows that both risk attitudes ($p = .017$) and the tendency to violate the norm of a 50-50 division ($p < .001$) affect the probability of agreement. Specifically, higher risk tolerance and a weaker concern for the 50-50 norm in the ultimatum game, on average, lower the likelihood of agreement in the multi-issue bargaining game. These behavioral factors will turn out to be essential for explaining the following critical deviation from theory: for surpluses $S > 15$, the agreement rate is the *highest* in No Info (91%), higher than in both Intermediate Info & Bundling (85%, $p = .049$) and Complete Info (79%, $p = .004$). The unconditional agreement rate (averaged over all item surpluses) is 76% in No Info, 72% in Intermediate Info & Item-by-Item, 79% in Intermediate Info & Bundling, and 82% in Complete Info. The latter numbers are qualitatively consistent with the theoretical predictions. However, the reversal in performance for items with large surpluses reduces the differences observed for small-surplus items.

We conclude that theory correctly predicts the comparative statics effects of information and bundling for small-surplus items. Indeed, theory predicts differences in agreement

[16] In fact, note that the advantage of both Complete Info treatments and Intermediate Info & Bundling disappears once the surplus exceeds 15. Both treatments then start to perform worse than No Info & Bundling. This indicates a detrimental effect of improved information.

rates only for such items. However, we also observe differences in behavior for large-surplus items—particularly, a detrimental effect of improved information—which constitutes a deviation from theory. This requires us to investigate the hurdles that stand in the way of trade under Complete Info and Intermediate Info & Bundling. To that end, we now delve deeper into the micro-level of the data and focus on the negotiation process itself.

5.2 Negotiation Process

We approach the analysis of the negotiation process with three questions in mind.

First, we want to understand the price discovery process. This involves examining if there are differences in the timing and type of offers bargainers make. Given that a unique feature of our experiment is the presence of multiple items, understanding when and how bargainers use bundled offers is of particular interest.

Second, a related question is how bargainers achieve compromise. To shed light on this, we explore the bargaining conventions that emerge in our data—note that because bargaining is unstructured, any such convention emerges endogenously.

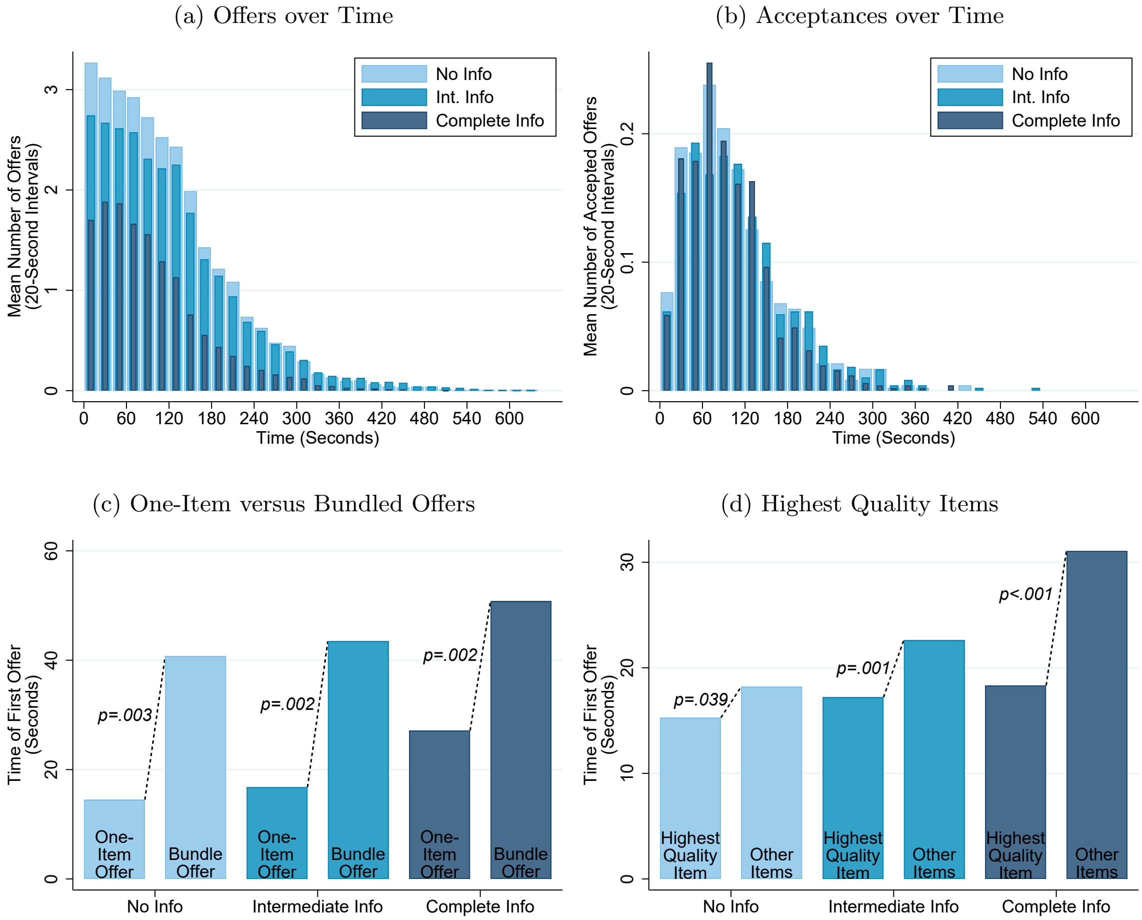
Third, we conclude the section by studying the causes of trade failures. In particular, we analyze how the elicited behavioral measures affect agreement rates.

5.2.1 Price Discovery: Timing and Strategies

Figure 5a shows that, on average, 3.2 offers happen in the first 20 seconds of the No Info treatments. With Complete Info, offer frequency is approximately half of that. The Intermediate Info treatments lie between the other two information conditions. The number of offers decreases as items trade and negotiations conclude, but activity remains high for two to three minutes. Figure 5b, on the other hand, shows that the distribution of *accepted* price offers is strikingly similar across information conditions. We conclude that treatments with less information through a higher bargaining activity can maintain the same pace of successful trades as the Complete Info treatments.

Bundled offers are common, although not as common as single-item offers. In the treatments that allow for bundling, the percentage of items that are offered (respectively, accepted) in a bundle are 44% (resp., 37%) in No Info, 42% (resp., 32%) in Intermediate Info, and 49% (resp., 42%) in Complete Info. In Figure 5c, we show the median time of the *first* price offer for a given item or bundle. As can be seen, negotiations are initiated significantly earlier for individual items than for bundled offers in all information conditions. This is not in line with theory. Theory predicts that under Intermediate Info, all positive-surplus items should trade through a single bundled offer. When bargainers "start simple" by making

Figure 5: Bargaining Timing and Strategies



Notes: Figure ***(a)*** shows the mean number of proposed offers (single-item and bundled offers) per 20-second interval averaged by information structure. Figure ***(b)*** shows the mean number of accepted offers. Figure ***(c)*** shows the median time of the first offer separated by one-item and bundled offers. Figure ***(d)*** focuses on one-item (non-bundled) offers, showing the median time of the first offer for the highest quality item (i.e., highest valuation for the buyer and lowest cost for the seller) compared to the other items.

Table 3: Demanded Share of Total Surplus

	No Information			*Intermediate Information*			*Complete Information*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total Surplus (TS)	0.576***	0.206***	0.153***	0.524***	0.308***	0.268***	0.487***	0.417***	0.410***
	(0.0248)	(0.0238)	(0.0207)	(0.0273)	(0.0281)	(0.0220)	(0.0265)	(0.0445)	(0.0473)
Two-Item Bundle * TS	0.0638*	0.148***	0.156***	0.0851**	0.117***	0.128***	0.0709***	0.0854***	0.0902***
	(0.0348)	(0.0327)	(0.0260)	(0.0300)	(0.0246)	(0.0224)	(0.0197)	(0.0301)	(0.0325)
Three-Item Bundle * TS	0.285***	0.381***	0.349***	0.257***	0.348***	0.332***	0.121**	0.154***	0.154***
	(0.0585)	(0.0524)	(0.0480)	(0.0358)	(0.0403)	(0.0363)	(0.0472)	(0.0494)	(0.0509)
Item-by-Item * TS	0.00225	0.0944***	0.0906***	0.0545*	0.140***	0.141***	0.0582*	0.0926**	0.0917**
	(0.0340)	(0.0300)	(0.0228)	(0.0294)	(0.0354)	(0.0310)	(0.0301)	(0.0433)	(0.0424)
Proposal Time (sec.)			-0.0269***			-0.0224***			-0.00778***
			(0.00209)			(0.00155)			(0.00161)
Risk Tolerance			0.0802			0.187			0.306***
			(0.133)			(0.256)			(0.103)
Violates 50-50 Norm			-0.429			1.132**			0.0455
			(0.545)			(0.490)			(0.413)
Constant		5.508***	8.524***		2.746***	3.826***		0.922**	1.793**
		(0.377)	(1.009)		(0.333)	(0.803)		(0.407)	(0.896)
Offers (N)	9,731	9,731	9,731	9,275	9,275	9,275	5,742	5,742	5,742
Matching Groups	17	17	17	17	17	17	17	17	17

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Ordinary least squares regressions for No Info, Intermediate Info, Complete Info with standard errors clustered on matching group level. Models (3), (6), (9) include period dummies. Reference group: One-item offers in bundling treatments. Data includes negotiations with a surplus greater than 0.

offers on single items, they thus undermine the ability to bundle.[17] Figure 5d further shows that offers on items with high valuations (for buyers) and low costs (for sellers) tend to be made before offers on items that are less attractive, in the sense that they are less likely to contain large surpluses.

As explained in case (*iv*) of Example 1, the price for any bundle offered by a buyer (or seller) should correspond to the sum of the buyer's valuations (or seller's costs) over the items contained in the bundle minus (or plus) a constant share of the total surplus. This stable share reflects what proposers think they can negotiate for themselves. To test this prediction, in Table 3 columns (4)-(6) on Intermediate Info, we provide regressions where the demanded share of the total surplus is the dependent variable and the total surplus interacted with the bundle sizes are the independent variables. Model (4) does not include a constant; thus, the coefficients measure the average demanded share of the total surplus. Model (5) includes a constant. Model (6) has additional controls. We find that, on average, demanded shares correspond to 52.4% of the total surplus for single-item offers. Demanded shares significantly increase for two and three-item bundles. The more ambitious demands

[17] For example, if items A and C contain surplus but not item B, then bundle $\{A, C\}$ should trade at once. Trying to exchange the items separately, at two prices, can lead to inefficiency. After the first trade occurs, bargainers no longer know the total surplus that remains on the table.

in bundled offers are not in line with the theoretical predictions.[18] We summarize these findings in the following result.

Result 4 *While bundling is common and effective, the empirical price discovery process limits its ability to facilitate agreement. Specifically, (i) subjects typically start making offers on individual items and use bundles only in a second step, and (ii) offers on bundles are more aggressive than those on individual items.*

5.2.2 Emergence of Bargaining Convention

Theoretical models assume different bargaining protocols. There is a single proposer, or the proposer is determined randomly in each round, or bargainers may alternate in making proposals. The unstructured bargaining in our experiment allows checking for the endogenous emergence of bargaining protocols. We can also observe which bargaining conventions tend to promote agreement rates.

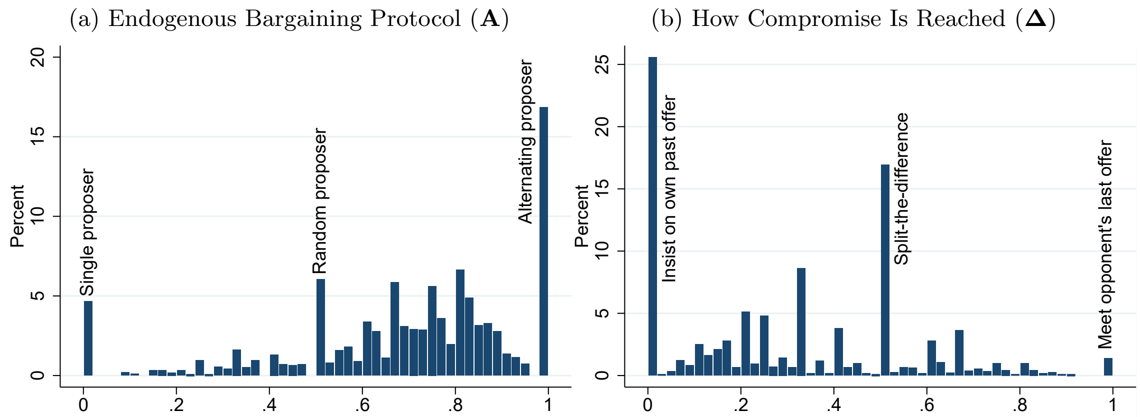
To study bargaining protocols, we focus on offer sequences for a particular item or bundle of items. We define a counteroffer as an offer made in direct response to the other player's offer. For example, suppose Ann makes the 1st, 3rd, 5th and 6th offer in an offer sequence while Bob makes the 2nd and 4th offer. Then, the 2nd, 3rd, 4th, and 5th offer are four counteroffers, but the 6th offer is not a counteroffer. Let $\mathbf{A}$ denote the proportion of counteroffers in an offer sequence (excluding the first offer). In the example with Ann and Bob, $\mathbf{A} = 0.8$. Note that $\mathbf{A} = 0$ occurs when only one side makes offers while $\mathbf{A} = 0.5$ would be consistent with a random selection of proposers. When $\mathbf{A} = 1$, the sequence is fully alternating.

Figure 6a shows the distribution of $\mathbf{A}$ across all offer sequences. It is apparent that alternating offers are the dominant mode of interaction: 17% of the offer sequences are fully alternating ($\mathbf{A} = 1$, median sequence length: 5.19 offers), and for 80% of the negotiations, we have $\mathbf{A} > 0.5$ (median sequence length: 15.72 offers). Other modes occur at $\mathbf{A} = 0.5$ (median sequence length: 9.16 offers) and $\mathbf{A} = 0$ (median sequence length: 4.12 offers). The median offer sequence has 75% alternating offers. In online Appendix A.1, we show that alternating offers are the dominant mode of interaction independent of the information condition. Although intuitive, we are unaware of another study showing that alternating offers emerge endogenously.

Next, consider a fully alternating sequence of offers of length T, $(p_1, ...p_T)$. For every offer p_t, $t > 2$, let $\mathbf{\Delta} = (p_t - p_{t-2})/(p_{t-1} - p_{t-2})$. Assume Bob makes the offer in period

[18] In online Appendix A.1, we show that the *accepted* shares of total surplus are not larger for bundled offers than for single-item offers. Thus, bundled offers exhibit a more significant discrepancy between offered and accepted prices than single-item offers. This difference suggests that repeated offers are necessary for bundling to promote agreement rates. We confirm this in online Appendix B.1, where we discuss the results of treatments that implemented a multi-issue ultimatum game setting.

Figure 6: Bargaining Convention



Notes: Figure ***(a)*** shows a histogram for the proportion of counter offers in an offer sequence (**A**). Figure ***(b)*** shows a histogram of the compromise measure (**Δ**).

t. Then, the numerator of **Δ** is the difference between Bob's current and his most recent previous offer. The denominator is the difference between the *other* player's current and Bob's most recent previous offer. If $\mathbf{\Delta} = 0$, Bob insists on his previous offer. If $\mathbf{\Delta} = 1$, Bob meets the other player's current offer. If $\mathbf{\Delta} = 0.5$, Bob makes an offer that lies halfway between his previous and the other player's current offer. We refer to such an offer as a split-the-difference offer. The variable **Δ** measures compromise conditional on the current state of the negotiation, that is, conditional on the standing offers of both bargaining sides (for a similar approach, see Gächter and Riedl, 2005). Figure 6b shows the distribution of **Δ**. Most bargainers either insist on their previously demanded price or meet the other party halfway to achieve a split-the-difference deal.

The spike at $\mathbf{\Delta} = 0.5$ is in line with recent studies that have discovered this pattern in the field. Backus et al. (2020) show the prevalence of split-the-difference offers for eBay data. Keniston et al. (2021) extend the analysis to a wide range of bargaining contexts. It is remarkable and reassuring that the way people interact via offers to reach a compromise is the same in the lab and the field, at least in terms of split-the-difference offers. One should note that meeting the other's offer halfway is not necessarily fair in the sense that the gains from trade are shared equally.[19] Split-the-difference offers can thus be seen as a fairness convention applying to the bargaining process rather than the bargaining outcome. We summarize these observations in the next result.

[19]Suppose the buyer's valuation for a bundle is 30, and the seller's cost is 10. Consider the sequence $(p_1, ...p_3) = (12, 20, 16)$ with trade happening at the price of 16. This last offer is a split-the-difference offer as it lies halfway between the first two offers. However, the buyer obtains a payoff of 14 and the seller a payoff of only 6.

Result 5 *Frequent alternating offers characterize negotiations, and split-the-difference offers are the modal way of narrowing the gap between the buyer's and the seller's demands.*

In online Appendix A.1, we further explore the alternating-offer and split-the-difference bargaining convention. We find that (*i*) they are observed in all treatments, (*ii*) split-the-difference offers are particularly common for early offers in a sequence, and (*iii*) the patterns are observed for both single-item and bundle offer sequences. We also generalize the definition of $\mathbf{\Delta}$ to offer sequences that are not fully alternating.

5.2.3 Causes of Trade Failures

Bundling, behavioral factors (risk tolerance, adherence to the 50-50 division norm), and bargaining conventions (alternating and split-the-difference offers) are all crucial aspects of the negotiations we observe in our data. How do these factors affect the probability of agreement? Can some of these factors explain why improved information can backfire and reduce agreement rates for large-surplus items? Table 4 presents regressions relating these factors to the probability of trade for each information condition.

The unit of observation in regression models (1) to (3) is an offer. The independent variables explaining whether an offer is accepted are the demanded share of the total surplus, a split-the-difference dummy equaling 1 if $\mathbf{\Delta} \in [0.475, 0.525]$, the responder's risk tolerance, Violates 50-50 Norm dummy, whether the offer is a counteroffer, and whether the offer is for a bundle. Counteroffers are more likely to be accepted, particularly when they split the difference. We also find that bundled offers are more likely to be accepted, controlling for the demanded share (offer aggressiveness). Thus, subjects became more accepting of bundled offers, possibly due to the previously reported high demands for bundles. Regarding the elicited behavioral measures, having weaker concerns for the 50-50 norm reduces acceptance probability though the effect is significant only under Complete Info.

The unit of observation in regression models (4) to (6) is an offer sequence. The dependent variable is whether a sequence concludes in a trade. The independent variables are the total surplus, a split-the-difference dummy equal to 1 if the sequence contains at least one such offer, the average risk tolerance of the buyer and the seller, the 50-50 division norm dummy equal to 1 if at least one of the subjects in the pair made a proposal that allocates more than half of the gains to themselves in the fairness elicitation task, the proportion of counteroffers ($\mathbf{A}$), and whether the offer sequence is for a bundle. We find that split-the-difference offers as well as alternating offers significantly raise agreement probability. We also find that bundle sequences tend to be less likely to conclude in trade. Risk tolerance and violations of the 50-50 norm have little impact under No Info. Crucially, when the total surplus is known (Intermediate and Complete Info), the behavioral factors strongly hamper

Table 4: Convention, Behavioral Preferences, and Trade

Dep. Var.: **Accept Offer**	No Info (1)	Int. Info (2)	Comp. Info (3)
Demanded Share	0.219***	0.174***	0.0316***
	(0.0447)	(0.0295)	(0.0123)
Split-the-Diff.	4.130***	3.780***	3.871***
	(0.685)	(0.672)	(0.462)
Risk Tolerance	1.050	0.928	0.970
	(0.0722)	(0.0540)	(0.0481)
Violates 50-50 Norm	0.954	0.819	0.585***
	(0.150)	(0.133)	(0.0768)
Counter Offer	1.471***	1.165	1.128
	(0.212)	(0.144)	(0.134)
Bundle	2.644***	1.939***	1.297
	(0.559)	(0.264)	(0.217)
Constant	0.196***	0.470**	0.835
	(0.0645)	(0.148)	(0.312)
Offers (N)	6524	6016	5467
Matching Groups	17	17	17

Dep. Var.: **Trade**	No Info (4)	Int. Info (5)	Comp. Info (6)
Total Surplus	1.038***	1.009	1.005
	(0.00925)	(0.00759)	(0.00860)
Split-the-Diff.	3.810***	3.783***	2.532***
	(1.413)	(1.015)	(0.614)
Risk Tolerance	1.111	0.703***	0.760**
	(0.131)	(0.0960)	(0.0842)
Violates 50-50 Norm	0.830	0.686*	0.688**
	(0.118)	(0.154)	(0.121)
Alternating (**A**)	6.583***	9.306***	4.715***
	(2.363)	(4.418)	(1.918)
Bundle	0.734	0.647	0.569**
	(0.221)	(0.386)	(0.156)
Constant	0.196***	1.420	1.857
	(0.115)	(1.022)	(1.122)
Offer Sequences (N)	929	894	786
Matching Groups	17	17	17

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%, Standard errors clustered on the level of matching groups in parentheses. Logistic random effects regression. Reported coefficients are odds ratios. In models (1) to (3), the unit of observation is an offer, the dependent variable is whether the offer is accepted, and Risk Tolerance and Violates 50-50 Norm are taken from the responding subject. In models (4) to (6), the unit of observation is an offer sequence. The dependent variable is whether the sequence concludes in a trade. Risk Tolerance is averaged across the two subjects, and the Violates 50-50 Norm dummy equals one if at least one of the two subjects has violated the 50-50 norm. Data includes offers on bundles (including single items) for which all items have a surplus greater than 0. We drop the first two offers in a sequence as the split-the-difference dummy is undefined for such offers.

beneficial exchange.[20]

To assess the magnitude of the behavioral effects, Figure 7 shows counterfactual agreement probabilities. The line with square markers corresponds to a hypothetical "worst-case" negotiation: no alternating offers ($\mathbf{A} = 0$) and hence no split-the-difference offers, high risk tolerance (95th percentile), and a Violates 50-50 Norm dummy equal to 1. In the figure, the label *High BF* abbreviates a high level of the behavioral factors. The line with diamond markers keeps $\mathbf{A} = 0$, but assumes *Low BF*, which means that risk tolerance is low (5th percentile) and the 50-50 norm dummy equals 0. As can be seen, switching off the impact of the behavioral factors leads to a substantial improvement in agreement probability in Complete Info and Intermediate Info. In contrast, behavioral factors do not impact agreement rates in No Info. A similar effect for risk tolerance and 50-50 norm violations holds when $\mathbf{A} = 1$ (and a split-the-difference dummy of 1); see the difference between the triangle and circle markers.

Furthermore, the importance of alternating offers and split-the-difference offers for successful agreements is apparent in all information conditions. Figure 7 shows a substantial increase from the square to the triangle markers and from the diamond to the circle markers. The dashed lines give the predicted agreement probability at the means of all variables with 95% confidence intervals.

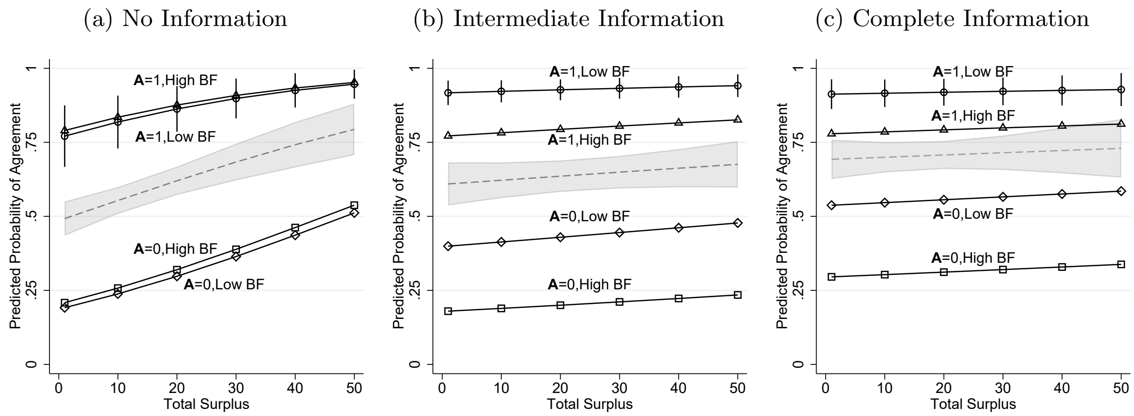
Comparing Figures 7a, 7b, and 7c shows that risk preferences and violations of the 50-50 norm are key factors that prevent higher agreement rates in the Intermediate and Complete Info conditions. On the other hand, agreement failures in the No Info conditions are predominantly due to the inability of bargainers to discover a mutually beneficial price in negotiations with a small total surplus. We summarize these insights in our final result.

Result 6 *In the Intermediate and Complete Information treatments, the leading cause of agreement failures is high risk tolerance levels and violations of the 50-50 division norm. In the No Information conditions, the leading cause of agreement failures is the information asymmetry that makes it challenging to trade small-surplus items. At the same time, risk preferences and the 50-50 division norm play no role.*

We note that experience in the bargaining experiment could affect subjects' choices in the subsequent elicitation tasks. Rather than the elicited behavioral measures explaining bargaining outcomes, the reverse could then be true. However, as we show in online

[20] As explained in Section 4.7, we also elicited the minimum offer a subject would be willing to accept in the fairness elicitation task. It measures inequality aversion. Using this measure in Table 4 in place of the dummy Violates 50-50 Norm leads to insignificant effects in models 4, 5, and 6 (see online Appendix A.2.1). This is intuitive, as two bargainers with a minimum acceptable offer of 50% of the pie should be able to agree in our unstructured bargaining setting where proposer power is non-existent. In contrast, subjects who violate the 50-50 norm in the fairness elicitation task may be, and indeed are, less willing to reach a compromise in the bargaining setting. This observation is in line with Gächter and Riedl (2005) who show that concession probabilities decrease when two subjects in a bargaining pair have conflicting fairness views.

Figure 7: Counterfactual Agreement Probabilities



Notes: Predicted agreement probabilities from random effects logistic regressions depending on total surplus, risk tolerance, the Violates 50-50 Norm dummy, **A**, and a split-the-difference dummy. The behavioral factors (risk tolerance and the 50-50 norm violation dummy) are abbreviated by BF. Square markers correspond to a "worst-case" scenario: $\mathbf{A} = 0$ and thus no split-the-difference offer, risk tolerance is high (average between the buyer and seller is 5 out of 6, the 95th percentile), and at least one of the bargainers in a pair has a Violates 50-50 Norm dummy of 1 (high BF). Diamond markers assume $\mathbf{A} = 0$, low risk tolerance (2 out of 6, the 5th percentile), and neither bargainer violates the 50-50 norm in the elicitation task (low BF). Circle and triangle markers provide the same variations for $\mathbf{A} = 1$ and a split-the-difference dummy of 1. The dashed line shows the prediction at the means of all variables, with 95% confidence interval.

Appendix A.3, neither the treatment a subject participated in nor differences in earnings between subjects affect behavior in the elicitation tasks. On the other hand, the elicited behavioral measures significantly correlate with bargaining process variables: initial demands, proposal times, and the likelihood of observing split-the-difference offers (see online Appendix A.4). This analysis suggests brinkmanship as the mechanism through which the behavioral variables cause trade failures. Notably, subjects characterized by a higher tolerance for risk and a lower concern for the 50-50 norm are more willing to delay agreement and less likely to make split-the-difference offers, which leads to more frequent negotiation breakdowns.

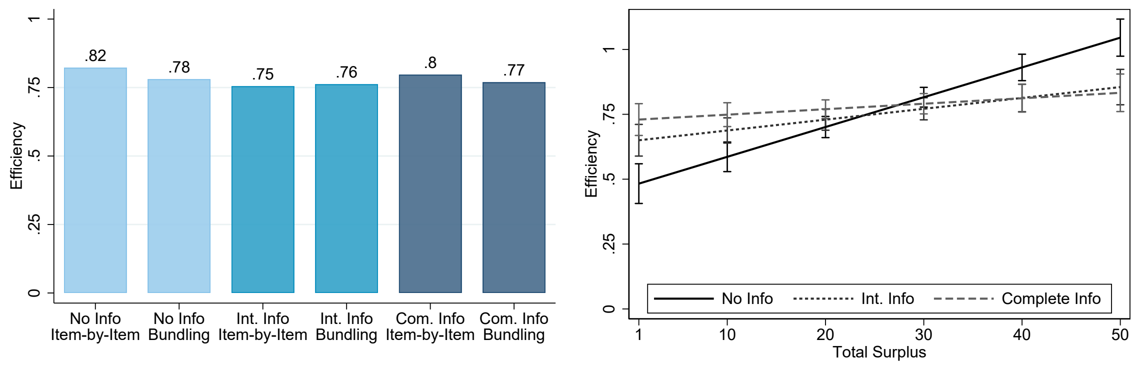
5.2.4 Information and Efficiency

We have established that improved information raises agreement rates when item surpluses are small but hampers beneficial exchange when item surpluses are large. This section looks at how this translates to efficiency as an alternative measure of bargaining success. We define efficiency as the sum of realized surplus divided by the total surplus in a negotiation. In contrast to agreement rates, efficiency puts more weight on items containing a larger surplus.

Figure 8: Efficiency

(a) Overall Efficiency

(b) Efficiency Conditional on Total Surplus



Notes: In figure ***(a)*** efficiency is calculated as the sum of realized surplus in a matching group divided by the maximum surplus possible in the matching group, and then averaged for each treatment. In figure ***(b)*** predicted probabilities with 95% confidence intervals are from linear random effects regressions with dependent variable efficiency on the negotiation-level (realized surplus divided by total surplus) with standard errors clustered on matching groups.

As shown in Figure 8a, efficiency lies between 75% and 82% in all treatments, and the differences are not significant. If anything, No Info performs best.[21] Figure 8b shows that efficiency is low in the No Info conditions when the total surplus in a negotiation is relatively small. On the other hand, efficiency in the No Info conditions exceeds the one under intermediate and complete information when the total surplus is large. The reversal in efficiency between these treatments occurs at a total surplus of about 25. The histogram of total surplus in Figure 2b shows that negotiations with a total surplus greater than 25 are frequent, so the efficiency reversal matters. These patterns are in line with our findings on agreement rates.

The regressions reported in models (4) and (5) in Table 2 further confirm these observations. Model (4) regresses the realized surplus in a negotiation (the sum of realized payoffs) on the treatments. We control for the size of the total surplus to account for potential between-treatment heterogeneity in the draws of buyer valuations and seller costs. As can be seen, there are no significant treatment differences in terms of overall realized surplus. In model (5), to analyze how efficiency depends on the size of the total surplus, we first compute efficiency for each negotiation by dividing the realized surplus by the total surplus and then regress this measure on the treatments and the total surplus. The results show that the Intermediate and Complete Info conditions are significantly more efficient than No

[21] Pooling by information, Wilcoxon rank-sum test p-values are $p = .173$ between No Info and Intermediate Info, $p = .263$ between No Info and Complete Info, and $p = .459$ between Intermediate Info and Complete Info.

Info when the total surplus is small. The reverse holds when the total surplus is large.

Overall, for all information conditions, between 20% and 25% of the total surplus is left on the table. It would be intuitive if the factors that prevent agreement in Intermediate or Complete Info would diminish as the total surplus increases because the costs of trade failure become increasingly large (e.g., Slonim and Roth, 1998; Andersen et al., 2011). Still, the hurdles that prevent trade in these conditions—risk tolerance, violations of the 50-50 division norm, and the associated brinkmanship—remain firmly in place.

6 Conclusion

When studying bargaining, allowing for multiple issues or aspects of a negotiation adds an essential layer of realism, as many real-life negotiations are more complex than "dividing-the-pie" bargaining. We provide evidence from a controlled laboratory experiment to understand the effects of different information structures and trading institutions in multi-issue negotiations. We also identify behavioral factors that characterize successful negotiations.

Our findings suggest the following rules for the design of bargaining institutions:

(*i*) The bargaining protocol should allow for bundling of issues in multi-issue bargaining. Item-by-item bargaining is less likely to lead to an agreement when multiple issues contain part of the surplus.

(*ii*) Improving information among the negotiators about each other's valuations and costs promotes the trade of items with relatively small gains from trade. Remarkably, in multi-issue bargaining, providing information about the total surplus in a negotiation, as opposed to more detailed information about each item, can suffice to achieve this effect.

(*iii*) Improving information among the negotiators about each other's valuations and costs tends to complicate agreement for large-surplus negotiations. Risk-tolerant bargainers are more likely to delay agreement under complete information, and distributional concerns negatively affect negotiations.

(*iv*) Therefore, establishing clear fairness norms is likely to promote agreement rates. Moreover, bargaining institutions should not reward risk-taking by bargainers that aim to exploit their willingness to risk disagreement. For example, one should avoid exogenous deadlines. These findings provide useful managerial advice. They also raise the question for future research of how to establish fairness norms and design institutions that do not reward risk-taking.

(*v*) Negotiations most likely result in agreement when bargainers adopt a convention of alternating offers. Split-the-difference offers (meet the other's previous offer halfway) are especially likely to create an atmosphere of cooperation. We showed that bargainers tend to use these patterns endogenously, suggesting that there may often be no need to impose a rigid bargaining structure.

In online Appendix B, we extend the discussion of our results to two other bargaining environments. One is the multi-issue ultimatum bargaining game (the particular case of our environment when the breakdown probability equals 1). The other is an unstructured bargaining environment with noisy information about valuations and costs. The total surplus can then be known only approximately.

Our study also raises a number of open questions. One example is when there are complementarities between different issues, that is, when agreeing on one aspect of a negotiation affects bargainers' valuations and costs for another element. Another crucial question—both on the theoretical and empirical side—is how multiple aspects and the possibility of flexible agreement scopes affect environments hampered by interdependent values and adverse selection.

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THE FOLLOWING PAGES CONTAIN APPENDICES A TO C.

ALL APPENDICES ARE FOR ONLINE PUBLICATION ONLY.

Online Appendices A and B — Beyond Dividing the Pie: Multi-Issue Bargaining in the Laboratory

Olivier Bochet Manshu Khanna Simon Siegenthaler

Appendix A provides supplementary analysis for the main treatments with unstructured bargaining. Appendix B provides supplementary analysis for the treatments with ultimatum bargaining and the treatments with noisy information.

A Unstructured Bargaining

A.1 Additional Analysis of Offers

Table 1 provides regressions of the demanded share of total surplus depending on the total surplus interacted with the bundle sizes. In contrast to the main text, here we provide the results focusing on accepted offers only. Models (1), (4) and (7) do not include a constant, thus the coefficients can be interpreted as the average realized share of total surplus. Models (2), (5) and (8) include a constant. Models (3), (6) and (9) include additional controls. Table 1 shows that the realized share of total surplus is not larger for bundles than for single-items in the *No Info* and *Intermediate Info* treatments.

Figure 1 shows the distribution of the proportion of alternating offers A across offer sequences. The histograms show that alternating-offers bargaining is the most important mode of interaction in all information treatments, and for both single-item and bundle offer sequences.

Figure 2 shows the distribution of Δ to highlight split-the-difference bargaining patterns. The histograms show that:

(i) There are no significant treatment differences (see 2a);

(ii) The patterns are observed for both single-item and bundle offer sequences (see 2b);

(iii) Split-the-difference offers are common for early offers in a sequence (see 2c).

Next, we extend the analysis of variable Δ to offer sequences that are not fully alternating. We do so by removing from the non-fully alternating offer sequences the non-alternating offers. Specifically, in an offer sequence, for each set of consecutive offers made by a player, we keep the last offer and remove the others. Suppose Ann makes the 1st, 2nd, 5th and 6th offer in an offer sequence while Bob makes the 3rd, 4th offer. Then, Ann's 2nd and 6th offer and Bob's 4th offer will be part of the sequence we used for subsequent analysis. Generating these offer sequences allows us to define Δ for offer sequences that are not fully alternating and thus provides a robustness check for the split-the-difference bargaining patterns presented for the fully alternating sequences. Figure 3 shows that including offer sequences that are not fully alternating does not change the results qualitatively. Most offers that do not insist on the previously proposed price meet the price proposed by the other party halfway to achieve a split-the-difference deal.

A.2 Further Analysis of Social Preferences

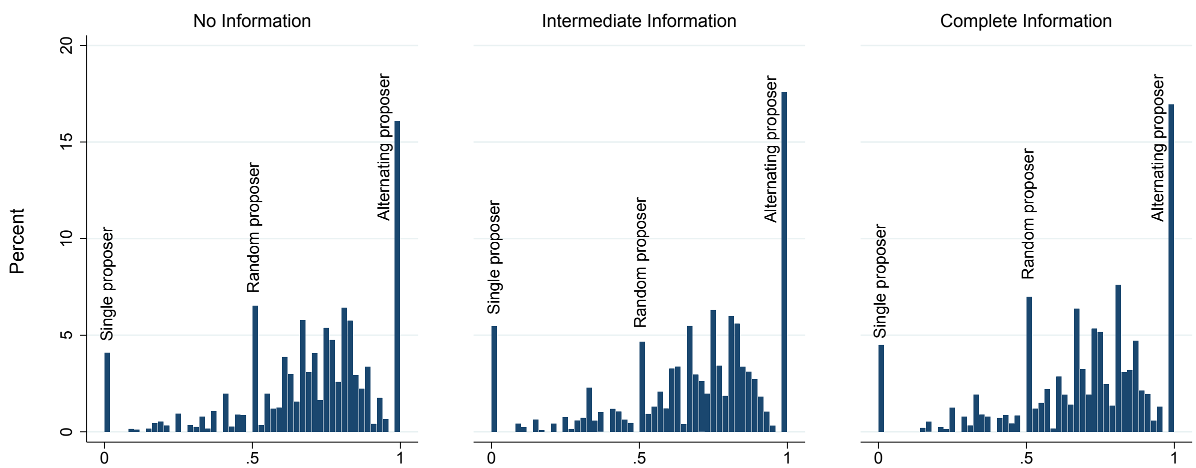
A.2.1 Inequality Aversion

In the main text we use adherence to the 50-50 division norm as one of the behavioral factors. In the fairness elicitation task we also elicited the minimum offer a subject would be willing to accept. We next define a new variable *Inequality Aversion* that equals 1 if, in the fairness elicitation task, a subject's minimum acceptable offers is at least half of the pie, and 0 otherwise. In this subsection we present results derived from replacing the dummy variable for violation of 50-50 norm with this measure of inequality aversion.

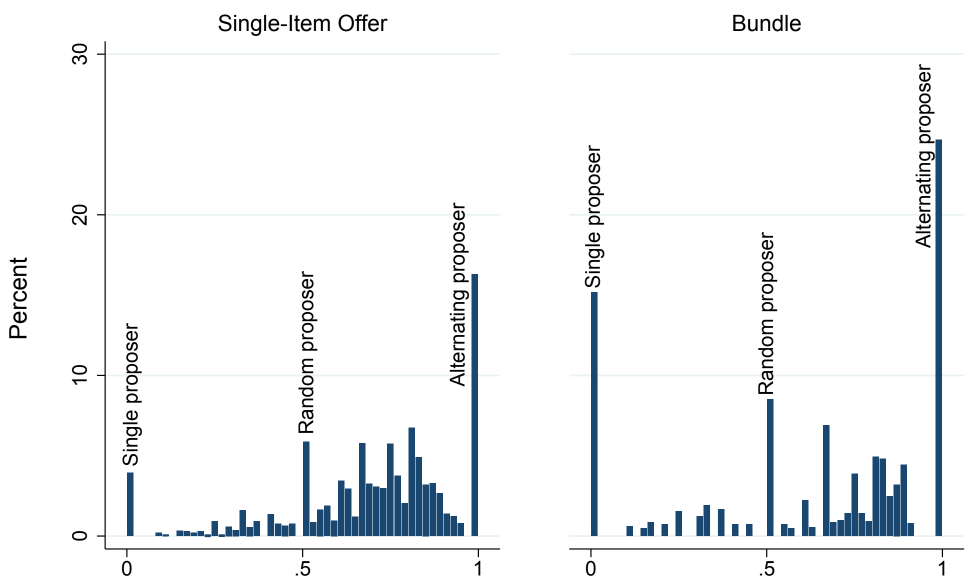
Model (1) in Table 2 is a counterpart of Model (1) in Table 2 in the main text, where the new variable Inequality Aversion replaces the Violates 50-50 Norm dummy. We find

Figure 1: Histograms for Alternating Proposers

(a) Information



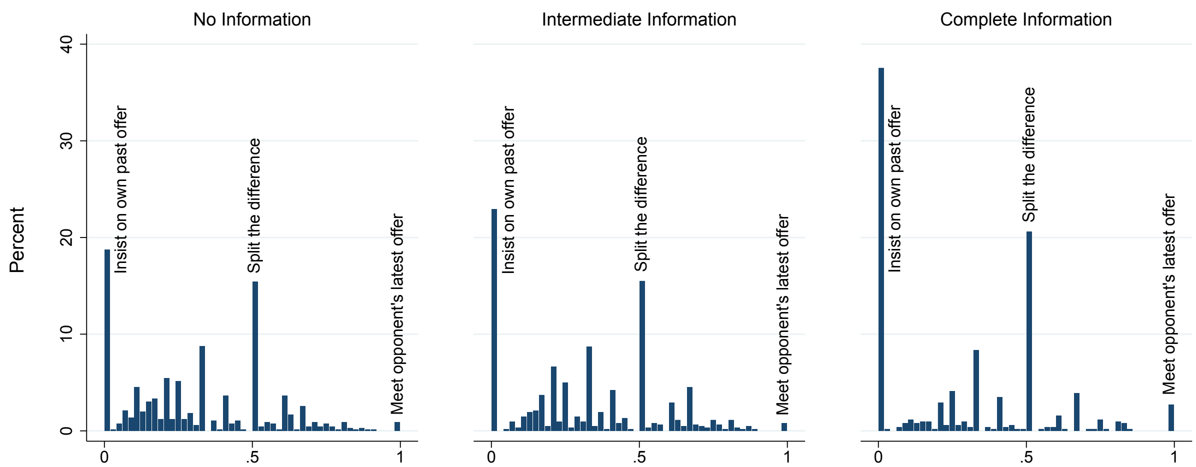
(b) Bundling



Notes: Figures show histograms for the proportion of alternating offers in a negotiation (A).

Figure 2: Histograms for Split-the-Difference

(a) Information



(b) Bundling

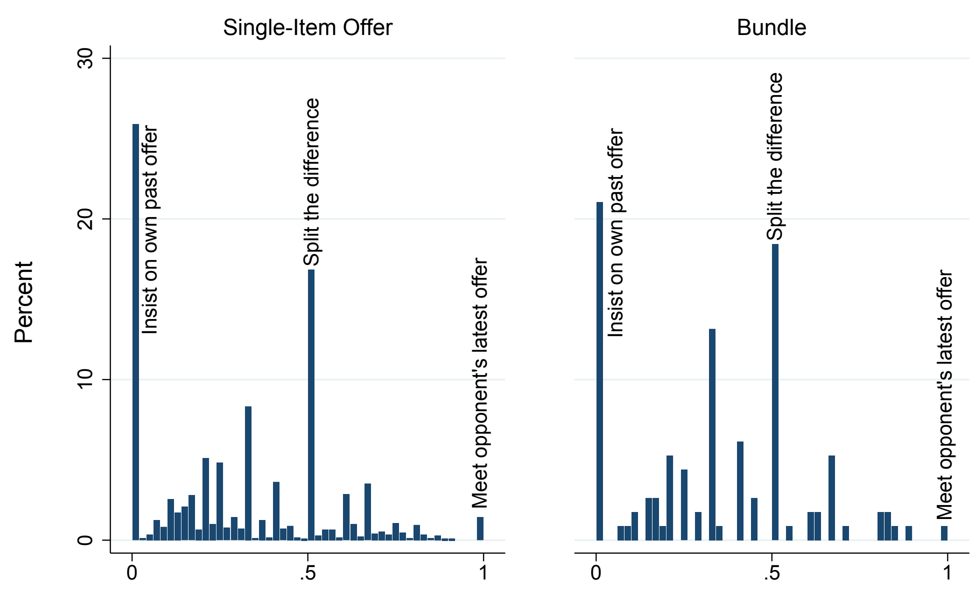
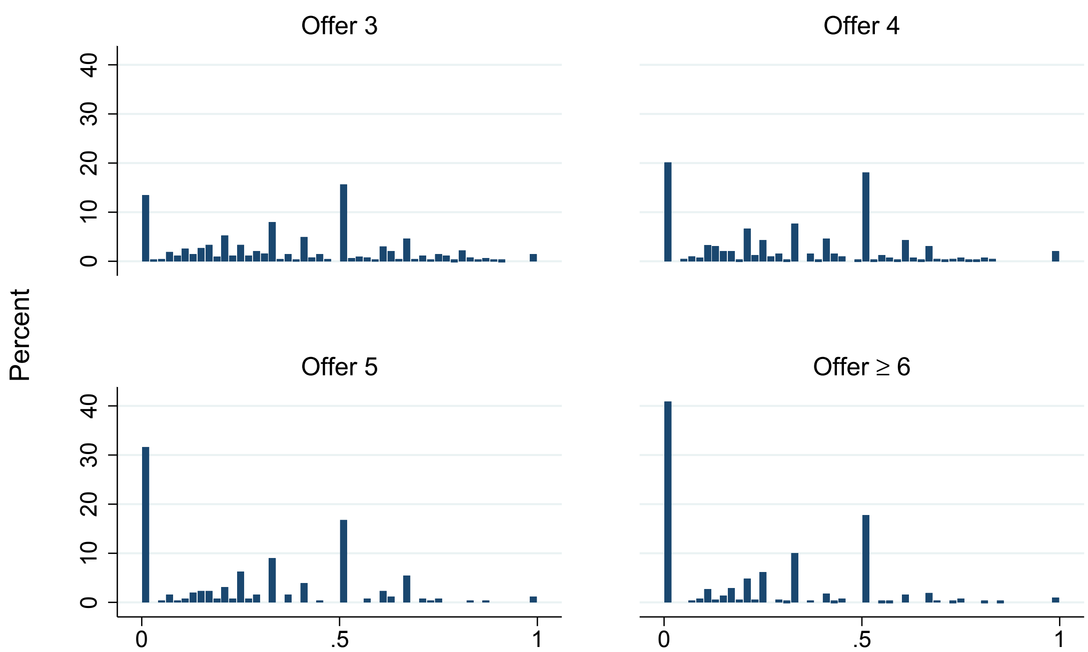


Figure 2: Histograms for Split-the-Difference

(c) By Offer Number



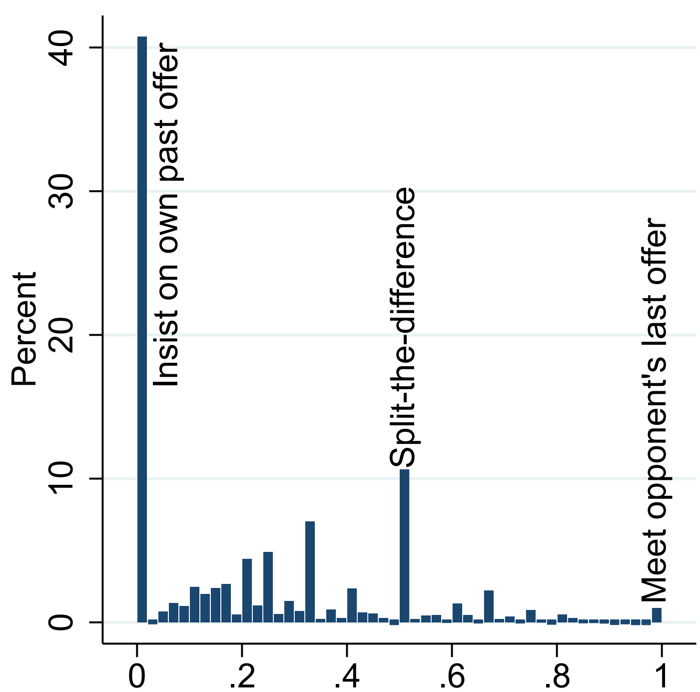
Notes: Figures shows a histogram of the split-the-difference measure (Σ).

Table 1: Realized Share of Total Surplus

	No Information			*Intermediate Information*			*Complete Information*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total Surplus (TS)	0.440***	0.415***	0.345***	0.391***	0.342***	0.322***	0.336***	0.300***	0.292***
	(0.0217)	(0.0377)	(0.0451)	(0.0395)	(0.0571)	(0.0583)	(0.0237)	(0.0307)	(0.0281)
Two-Item Bundle * TS	-0.0129	-0.00212	0.0159	0.0361	0.0487	0.0589	0.117***	0.125***	0.123***
	(0.0319)	(0.0275)	(0.0243)	(0.0393)	(0.0419)	(0.0421)	(0.0362)	(0.0337)	(0.0342)
Three-Item Bundle * TS	-0.129	-0.110	-0.0951	0.115	0.131	0.149	0.0505	0.0649*	0.0634*
	(0.0954)	(0.0784)	(0.0778)	(0.103)	(0.105)	(0.103)	(0.0414)	(0.0337)	(0.0330)
Item-by-Item * TS	0.0455	0.0499*	0.0546**	0.0495	0.0564	0.0561	0.0504*	0.0599**	0.0636**
	(0.0284)	(0.0278)	(0.0242)	(0.0478)	(0.0471)	(0.0478)	(0.0271)	(0.0278)	(0.0251)
Proposal Time (sec.)			-0.0176***			-0.0106***			0.00662***
			(0.00425)			(0.00226)			(0.00250)
Risk Tolerance			-0.141			0.162			-0.00425
			(0.276)			(0.203)			(0.157)
Violates 50-50 Norm			0.301			1.154**			-0.506
			(0.567)			(0.487)			(0.412)
Constant		0.508	3.923**		0.890*	0.680		0.659**	0.114
		(0.538)	(1.624)		(0.457)	(1.150)		(0.307)	(0.748)
Offers (N)	377	377	377	407	407	407	460	460	460
Matching Groups	17	17	17	17	17	17	17	17	17

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. OLS regressions for *No Info*, *Int. Info*, *Complete Info* with standard errors clustered on matching group level. Models (3), (6), (9) include period dummies.

Figure 3: Histogram for Split-the-Difference Including Non-Fully-Alternating Offer Sequences



no significant effect of inequality aversion on the probability of agreement in the multi-issue bargaining game. Table 3 is a counterpart of Table 4 in the main text. Unlike concerns for the 50-50 norm as shown in Table 4 in the main text, inequality aversion does not significantly impact whether a sequence concludes in trade under Complete Info (see model (6)). Under Complete Info, inequality aversion does reduce the acceptance probability of an offer (see model (3)), but the effect is less significant than the one observed for the Violates 50-50 Norm dummy in the main paper.

Intuitively, the minimum acceptable offer has little explanatory power in our setting. Expressing a minimum acceptable offer of one-half of the pie will likely cause trade failures in an ultimatum game or other games with asymmetric bargaining power. However, in our unstructured setting there is no proposer advantage. Therefore two bargainers with a minimum acceptable offer of one-half of the pie should be able to agree.

A.2.2 Demand in Ultimatum Game as a Continuous Measure

In the main text we used a dummy Violates 50-50 Norm that equals 1 if a subject proposed a split that, if accepted, gives more than half of the pie to herself. Because the proposed splits are concentrated on 50-50 shares, the dummy captures the idea that deviations from the 50-50 split likely have a non-continuous interpretation. In this subsection, we present results derived from replacing the dummy variable for violation of the 50-50 norm with the demanded share of the pie in the ultimatum game as a continuous measure.

Model (2) in Table 2 is a counterpart of Model (1) in Table 2 in the main text, where the new variable Demand in UG replaces the Violates 50-50 Norm dummy. When using this measure, we get qualitatively similar results. Demanding a larger share of the pie in the elicitation task reduces the probability of agreement in the main bargaining game.

Table 2: Probability of Agreement: Inequality Aversion and Demand in UG

Dep. Var.: **Agreement**	(1)	(2)
Int. Info & Bundling	2.748***	2.891***
	(0.953)	(0.950)
Com. Info & Bundling	3.882***	3.793***
	(1.142)	(1.019)
No Info & Item-by-Item	0.994	0.992
	(0.297)	(0.273)
Int. Info & Item-by-Item	0.819	0.875
	(0.288)	(0.288)
Com. Info & Item-by-Item	9.328***	8.847***
	(3.315)	(2.943)
Surplus (S)	1.130***	1.131***
	(0.0241)	(0.0249)
Int. Info & Bundling ∗ S	0.933***	0.933***
	(0.0239)	(0.0243)
Com. Info & Bundling ∗ S	0.909***	0.908***
	(0.0214)	(0.0220)
No Info & Item-by-Item ∗ S	1.011	1.011
	(0.0292)	(0.0299)
Int. Info & Item-by-Item ∗ S	0.989	0.988
	(0.0264)	(0.0270)
Com. Info & Item-by-Item ∗ S	0.863***	0.863***
	(0.0200)	(0.0206)
Risk Tolerance	0.882***	0.899**
	(0.0428)	(0.0433)
Inequality Aversion	1.084	
	(0.143)	
Demand in UG		0.908***
		(0.0281)
Period	0.946*	0.946*
	(0.0317)	(0.0316)
Constant	1.890*	5.259***
	(0.708)	(2.211)
Items	3,039	3,039
Negotiations	1,777	1,777
Matching Groups	51	51

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%, Standard errors in parentheses. Random effects regression for probability of agreement (logistic) with standard errors clustered on matching group level. For both models, reported coefficients are odds ratios. Risk Tolerance, Inequality Aversion and Demand in UG are taken from the buyer in a negotiation. Both regressions control for item valuations. Reference group: No Info & Bundling. Data includes items with a surplus greater than 0.

Table 3: Institution, Preferences, and Trade: Inequality Aversion

Dep. Var.: **Accept Offer**	No Info (1)	Int. Info (2)	Comp. Info (3)
Demanded Share	0.220***	0.174***	0.0365***
	(0.0449)	(0.0299)	(0.0136)
Split-the-Diff. (**Δ**)	4.132***	3.806***	3.960***
	(0.680)	(0.684)	(0.448)
Risk Tolerance	1.044	0.910	0.983
	(0.0750)	(0.0565)	(0.0488)
Inequality Aversion	1.052	1.216	0.748**
	(0.176)	(0.209)	(0.108)
Counter Offer	1.473***	1.165	1.162
	(0.211)	(0.145)	(0.133)
Bundle	2.641***	1.964***	1.376*
	(0.568)	(0.271)	(0.258)
Constant	0.192***	0.400**	0.781
	(0.0643)	(0.149)	(0.290)
Offers (N)	6524	6016	5467
Matching Groups	17	17	17

Dep. Var.: **Trade**	No Info (4)	Int. Info (5)	Comp. Info (6)
Total Surplus	1.038***	1.010	1.003
	(0.00921)	(0.00749)	(0.00858)
Split-the-Diff. (**Δ**)	3.813***	3.829***	2.607***
	(1.411)	(1.024)	(0.648)
Risk Tolerance	1.102	0.697***	0.767**
	(0.131)	(0.0968)	(0.0853)
Inequality Aversion	1.011	1.938*	0.716
	(0.203)	(0.692)	(0.342)
Alternating (**A**)	6.594***	9.011***	4.791***
	(2.314)	(4.305)	(1.966)
Bundle	0.743	0.664	0.594**
	(0.222)	(0.402)	(0.157)
Constant	0.181***	0.567	2.136
	(0.0957)	(0.378)	(1.415)
Offer Sequences (N)	929	894	786
Matching Groups	17	17	17

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%, Standard errors clustered on the level of matching groups in parentheses. Logistic random effects regression. Reported coefficients are odds ratios. In models (1) to (3), the unit of observation is an offer, the dependent variable is whether the offer is accepted, and Risk Tolerance and Inequality Aversion are taken from the responding subject. In models (4) to (6), the unit of observation is an offer sequence, the dependent variable is whether the sequence concludes in a trade, Risk Tolerance is averaged across the two subjects, and Inequality Aversion is a dummy equal to one if at least one of the two subjects has a Inequality Aversion dummy of 1. Data includes offers on bundles (including single items) for which all items have a surplus greater than 0.

A.3 Social Preferences and the Bargaining Experience

In this subsection we check whether there is a noticeable effect of the main bargaining experiment on subjects' choices in the subsequent elicitation tasks. Using OLS regressions with the measures elicited after the main experiment as the dependent variables and earnings and the treatments as the independent variables, we check for possible correlation. We find that neither the treatment a subject participated in nor differences in earnings between subjects affect behavior in the elicitation tasks.

Table 4 shows that the different experimental treatments did not shift the elicited measures in one or the other direction. For example, having experienced the Complete Information treatment did not affect, on average, the choice in the elicitation tasks compared to having experienced the No Information treatment (and this holds for all treatment comparisons). We also find no evidence that differences in earnings between subjects systematically affect choices in the elicitation tasks.[1] We also consider interaction with the regressor *Late*, which is a dummy equal to 1 for the last three periods of the bargaining game. We do not find any evidence that outcomes in later bargaining games affected choices in the elicitation tasks.

A.4 Social Preferences and the Bargaining Process

In this subsection we check whether the elicited behavioral measures correlate with bargaining process variables. For this purpose, we consider three process variables: initial demands, the average time a proposal is made, and split-the-difference offers.

Table 5 provides evidence of an increase in initial demands and later proposal times on average for 50-50 norm violators and risk tolerant subjects but only when some (or all) information about the surpluses is known. The table also shows that 50-50 norm violators and risk tolerant subjects are less likely to make split-the-difference offers (mainly under

[1]We also checked for non-linearities of the payoff variable by adding dummies for the top and bottom 25% of earners. We did not find any impact of these variables on the demanded shares in the Ultimatum Game.

Table 4: Social Preferences and the Bargaining Experience

	(1) Demand UG	(2) Demand UG	(3) Violates 50-50	(4) Violates 50-50	(5) Risk	(6) Risk
Profit	0.00762	0.00721	0.0000620	-0.000192	-0.000595	-0.000711
	(0.00560)	(0.00542)	(0.000708)	(0.000778)	(0.00253)	(0.00254)
Int. Information	0.270	0.270	0.0702	0.0701	0.0302	0.0302
	(0.252)	(0.252)	(0.0548)	(0.0548)	(0.129)	(0.129)
Com. Information	-0.160	-0.160	-0.0474	-0.0477	0.0533	0.0532
	(0.212)	(0.213)	(0.0488)	(0.0488)	(0.136)	(0.136)
Period	-0.000324		0.0000455		-0.0000868	
	(0.000519)		(0.0000655)		(0.000202)	
Late $\times$ Profit		0.00171		0.00107		0.000484
		(0.00461)		(0.000981)		(0.00224)
Constant	10.60***	10.60***	0.294***	0.294***	3.280***	3.280***
	(0.191)	(0.191)	(0.0420)	(0.0420)	(0.101)	(0.101)
N	5098	5098	5098	5098	5098	5098
Matching Groups	51	51	51	51	51	51

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%, Standard errors in parentheses. Reference group: No Information treatments. Dependent variable in models 1 and 2 is the demand in the Ultimatum Game. Dependent variable in models 3 and 4 is the Violates 50-50 Norm dummy. Dependent variable in models 5 and 6 is the risk measure. Regressor "Late" is a dummy equal to 1 for the last three periods.

complete information). This additional evidence is noisier than the one presented on rates of trade in the main body of the paper. However, this seems natural given that rates of trade pick up the combined effect of higher initial demands, later proposals, and fewer spit-the-difference offers. We see this as strong evidence that the behavioral model we have in mind is valid.

This analysis suggests brinkmanship as the mechanism through which the behavioral variables cause trade failures. Particularly, subjects characterized by a higher tolerance for risk and a lower concern for the 50-50 norm are more willing to delay the agreement, which leads to more frequent negotiation breakdowns before the entire surplus is realized.

Table 5: Social Preferences and the Bargaining Process

	(1) Initial Demand	(2) Proposal Time	(3) Split-the-Diff. Offer
Total Surplus	0.203***	-0.382***	0.000812
	(0.0181)	(0.0754)	(0.000712)
Int. Info	-1.766	-19.10*	-0.0973
	(1.894)	(10.26)	(0.103)
Com. Info	-4.179**	-20.29*	0.107
	(1.865)	(11.81)	(0.103)
Risk Tolerant × No Info	0.198	-1.814	-0.0384**
	(0.446)	(1.825)	(0.0174)
Risk Tolerant × Int. Info	0.351	4.347**	-0.0184
	(0.269)	(1.818)	(0.0207)
Risk Tolerant × Com. Info	0.478**	2.722	-0.0465**
	(0.237)	(2.635)	(0.0220)
Violates 50-50 × No Info	-0.300	-0.438	-0.0393
	(0.558)	(2.884)	(0.0259)
Violates 50-50 × Int. Info	1.015**	5.455	0.00130
	(0.505)	(4.041)	(0.0371)
Violates 50-50 × Com. Info	-0.463	7.740***	-0.0848**
	(0.488)	(2.984)	(0.0346)
Constant	6.059***	96.54***	0.423***
	(1.621)	(7.798)	(0.0577)
N	4045	4045	2609
Matching Groups	51	51	51

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%, Standard errors in parentheses. Reference group: No Information treatments. In all models, the unit of observation is an offer sequence. Dependent variable in model 1 is the profit demanded in the first offer in a trade sequence. Dependent variable in model 2 is the average time a proposal is made in a trade sequence. Dependent variable in model 3 is a dummy that takes value 1 if the trade sequence contains a split-the-difference offer. All models include period dummies.

B Robustness in Other Bargaining Institutions

Laboratory experiments face a challenge of external validity. This is a second-order issue when testing theoretically predicted effects, e.g., our Hypotheses 1 to 3, because the theory should apply in particular in the controlled environment of the laboratory. When studying strategies, such as the alternating-offer bargaining pattern we document, there is less theoretical guidance and it is useful to combine the findings from our controlled environment with field data. Backus et al. (2020) provide a fascinating look at bargaining on eBay, and also find that alternating-offer bargaining and split-the-difference offers have a crucial impact on the likelihood of agreement. We were also able to connect the behavioral factors we documented to field data (Larsen, 2020).

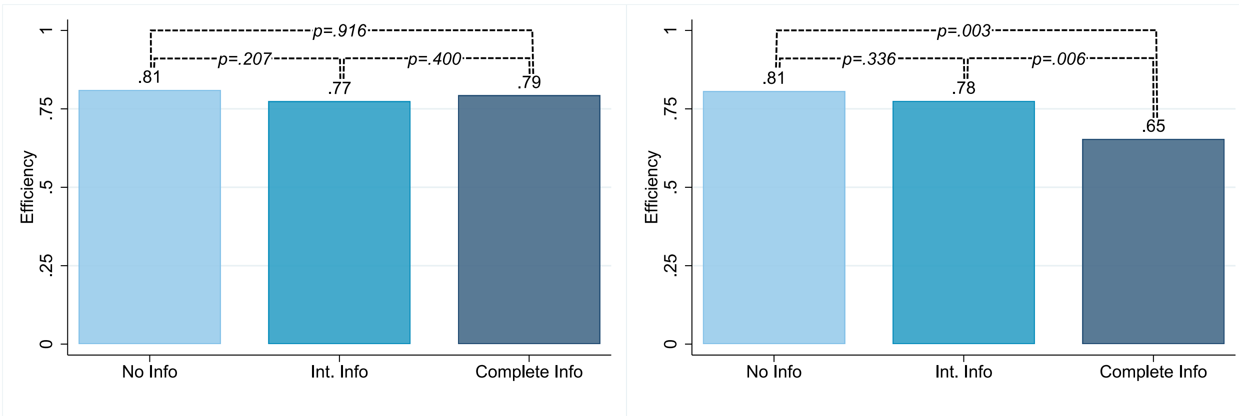
However, the similarity of efficiency across treatments calls for further investigation, as it is neither theoretically predicted nor is there an established empirical literature pointing in the same direction. It is difficult to validate this result in the field as it would require information about bargainers' valuations as well as exogenous variation in the information bargainers have access to. To offer a robustness check within the laboratory setting, we investigate two other bargaining institutions.

B.1 Multi-Issue Ultimatum Bargaining

In the ultimatum game, a proposer makes a take-it-or-leave-it offer to a responder on how to share a surplus. If the responder accepts, the proposal is implemented. If the responder rejects, both parties earn a payoff of zero. When there are multiple issues, the proposer can submit *a set* of take-it-or-leave-it offers. In our setting with three items, there can thus be at most 7 offers, one for each individual item and each bundle. All offers are sent to the responder at the same time. The responder observes the set of offers and chooses which non-overlapping subset of offers to accept. That the responder can select multiple non-overlapping offers ensures that the bargaining protocol is sufficiently rich for the theoretical

Figure 4: Efficiency and Information in Other Bargaining Institutions

(a) Ultimatum Bargaining (b) Noisy Information



Notes: Efficiency is calculated as the sum of realized surplus in a matching group divided by the sum of maximum surplus possible in the matching group and then averaged for each treatment.

hypotheses from Section 3.5 to continue to hold.[2]

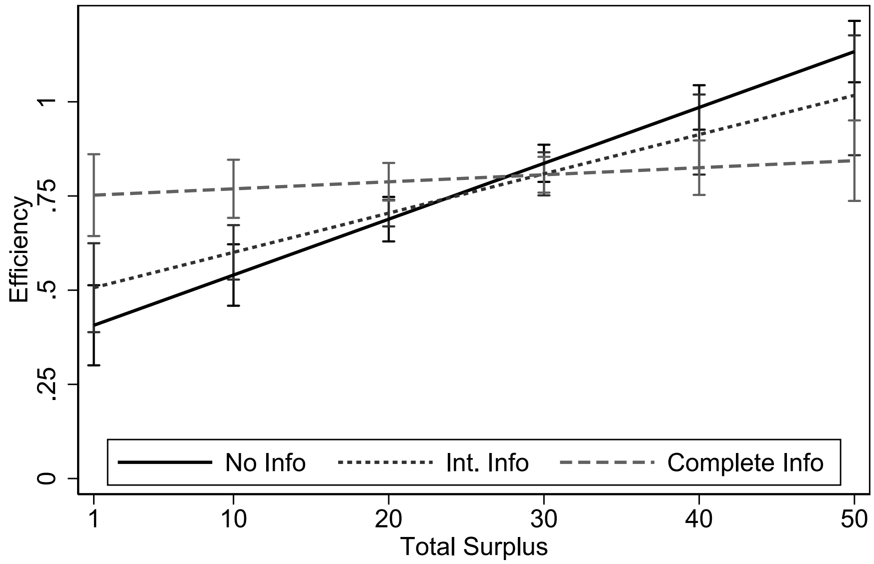
We conducted additional sessions on multi-issue ultimatum bargaining. Specifically, we collected data from 240 subjects (24 independent matching groups), 80 subjects for each information condition.[3] Ultimatum bargaining has historically been the most explored bargaining institution in the experimental sciences (e.g., Güth et al., 1982; Nowak et al., 2000). More importantly, for our purposes, one may expect ultimatum bargaining to lower efficiency in the incomplete information environments compared with unstructured bargaining. The reason is that, by design, back-and-forth offers, and hence gradual price discovery, are no longer possible. Price discovery is less crucial with complete information. The ultimatum game is thus a useful setting to test the robustness of similarity of efficiency across treatments.

As shown in Figure 4a, efficiency levels in ultimatum bargaining are again close to 80% for all information conditions. The small treatment differences are insignificant. In what

[2]The richness condition in Jackson et al. (2020) requires that there exists a set of offers that, when accepted, allocates a fraction αTS to the proposer and $(1-\alpha)TS$ to the responder.

[3]For each information condition, we conducted 4 sessions with bundling and 4 with item-by-item offers. We confirm in these sessions the result that bundling is instrumental for reaching agreement when the efficient scope involves multiple items.

Figure 5: Multi-Issue Ultimatum Bargaining: Efficiency



Notes: Efficiency is calculated as the sum of realized surplus divided by the sum of maximum surplus in a matching group and then averaged for each treatment. Predicted probabilities with 95% confidence intervals are from linear random effects regressions with dependent variable efficiency on the negotiation-level (realized surplus divided by maximum surplus available in a given negotiation) and standard errors clustered on matching groups.

follows, we show that, as in the main treatments, more information promotes efficiency in small-surplus negotiations, but hinders agreement in large-surplus negotiations. The hurdles that prevent agreement under intermediate and complete information remain in place, in particular conflicting fairness preferences. Crucially, efficiency in *No Info* is *not* lowered when removing the possibility of repeated offers. The reason is that proposers lower their initial demands significantly below those in *Intermediate Info* and *Complete Info* (on average by 15% points of the total surplus), compensating for the informational incompleteness. We conclude that efficiency is similar across treatments in ultimatum bargaining as well.

Figure 5 shows that, as in the main treatments, improved information facilitates trade of small-surplus items and thus raises efficiency, but improved information plays the opposite role for large-surplus items. Table 6 shows that fairness preferences are among the main hurdles that prevent agreement under complete information, as the Violates 50-50 dummy has a significant and negative effect on the probability of agreement.

Table 6: Ultimatum Bargaining: Regressions—Probability of Agreement and Efficiency

	Agreement
Int. Info	0.358
	(0.246)
Complete Info	0.715***
	(0.211)
Surplus	0.0486***
	(0.00508)
Int. Info ∗ S	-0.0172**
	(0.00775)
Complete Info ∗ S	-0.0469***
	(0.00761)
Violates 50-50 Norm	0.230***
	(0.0709)
Int. Info ∗ Violates 50-50 Norm	-0.378**
	(0.164)
Complete Info ∗ Violates 50-50 Norm	-0.424***
	(0.102)
Risk Tolerance	-0.0226
	(0.0348)
Int. Info ∗ Risk Tolerance	0.0255
	(0.0473)
Complete Info ∗ Risk Tolerance	0.0679
	(0.0447)
Period	-0.00389
	(0.0100)
Constant	0.540***
	(0.170)
Items	832
Matching Groups	24

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors in parentheses. Random effects for probability of agreement (linear) with standard errors clustered on matching group level. Reference group: *No Info*. The variable Surplus corresponds to the surplus of an item. Risk Tolerance is taken from the proposer in a negotiation. Violates 50-50 Norm is a dummy variable that equals 1 if at least one of the two subjects has Violates 50-50 Norm dummy of 1.

B.2 Unstructured Bargaining with Noisy Information

We also conducted additional sessions using the unstructured bargaining environment but in a situation where information is noisy. Specifically, negotiators learn that their own valuations/costs for the three items lie in an *interval* (of size 5) but they do not known their true valuations/costs until after the bargaining game. Each value in the interval is equally likely. In *Intermediate Info*, negotiators also learn the *expected* total surplus associated with the buyer's valuation and the seller's cost intervals. In particular, we compute the expected surplus based on the realized intervals of valuations/costs and reveal this number to the bargainers. In *Complete Info*, negotiators in addition know the intervals of valuations/costs of the other party. We collected data from 180 subjects (18 independent matching groups) in this bargaining environment, 60 per information condition with bundling being possible in all sessions.

There are two main reasons why we consider this to be a setting worth exploring. First, it feels natural to assume that bargainers are uncertain about the exact valuation/cost they have for an item. One way to think about this is that items have a common value component, that is, the value of an item depends on how agents other than the bargaining pair will value it. Second, as with the ultimatum game, we expected that these treatments will favor the complete information condition and thus provide a good robustness test for the similarity of efficiency across treatments. This is because we expected uncertainty about the exact valuations would reduce the impact of conflicting fairness preferences in *Complete Info* and also align the effects of risk preferences across conditions.[4] These behavioral factors have been show to reduce efficiency under complete information but not incomplete information (see the literature discussed in the main paper).

As shown in Figure 4b, the empirical results reveal that with noisy information efficiency

[4] Dana et al. (2007) show that the presence of incomplete information provides subjects with a moral wiggle room that makes them act more selfishly in a dictator game setting. This is in line with our finding: the impact of fairness preferences is reduced in incomplete information environments. The difference is that in Dana et al.'s environment the impact of fairness leads to more equal outcomes. In our setting, with symmetric proposer power, a focus on distributional concerns can lead to trade failures.

is significantly *lower* in *Complete Info* than in *No Info* ($p = .003$) or *Intermediate Info* ($p = .006$). For large-surplus items the additional uncertainty has almost no impact on agreement rates and the behavioral factors still adversely impact agreement probability. In particular, agreement rates with complete information remain below 75%. However, noisy information leads to a significant reduction in efficiency for low-surplus items in treatments with complete information, because there the additional noise is relatively large compared to the possible gains from trade. The key takeaway is that bargaining impasses under complete information are not an artefact of high information precision. Adding a small but non-negligible amount of uncertainty does not alleviate the detrimental impact of behavioral preferences.

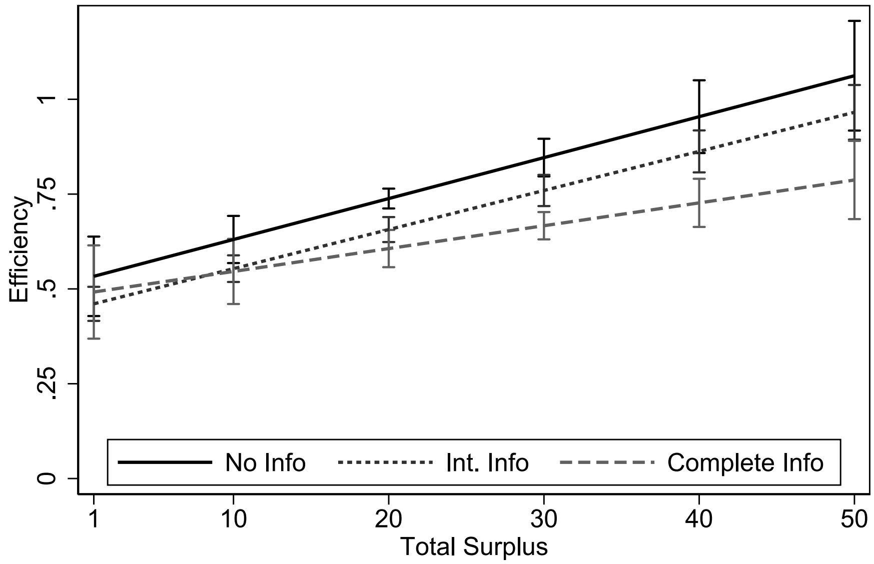
There is another benefit we get from the noisy information treatments, which is that we can test if the results on the negotiation process from our main treatments replicate. We find that they do. In what follows, we show that the number of offers made is almost double in *No Info* than in *Complete Info*, with *Intermediate Info* lying between the two, that the timing of offer acceptances is the same across treatments, and that bundled offers are significantly more aggressive than offers on single items. Most importantly, we show that negotiations are characterized by alternating-offer bargaining with frequent split-the-difference offers and that such offer sequences are significantly more likely to result in agreement than offer sequences that exhibit other bargaining formats.

Figure 6 shows that noisy information leads to a reduction in efficiency for small-surplus items in *Complete Info* compared to the main treatments, thus making the efficiency gains from information disappear for small-surplus items as well.

In the main text we presented results regarding the negotiation process for our main treatments. Now we show that the results replicate well in the treatments with noisy information.

(i) Figure 7 shows the number of offers made is almost double in *No Info* than in *Complete Info*, with *Int. Info* lying between the two. The timing of offer acceptances is the same

Figure 6: Noisy Information: Efficiency



Notes: Efficiency is calculated as the sum of realized surplus divided by the sum of maximum surplus in a matching group and then averaged for each treatment. Predicted probabilities with 95% confidence intervals are from linear random effects regressions with dependent variable efficiency on the negotiation-level (realized surplus divided by maximum surplus available in a given negotiation) and standard errors clustered on matching groups.

across treatments.

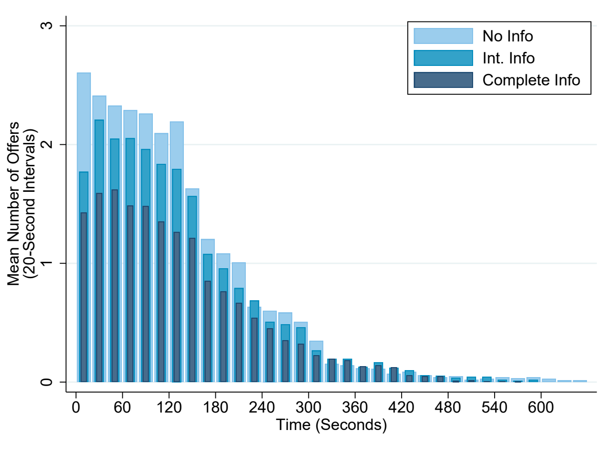
(ii) Table 7 shows that bundled offers are significantly more aggressive than offers on individual items.

(iii) Figure 8 most negotiations are characterized by alternating offers bargaining, with frequent split-the-difference offers.

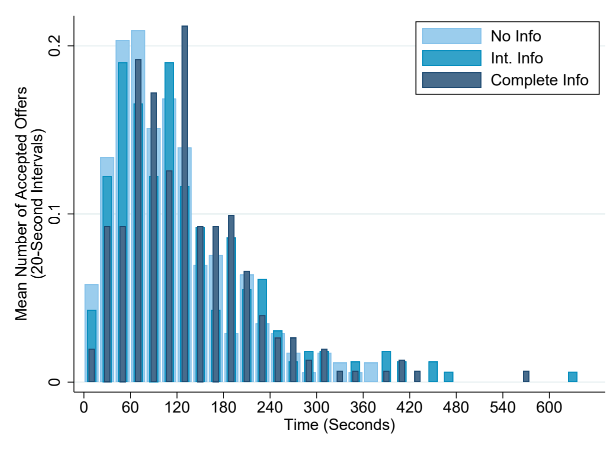
(iv) Table 8 shows that offer sequences with a larger percentage of alternating offers are substantially more likely to result in agreement, and split-the-difference offers are particularly likely to be accepted.

Figure 7: Noisy Information: Timing of Proposed and Accepted Offers

(a) Offers over Time



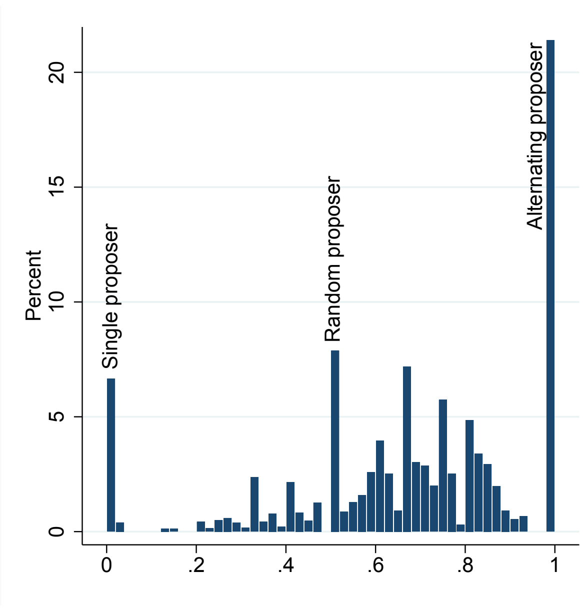
(b) Acceptances over Time



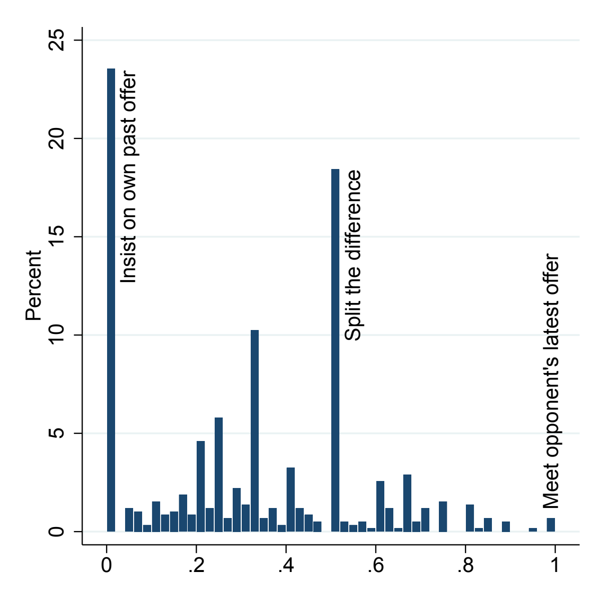
Notes: Figure ***(a)*** shows the mean number of proposed offers (single-item and bundles) per 20-second interval averaged by information structure. Figure ***(b)*** shows the mean number of accepted offers.

Figure 8: Noisy Information: Alternating Proposers and Split-the-Difference

(a) Alternating Offers (A)



(b) Split-the-Difference (Σ)



Notes: Figure ***(a)*** shows a histogram for the percentage of alternating offers in a negotiation (A). Figure ***(b)*** shows a histogram of the split-the-difference measure (Σ).

Table 7: Demanded Share of Total Surplus

	No Information			*Intermediate Information*			*Complete Information*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total Surplus (TS)	0.545***	0.107**	0.0749	0.547***	0.243***	0.205***	0.430***	0.276***	0.277***
	(0.0163)	(0.0479)	(0.0461)	(0.0246)	(0.0435)	(0.0297)	(0.0465)	(0.0510)	(0.0413)
Two-Item Bundle $*$ TS	0.118***	0.246***	0.231***	0.0739***	0.148***	0.159***	0.0803	0.126***	0.134***
	(0.0221)	(0.0340)	(0.0273)	(0.0154)	(0.0235)	(0.0221)	(0.0418)	(0.0390)	(0.0388)
Three-Item Bundle $*$ TS	0.497***	0.653***	0.579***	0.255***	0.394***	0.385***	0.248**	0.301***	0.290***
	(0.0692)	(0.0525)	(0.0558)	(0.0338)	(0.0436)	(0.0469)	(0.0829)	(0.0683)	(0.0554)
Proposal Time (sec.)			-0.0255***			-0.0163***			-0.0129***
			(0.00314)			(0.00457)			(0.00171)
Risk Tolerance			-0.0522			-0.0553			-0.0935
			(0.246)			(0.312)			(0.248)
Violates 50-50 Norm			-0.657			1.704*			0.451
			(1.090)			(0.940)			(0.651)
Constant		6.458***	9.506***		4.887***	6.159***		3.022***	5.610***
		(0.722)	(1.017)		(0.536)	(1.277)		(0.470)	(1.186)
Offers (N)	3063	3063	3063	2536	2536	2536	2039	2039	2039
Matching Groups	6	6	6	6	6	6	6	6	17

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. OLS regressions for *No Info*, *Int. Info*, *Complete Info* with standard errors clustered on matching group level. Models (3), (6), (9) include period dummies.

Table 8: Noisy Information: Institution, Preferences, and Trade

Dep. Var.: **Accept Offer**	No Info (1)	Int. Info (2)	Comp. Info (3)
Demanded Share	0.390**	0.301***	0.0924***
	(0.176)	(0.0420)	(0.0415)
Split-the-Diff. (**Δ**)	5.360***	3.738***	3.324***
	(1.356)	(0.569)	(0.885)
Risk Tolerance	0.924	1.249**	0.832
	(0.112)	(0.129)	(0.0954)
Violates 50-50 Norm	1.141	1.127	0.965
	(0.374)	(0.221)	(0.192)
Counter Offer	1.111	1.121	0.815
	(0.284)	(0.208)	(0.165)
Bundle	1.230	1.143	0.935
	(0.422)	(0.222)	(0.223)
Constant	0.105**	0.187**	0.930
	(0.103)	(0.131)	(1.005)
Offers (N)	1581	1292	1549
Matching Groups	6	6	6

Dep. Var.: **Trade**	No Info (4)	Int. Info (5)	Comp. Info (6)
Total Surplus	1.025	1.014	1.006*
	(0.0227)	(0.00936)	(0.00342)
Split-the-Diff. (**Δ**)	4.329***	2.980***	2.907***
	(2.421)	(0.935)	(1.069)
Risk Tolerance	1.074	1.330	0.673**
	(0.280)	(0.335)	(0.123)
Violates 50-50 Norm	0.900	0.695	0.882
	(0.384)	(0.321)	(0.405)
Alternating (**A**)	6.649***	6.614***	1.311
	(1.424)	(3.085)	(0.923)
Bundle	0.531*	0.316**	0.357**
	(0.202)	(0.154)	(0.149)
Constant	0.0598	0.283	1.924
	(0.104)	(0.342)	(2.145)
Offer Sequences (N)	297	263	293
Matching Groups	6	6	6

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%, Standard errors clustered on the level of matching groups in parentheses. Logistic random effects regression. Reported coefficients are odds ratios. In models (1) to (3), the unit of observation is an offer, the dependent variable is whether the offer is accepted, and Risk Tolerance and Violates 50-50 Norm are taken from the responding subject. In models (4) to (6), the unit of observation is an offer sequence, the dependent variable is whether the sequence concludes in a trade, Risk Tolerance is averaged across the two subjects, and Violates 50-50 Norm is a dummy equal to 1 if at least one of the two subjects has a Violates 50-50 Norm dummy of 1. Data includes offers on bundles (including single items) for which all items have a surplus greater than 0.

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Online Appendix C

Beyond Dividing the Pie:

Multi-Issue Bargaining in the Laboratory

By Olivier Bochet, Manshu Khanna and Simon Siegenthaler

This online appendix contains the experiment instructions for three of the twelve treatments discussed in the article. The instructions for the remaining nine treatments follow directly from them. Contact the authors for the full set of instructions.

[Treatment: Unstructured Bargaining & Bundling & Intermediate Information]

General Instructions

Welcome to the Laboratory for Research in Experimental Economics.

Your earnings from the experiment will largely depend on your decisions and the decisions of others. Therefore, it is important that you read the instructions carefully. The experiment consists of three parts that are independent of each other. The instructions for Part 1 can be found on the following pages. The instructions for Part 2 and Part 3 will be given on the computer screen.

In the experiment, we will not speak of EUR, but rather of ECU (Experimental Currency Units). At the end of the experiment the total amount of ECU you earned will be converted to EUR at the **exchange rate ECU 1 = EUR 0.25**. The final earnings will be rounded to the closest 10 cents. You will also receive a **show up fee** of **EUR 5**. You will be paid your earnings in cash, privately at the end of the session.

All interactions between you and other participants will occur through the computer terminals. Please do not talk directly to or attempt to communicate with other participants during the session. Please also do not ask questions aloud. If you have a question, raise your hand and a member of the experimenter team will come to you. All personal electronic devices should remain switched off until the end of the experiment.

Please now proceed to the instructions for Part 1.

Instructions Part 1

General Description of the Experiment

At the beginning of the experiment, all participants in the room will be divided into groups of 10. We will refer to this group as your "matching group". In each matching group, the computer will randomly determine **5 buyers** and **5 sellers**. You will be either in the role of a buyer or a seller. If you are buyer (respectively, a seller), you will be a buyer (respectively, a seller) for the entire experiment. At the start of Part 1, everyone will receive 8 ECU to begin with.

You will play **10 rounds** of a decision situation. At the start of each round, you will be **randomly matched** with another participant in your matching group. In particular, if you are a buyer, you will be matched at random to one of the 5 sellers in your matching group. If you are a seller, you will be matched at random to one of the 5 buyers in your matching group. Hence, the person you are matched with will typically change between rounds. You will never know the identity of the person with whom you are matched in a given round or of the people in your matching group.

Decision Situation in each Round

We will now explain the decision situation you will face in each of the 10 rounds.

Objects

In each round, there are **3 objects**: **object A, object B and object C**. For each object, the buyer has a **valuation**. A valuation is the worth a buyer assigns to an object. Similarly, for each object, the seller has a **production cost**. The production cost is the cost the seller incurs if producing an object in order to sell it to the buyer.

At the beginning of each round, the buyer's valuations and the seller's production costs for the 3 objects will be randomly chosen to be **0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 or 33 ECU.** Any value between 0 ECU and 33 ECU is **equally likely.** All valuations and production costs are randomly determined by the computer and are independent of each other, that is, the buyer's values for the different objects will typically not be the same and neither will the seller's production costs.

Information

The buyer's valuations and the seller's production costs are **private information**. In particular, the buyer will be told his or her valuations for the 3 objects and the seller will be told his or her production costs for the 3 objects. However, we will not tell the buyer what the seller's production costs are and neither will we tell the seller the buyer's valuations.

There is an additional piece of information that both the buyer and the seller will know: each participant will be told the **maximal surplus** the buyer and the seller could realize in a given round. The maximal surplus corresponds to the maximal earnings the buyer and the seller can jointly realize in this round. In other words, the maximal surplus is the sum of the buyer's and the seller's earnings if they only trade the objects for which the buyer's valuation exceeds the seller's production cost. (An object generates a negative surplus if the buyer's valuation is smaller than the seller's production costs)

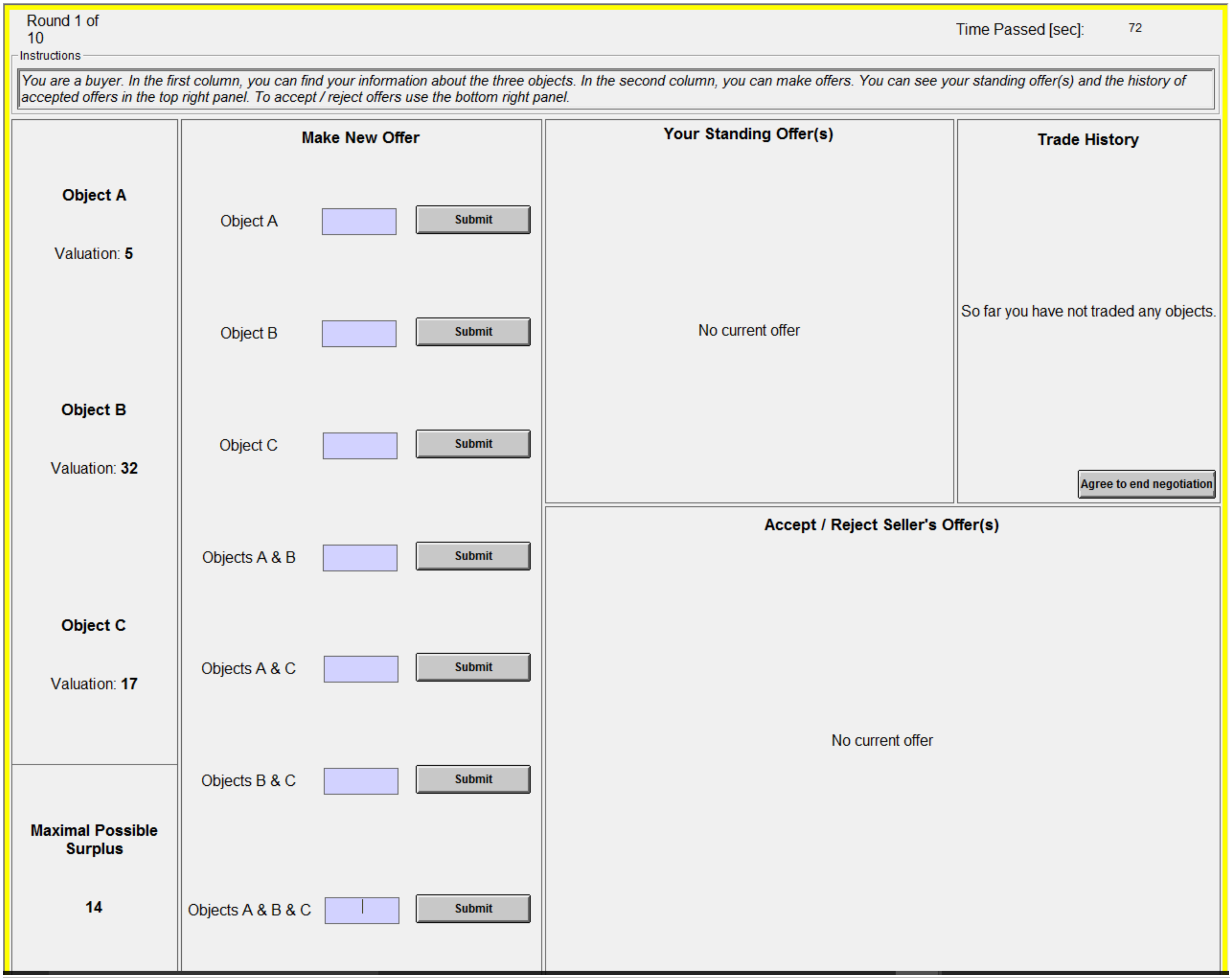
To understand what the maximal surplus is, it is easiest to look at an *example*:
Suppose the buyer's valuations are **15** for object A, **10** for object B and **5** for object C.
The seller's production cost is **7** for each of the objects.
The possible surplus for object A is therefore **15 – 7 = 8**.
The possible surplus for object B is **10 – 7 = 3**.
The possible surplus for object C is **0**, because if the object is traded the buyer receives a valuation of 5 and the seller pays a production cost of 7, and 5 – 7 = –2 is negative. Trading object C generates a negative surplus.
Thus, in this example, the maximal surplus is **8 + 3 + 0 = 11**. It is obtained if objects A and B are traded and object C is not traded.

We next describe the **bargaining process**. The bargaining process will determine which objects the buyer and the seller trade, and the price at which the objects are traded.

Making Offers
The buyer and seller will both be able to make offers. **An offer includes a selection of objects and a price.** Thus, when you are buyer, an offer will specify which objects you would like to buy and the price for these objects. When you are a seller, an offer will specify which objects you would like to sell and the price of these objects.

Since there are 3 objects, there are **7 possible selections of objects: {A}**, **{B}**, **{C}**, **{A, B}**, **{A, C}**, **{B, C}** and **{A, B, C}**. An offer will be a selection of objects and a price at which you would like to trade the selected objects. **The price has to be a whole number between 0 and 33 ECU for a single object, between 0 and 66 ECU for a selection of two objects and between 0 and 99 ECU for an offer that includes all three objects.** The price is for the whole selection of objects, for instance, if a seller accepts to sell objects A and B at a price of 29 ECU, s/he receives 29 ECU for both objects together, and not 29 ECU per object.

Below you can see a screen shot of the experiment. The screen shows the situation of a buyer. Notice that the buyer can **see his/her valuations for each object on the left-hand side of the screen, but s/he does not know the production costs of the seller. You can see the maximal possible surplus in the bottom left corner of the screen**. You can further see the 7 possible selections of objects. To make an offer, you can enter a price in the box next to the selection of objects you wish to buy / sell and click on "Submit". You can make up to 7 simultaneous offers, one for each selection of objects. You can revise an offer by making a new offer for the same selection of objects. You can also cancel an offer, in which case this offer will be removed from your standing offers.


Round 1 of 10
Time Passed [sec]: 72
Instructions
You are a buyer. In the first column, you can find your information about the three objects. In the second column, you can make offers. You can see your standing offer(s) and the history of accepted offers in the top right panel. To accept / reject offers use the bottom right panel.
Object A
Valuation: 5
Object B
Valuation: 32
Object C
Valuation: 17
Maximal Possible Surplus
14
Make New Offer
Object A
Object B
Object C
Objects A & B
Objects A & C
Objects B & C
Objects A & B & C
Submit
Your Standing Offer(s)
No current offer
Trade History
So far you have not traded any objects.
Agree to end negotiation
Accept / Reject Seller's Offer(s)
No current offer

Accepting and Rejecting Offers

You will also decide whether you would like to accept or reject the offers made by the other party. If an offer is accepted, the corresponding selection of objects is traded at the specified price. If an offer is rejected, the offer is removed from the list of offers. In a given round, **it is possible that the buyer and the seller agree to trade several different selections of objects.** For example, it is possible that objects {A, C} are traded first and then, later on, object B is traded as well. Of course, offers cannot include objects which have already been traded.

Timing

The buyer and the seller can make, accept or reject offers at any time they wish to do so. In the top right corner of the screen, you will see how long the bargaining process has already lasted.

When Does Bargaining End?

There are three ways the bargaining process can end.

- The bargaining process will be stopped if all **3 objects have been traded**.
- The bargaining process may also end at a random point in time before all objects have been traded. We will refer to this as a **bargaining breakdown**. This will not happen during the **first minute.** After the first minute, bargaining will be stopped with a probability of **4% every 10 seconds**. This means that bargaining breaks down at exactly 1 minute with a probability of 4%. With a probability of 96% bargaining continues beyond 1 minute. The next point in time at which bargaining could break down is 1 minute and 10 seconds, and so on. You do not need to calculate the breakdown probabilities. It is sufficient to know that this implies that bargaining never breaks down before 1 minute, bargaining does not break down before 2 minutes with a probability of 78%, before 3 minutes with 61%, before 4 minutes with 48%, before 5 minutes with 38%, before 6 minutes with 29%, before 7 minutes with 23%, before 8 minutes with 18%, before 9 minutes with 14%, before 10 minutes with 11%, before 11 minutes with 9%, and before 12 minutes with 7%. If bargaining has not ended after 12 minutes, we will stop at 12 minutes.
- The third way through which the bargaining process can end is if the buyer and the seller **agree to end negotiations**. In particular, there will be a button “agree to end negotiation”, and the bargaining process ends if both bargaining parties click the button. You will not observe if the other bargaining party has clicked the button, that is, to end bargaining both parties need to click the button independently.

Earnings

As a buyer, your earnings will depend on your valuations and on the prices you agree to pay. For each object you buy, you will earn your valuation minus the agreed price.

Buyer's Earnings = Sum of valuations of traded objects – Sum of prices for traded objects

As a seller, your earnings will depend on your production costs and on the prices at which you agree to sell objects. For each object you sell, you will earn the agreed price minus your production cost.

Seller's Earnings = Sum of prices for traded objects – Sum of production costs of traded objects

Untraded objects do not affect your earnings. In other words, if the bargaining process ends before all three objects are traded, **the earnings for the untraded objects are zero**.

Below you can find five examples of how earnings are calculated. All examples are to help you understand better the experiment. They should not be considered as guides on how to behave in the experiment.

Example 1: You are a buyer and your valuation for object A is 26. You made an offer to buy object A at a price of 20 and the offer was accepted. No other offers were accepted. Then you will earn 26 ECU – 20 ECU = 6 ECU.

Example 2: You are a seller and your production costs are 8 for object A and 17 for object B. You offer to sell object A at a price of 13 and the buyer accepts the offer. You also accept an offer by the buyer to buy object B at a price of 19. Then you will earn 13 ECU + 19 ECU – 8 ECU – 17 ECU = 7 ECU.

Example 3: You are a buyer with valuations 33 for object B and 15 for object C. You buy objects B and C jointly at a price of 32. Then you will earn 33 ECU + 15 ECU – 32 ECU = 16 ECU.

Example 4: You are a seller and your production costs are 17 for each object A and B and 28 for object C. You sell objects A, B and C jointly for a price of 57. Then you will earn 57 ECU – 17 ECU – 17 ECU – 28 ECU = – 5 ECU. That is, you will lose 5 ECU.

Example 5: The buyer's valuations are 10 for object A, 20 for object B and 30 for object C. The seller's production costs are 24 for object A, 18 for object B and 12 for object C. If the buyer and the seller trade object A, the generated surplus is 10 ECU – 24 ECU= –14 ECU. The generated surplus if object B is traded is 20 ECU – 18 ECU= 2 ECU. The generated surplus if object C is traded is 30 ECU – 12 ECU= 18 ECU. In this example, the maximal possible surplus of 2 ECU + 18 ECU = 20 ECU is thus achieved if objects B and C are traded and object A is not traded.

Your earnings from each of the 10 rounds will be summed up and paid to you at the end of the session. If your earnings in a given round are below 0 ECU, the amount will be subtracted from your previous earnings. If your earnings at the end of the experiment are below 5 EUR, you will receive the minimum of 5 EUR. As a buyer, you should thus be careful to not accept or make offers for which you pay more for an object than your valuation. As a seller, you should be careful to not accept or make offers for which your production cost for an object exceed the selling price.

All 10 rounds of this part of the experiment will be the same, except that your valuations (as a buyer) or productions costs (as a seller) for the objects are randomly determined at the beginning of each round, and the participant you are matched with will change between rounds.

This completes the description of the instructions. If you have any questions, please raise your hand. Otherwise, please proceed to answer the questions that will be shown on your computer. The purpose of the questions is to make sure that you understand the different elements of the experiment. Any unclear points will be explained by the experimenter.

[Treatment: Unstructured Bargaining & Item-by-Item & Full Information]

General Instructions

Welcome to the Laboratory for Research in Experimental Economics.

Your earnings from the experiment will largely depend on your decisions and the decisions of others. Therefore, it is important that you read the instructions carefully. The experiment consists of three parts that are independent of each other. The instructions for Part 1 can be found on the following pages. The instructions for Part 2 and Part 3 will be given on the computer screen.

In the experiment, we will not speak of EUR, but rather of ECU (Experimental Currency Units). At the end of the experiment the total amount of ECU you earned will be converted to EUR at the **exchange rate ECU 1 = EUR 0.25**. The final earnings will be rounded to the closest 10 cents. You will also receive a **show up fee** of **EUR 5**. You will be paid your earnings in cash, privately at the end of the session.

All interactions between you and other participants will occur through the computer terminals. Please do not talk directly to or attempt to communicate with other participants during the session. Please also do not ask questions aloud. If you have a question, raise your hand and a member of the experimenter team will come to you. All personal electronic devices should remain switched off until the end of the experiment.

Please now proceed to the instructions for Part 1.

Instructions Part 1

General Description of the Experiment

At the beginning of the experiment, all participants in the room will be divided into groups of 10. We will refer to this group as your "matching group". In each matching group, the computer will randomly determine **5 buyers** and **5 sellers**. You will be either in the role of a buyer or a seller. If you are buyer (respectively, a seller), you will be a buyer (respectively, a seller) for the entire experiment. At the start of Part 1, everyone will receive 8 ECU to begin with.

You will play **10 rounds** of a decision situation. At the start of each round, you will be **randomly matched** with another participant in your matching group. In particular, if you are a buyer, you will be matched at random to one of the 5 sellers in your matching group. If you are a seller, you will be matched at random to one of the 5 buyers in your matching group. Hence, the person you are matched with will typically change between rounds. You will never know the identity of the person with whom you are matched in a given round or of the people in your matching group.

Decision Situation in each Round

We will now explain the decision situation you will face in each of the 10 rounds.

Objects
In each round, there are **3 objects**: **object A, object B and object C**. For each object, the buyer has a **valuation**. A valuation is the worth a buyer assigns to an object. Similarly, for each object, the seller has a **production cost**. The production cost is the cost the seller incurs if producing an object in order to sell it to the buyer.

At the beginning of each round, the buyer's valuations and the seller's production costs for the 3 objects will be randomly chosen to be **0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 or 33 ECU.** Any value between 0 ECU and 33 ECU is **equally likely.** All valuations and production costs are randomly determined by the computer and are independent of each other, that is, the buyer's values for the different objects will typically not be the same and neither will the seller's production costs.

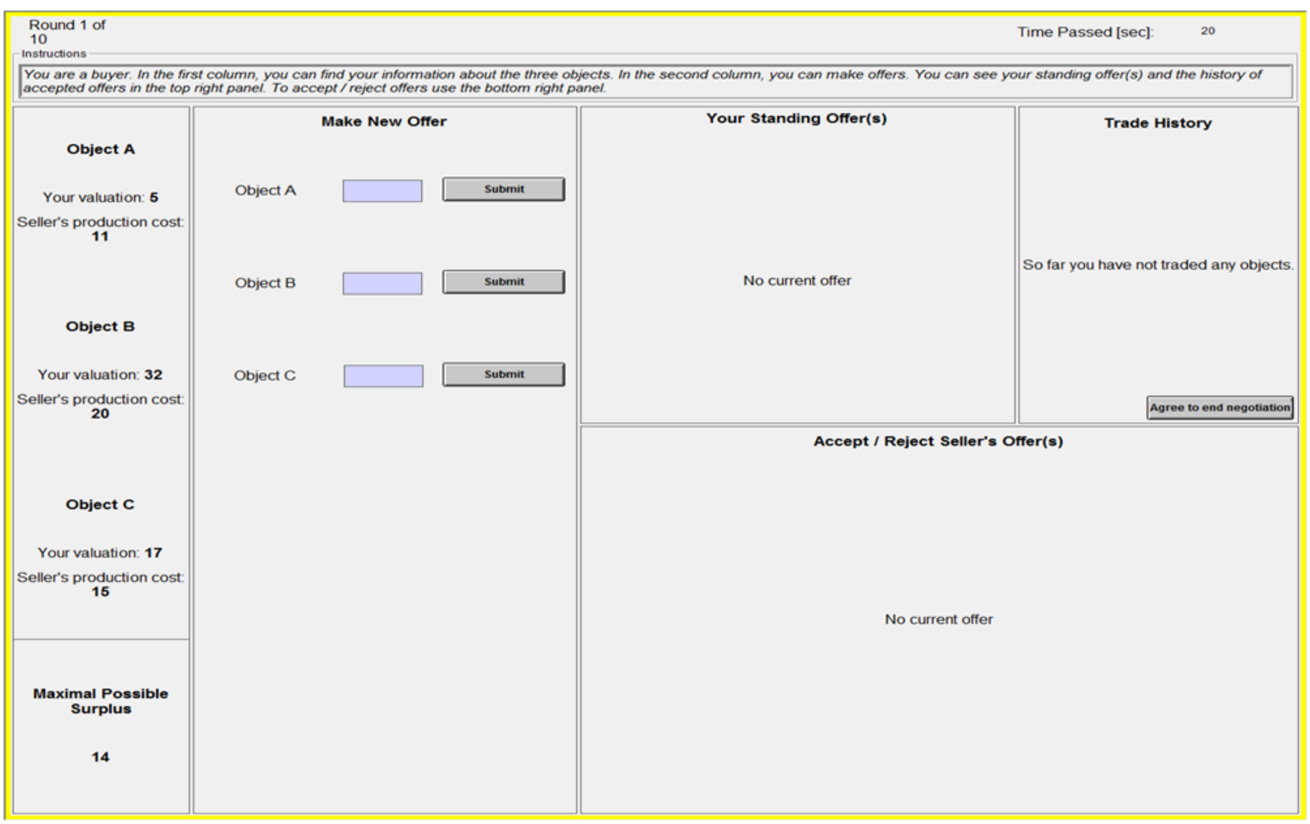
Information
The buyer and the seller will be informed about all valuations and production costs. In particular, at the beginning of a round, the buyer will be told his/her valuations as well as the seller's production costs for each of the 3 objects. The same applies to the seller.

We next describe the **bargaining process**. The bargaining process will determine which objects the buyer and the seller trade, and the price at which the objects are traded.

<u>Making Offers</u>

The buyer and seller will both be able to make offers. **An offer includes an object and a corresponding price.** Thus, when you are buyer, an offer will specify the object you would like to buy and the price for this object. When you are a seller, an offer will specify which object you would like to sell and the price of the objects. **The price has to lie between 0 and 33 ECU and has to be a whole number.** For instance, a seller could offer to sell object A at a price of 29 ECU, or a buyer could offer to buy object B at a price of 4 ECU.

Below you can see a screen shot of the experiment. The screen shows the situation of a buyer. Notice that **the buyer can see his or her valuations as well as the seller's production costs on the left-hand side of the screen.** You can also see the **maximal possible surplus,** which is given by the sum of the buyer's and the seller's earnings when trading all objects for which the buyer's valuation exceeds the seller's production cost. The screen will be the same for the seller, except that s/he will see his/her production costs instead of the valuations (s/he will also see the buyer's valuations). As you can see, there are 3 objects. To make an offer, you can enter a price in the box next to the object you wish to buy / sell and click on "Submit". You can make up to 3 simultaneous offers, one for each object. You can revise an offer by making a new offer for the same object. You can also cancel an offer, in which case this offer will be removed from your standing offers.



Accepting and Rejecting Offers

You will also decide whether you would like to accept or reject the offers made by the other party. If an offer is accepted, the corresponding object is traded at the specified price. If an offer is rejected, the offer is removed from the list of offers. In a given round, **it is possible that the buyer and the seller agree to trade several objects.** For example, it is possible that object A is traded first and then, later on, object B is traded as well. Of course, offers cannot include objects which have already been traded.

Timing

The buyer and the seller can make, accept or reject offers at any time they wish to do so. In the top right corner of the screen, you will see how long the bargaining process has already lasted.

When Does Bargaining End?

There are three ways the bargaining process can end.

- The bargaining process will be stopped if all **3 objects have been traded**.
- The bargaining process may also end at a random point in time before all objects have been traded. We will refer to this as a **bargaining breakdown**. This will not happen during the **first minute.** After the first minute, bargaining will be stopped with a probability of **4% every 10 seconds**. This means that bargaining breaks down at exactly 1 minute with a probability of 4%. With a probability of 96% bargaining continues beyond 1 minute. The next point in time at which bargaining could break down is 1 minute and 10 seconds, and so on. You do not need to calculate the breakdown probabilities. It is sufficient to know that this implies that bargaining never breaks down before 1 minute, bargaining does not break down before 2 minutes with a probability of 78%, before 3 minutes with 61%, before 4 minutes with 48%, before 5 minutes with 38%, before 6 minutes with 29%, before 7 minutes with 23%, before 8 minutes with 18%, before 9 minutes with 14%, before 10 minutes with 11%, before 11 minutes with 9%, and before 12 minutes with 7%. If bargaining has not ended after 12 minutes, we will stop at 12 minutes.
- The third way through which the bargaining process can end is if the buyer and the seller **agree to end negotiations**. In particular, there will be a button “agree to end negotiation”, and the bargaining process ends if both bargaining parties click the button. You will not observe if the other bargaining party has clicked the button, that is, to end bargaining both parties need to click the button independently.

Earnings
As a buyer, your earnings will depend on your valuations and on the prices you agree to pay. For each object you buy, you will earn your valuation minus the agreed price.

Buyer's Earnings = Sum of valuations of traded objects – Sum of prices for traded objects

As a seller, your earnings will depend on your production costs and on the prices at which you agree to sell objects. For each object you sell, you will earn the agreed price minus your production cost.

Seller's Earnings = Sum of prices for traded objects – Sum of production costs of traded objects

Untraded objects do not affect your earnings. In other words, if the bargaining process ends before all three objects are traded, **the earnings for the untraded objects are zero**.

Below you can find five examples of how earnings are calculated. All examples are to help you understand better the experiment. They should not be considered as guides on how to behave in the experiment.

Example 1: You are a buyer and your valuation for object A is 26. You made an offer to buy object A at a price of 20 and the offer was accepted. No other offers were accepted. Then you will earn 26 ECU – 20 ECU = 6 ECU.

Example 2: You are a seller and your production costs are 8 for object A and 17 for object B. You offer to sell object A at a price of 13 and the buyer accepts the offer. You also accept an offer by the buyer to buy object B at a price of 19. Then you will earn 13 ECU + 19 ECU – 8 ECU – 17 ECU = 7 ECU.

Example 3: You are a buyer with valuations 33 for object B and 15 for object C. You buy object B at a price of 20 and object C at a price of 12. Then you will earn 33 ECU + 15 ECU – 20 ECU – 12 ECU = 16 ECU.

Example 4: You are a seller and your production costs are 17 for each object A and B and 28 for object C. You sell object A at a price of 20, object B at a price of 20 and object C at a price of 17. Then you will earn 57 ECU – 17 ECU – 17 ECU – 28 ECU = – 5 ECU. That is, you will lose 5 ECU.

Example 5: The buyer's valuations are 10 for object A, 20 for object B and 30 for object C. The seller's production costs are 24 for object A, 18 for object B and 12 for object C. If the buyer and the seller trade object A, the generated surplus is 10 ECU – 24 ECU = –14 ECU. The generated surplus if object B is traded is 20 ECU – 18 ECU = 2 ECU. The generated surplus if object C is traded is 30 ECU – 12 ECU = 18 ECU.

Your earnings from each of the 10 rounds will be summed up and paid to you at the end of the session. If your earnings in a given round are below 0 ECU, the amount will be subtracted from your previous earnings. If your earnings at the end of the experiment are below 5 EUR, you will receive the minimum of 5 EUR. As a buyer, you should thus be careful to not accept or make offers for which you pay more for an object than your valuation. As a seller, you should be careful to not accept or make offers for which your production cost for an object exceed the selling price.

All 10 rounds of this part of the experiment will be the same, except that your valuations (as a buyer) or productions costs (as a seller) for the objects are randomly determined at the beginning of each round, and the participant you are matched with will change between rounds.

This completes the description of the instructions. If you have any questions, please raise your hand. Otherwise, please proceed to answer the questions that will be shown on your computer. The purpose of the questions is to make sure that you understand the different elements of the experiment. Any unclear points will be explained by the experimenter.

[Treatment: Ultimatum Game & Bundling & No Information]

General Instructions

Welcome to the Laboratory for Research in Experimental Economics.

Your earnings from the experiment will largely depend on your decisions and the decisions of others. Therefore, it is important that you read the instructions carefully. The experiment consists of three parts that are independent of each other. The instructions for Part 1 can be found on the following pages. The instructions for Part 2 and Part 3 will be given on the computer screen.

In the experiment, we will not speak of EUR, but rather of ECU (Experimental Currency Units). At the end of the experiment the total amount of ECU you earned will be converted to EUR at the **exchange rate ECU 1 = EUR 0.25**. The final earnings will be rounded to the closest 10 cents. You will also receive a **show up fee** of **EUR 5**. You will be paid your earnings in cash, privately at the end of the session.

All interactions between you and other participants will occur through the computer terminals. Please do not talk directly to or attempt to communicate with other participants during the session. Please also do not ask questions aloud. If you have a question, raise your hand and a member of the experimenter team will come to you. All personal electronic devices should remain switched off until the end of the experiment.

Please now proceed to the instructions for Part 1.

Instructions Part 1

General Description of the Experiment

At the beginning of the experiment, all participants in the room will be divided into groups of 10. We will refer to this group as your "matching group". In each matching group, the computer will randomly determine **5 buyers** and **5 sellers**. You will be either in the role of a buyer or a seller. If you are buyer (respectively, a seller), you will be a buyer (respectively, a seller) for the entire experiment. At the start of Part 1, everyone will receive 8 ECU to begin with.

You will play **10 rounds** of a decision situation. At the start of each round, you will be **randomly matched** with another participant in your matching group. In particular, if you are a buyer, you will be matched at random to one of the 5 sellers in your matching group. If you are a seller, you will be matched at random to one of the 5 buyers in your matching group. Hence, the person you are matched with will typically change between rounds. You will never know the identity of the person with whom you are matched in a given round or of the people in your matching group.

Decision Situation in each Round

We will now explain the decision situation you will face in each of the 10 rounds.

Objects
In each round, there are **3 objects**: **object A, object B and object C**. For each object, the buyer has a **valuation**. A valuation is the worth a buyer assigns to an object. Similarly, for each object, the seller has a **production cost**. The production cost is the cost the seller incurs if producing an object in order to sell it to the buyer.

At the beginning of each round, the buyer's valuations and the seller's production costs for the 3 objects will be randomly chosen to be **0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 or 33 ECU.** Any value between 0 ECU and 33 ECU is **equally likely.** All valuations and production costs are randomly determined by the computer and are independent of each other, that is, the buyer's values for the different objects will typically not be the same and neither will the seller's production costs.

Information
The buyer's valuations and the seller's production costs are **private information**. In particular, the buyer will be told his or her valuations for the 3 objects and the seller will be told his or her production costs for the 3 objects. However, we will not tell the buyer what the seller's production costs are and neither will we tell the seller the buyer's valuations.

We next describe the **bargaining process**. The bargaining process will determine which objects the buyer and the seller trade, and the price at which the objects are traded.

Proposer or Responder

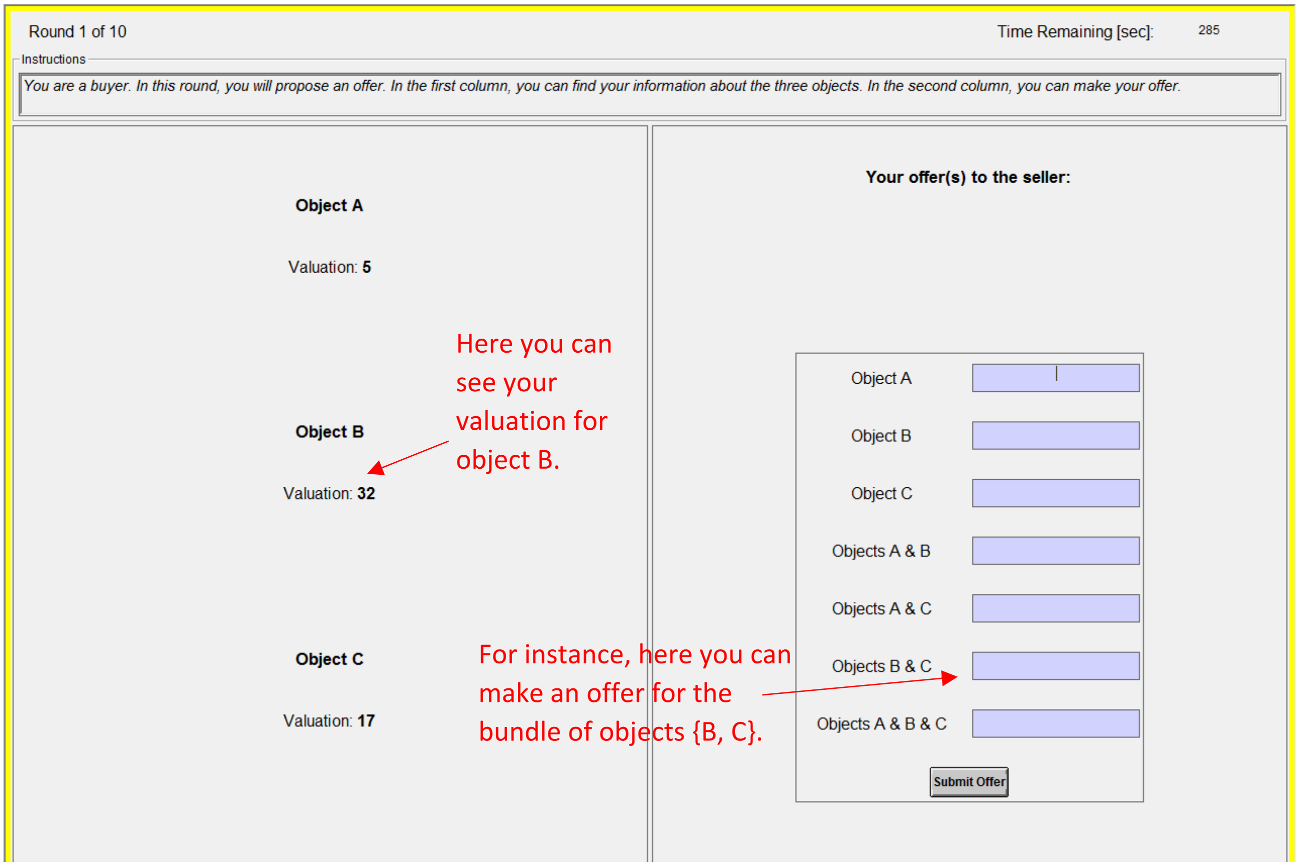
In each round, you will be a **proposer** or a **responder**. This will be determined randomly. That is, either the buyer will be the proposer and the seller the responder or vice versa, both with probability 50%.

Making Offers

The proposer will make offers. **An offer includes a selection of objects and a price.** Thus, when you are buyer, an offer will specify which objects you would like to buy and the price for these objects. When you are a seller, an offer will specify which objects you would like to sell and the price of these objects.

Since there are 3 objects, there are **7 possible selections of objects: {A}**, **{B}**, **{C}**, **{A, B}**, **{A, C}**, **{B, C}** and **{A, B, C}**. An offer will be a selection of objects and a price at which you would like to trade the selected objects. The price has to be a whole number between 0 and 33 ECU for a single object, between 0 and 66 ECU for a selection of two objects and between 0 and 99 ECU for an offer that includes all three objects. The price is for the whole selection of objects, for instance, if a buyer offers objects A and B at a price of 29 ECU and the seller accepts, the buyer will pay 29 ECU for both objects together, and not 29 ECU per object.

Below you can see a screen shot of the experiment. The screen shows the situation of a buyer who is also a proposer. Notice that the buyer can **see his/her valuations for each object on the left-hand side of the screen, but s/he does not know the production costs of the seller.**

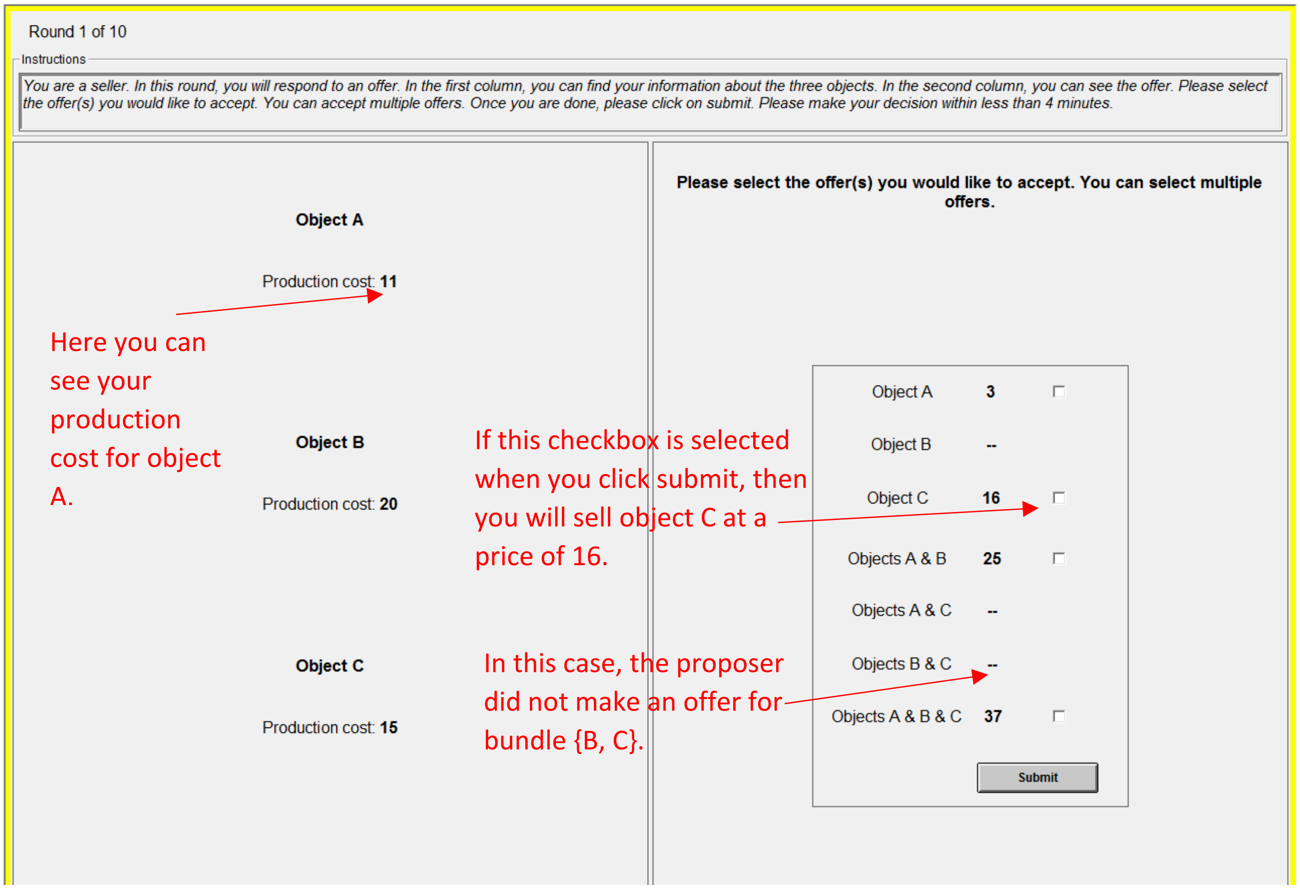


The screen will be the same for the seller, except that s/he will see his/her production costs instead of the valuations. As you can see, there are 7 possible selections of objects. To make an offer, you can enter a price in the box next to the selection of objects you wish to buy / sell. You can make up to 7 offers, one for each possible selection of objects. If you do not enter a price for a selection of objects, no offer will be made for this combination of objects. Once you are done entering offers, you need to click on “Submit Offer”. The responder will then receive the offers and choose which ones s/he would like to accept. **Notice that once you click on submit, you cannot revise your offers in this round anymore.**

Accepting and Rejecting Offers

As a responder, you will decide whether you would like to accept or reject the offers made by the other party. To do so, you will **select the offers you would like to accept by clicking the respective checkbox** (see the screen shot below). Once you have selected all offers you would like to accept, confirm your choice by clicking on “Submit”. **A responder can accept several offers, as long as no two accepted offers contain the same object.** For instance, you can accept the offer for {A} and {C}, or the offer for {C} and {A, B}. But you cannot accept the offer for {A} as well as the offer for {A, B}, because object A cannot be traded more than once.

Once the responder clicks on “Submit”, all selected offers are traded at the specified prices.



Earnings

As a buyer, your earnings will depend on your valuations and on the prices you agree to pay. For each object you buy, you will earn your valuation minus the agreed price.

Buyer's Earnings = Sum of valuations of traded objects – Sum of prices for traded objects

As a seller, your earnings will depend on your production costs and on the prices at which you agree to sell objects. For each object you sell, you will earn the agreed price minus your production cost.

Seller's Earnings = Sum of prices for traded objects – Sum of production costs of traded objects

Untraded objects do not affect your earnings.

Below you can find four examples of how earnings are calculated. All examples are to help you understand better the experiment. They should not be considered as guides on how to behave in the experiment.

Example 1: You are a buyer and your valuation for object A is 26. You made an offer to buy object A at a price of 20 and the offer was accepted. No other offers were accepted. Then you will earn 26 ECU – 20 ECU = 6 ECU.

Example 2: You are a seller and your production costs are 8 for object A and 17 for object B. Your offers to sell object A at a price of 13 and object B at a price of 19 are accepted. Then you will earn 13 ECU + 19 ECU – 8 ECU – 17 ECU = 7 ECU.

Example 3: You are a buyer with valuations 33 for object B and 15 for object C. You accept an offer of the seller and buy objects B and C jointly at a price of 32. Then you will earn 33 ECU + 15 ECU – 32 ECU = 16 ECU.

Example 4: You are a seller and your production costs are 17 for each object A and B and 28 for object C. You accept an offer of the buyer and sell objects A, B and C jointly for a price of 57. Then you will earn 57 ECU – 17 ECU – 17 ECU – 28 ECU = – 5 ECU. That is, you will lose 5 ECU.

Your earnings from each of the 10 rounds will be summed up and paid to you at the end of the session. If your earnings in a given round are below 0 ECU, the amount will be subtracted from your previous earnings. If your earnings at the end of the experiment are below 5 EUR, you will receive the minimum of 5 EUR. As a buyer, you should thus be careful to not accept or make offers for which you pay more for an object than your valuation. As a seller, you should be careful to not accept or make offers for which your production cost for an object exceed the selling price.

All 10 rounds of this part of the experiment will be the same, except that your valuations (as a buyer) or productions costs (as a seller) for the objects are randomly determined at the beginning of each round, the participant you are matched with will change between rounds, and in some rounds you will be a proposer while in others you will be a responder.

This completes the description of the instructions. If you have any questions, please raise your hand. Otherwise, please proceed to answer the questions that will be shown on your computer. The purpose of the questions is to make sure that you understand the different elements of the experiment. Any unclear points will be explained by the experimenter.