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

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Abstract

We design a laboratory experiment to study bargaining behavior when negotiations involve multiple issues. Parties must discover both trading prices and agreement scopes, giving rise to unexplored information structures and bargaining strategies. We find that bargainers often trade the efficient set of issues despite lacking information about individual aspects. However, beneficial agreements critically hinge on integrated negotiations that allow deals on bundles of issues. Moreover, access to more information boosts agreement rates in small-surplus negotiations but can also backfire as it triggers increased risk-taking and conflicting fairness preferences in large-surplus negotiations. Finally, successful negotiations display a specific bargaining convention that emerges endogenously. It involves alternating offers that meet the other side's most recent demand halfway.

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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 when there is uncertainty about valuations (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 set of issues to trade to maximize the total surplus. Identifying this set of issues, which we refer to as the optimal agreement scope, is not easy because both sides may have an incentive to misrepresent their valuations.

The multi-issue case thus gives rise to new information structures, where 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 about the optimal agreement scope. The presence of multiple issues also introduces the possibility of 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 economics point to the importance of

[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.

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)—we are interested to examine it in the bargaining context.

We address the following key questions to understand how information and bargaining protocols shape multi-issue negotiations. First, does a lack of information about the optimal agreement scope hamper beneficial exchange and agreements? Second, are integrated negotiations (bundling) critical for reaching beneficial agreements in multi-issue bargaining? Third, what are the distinctive features of the bargaining process when there are multiple issues? Which strategies do negotiators use, and how do they differ from the single-issue case? The theoretical answer to our first question depends on the bargaining protocol. In the semiconductor company example, uncertainty about the optimal scope leads to inefficiency when negotiating technology licensing and maintenance services separately. However, theory predicts that integrated negotiations that allow price offers on bundles of issues achieve an efficient joint deal. The theoretical answer to the second question is thus affirmative. Regarding the third question, theory predicts negotiators to use specific multi-issue price offers that reflect a more collaborative mindset, one of problem-solving (identifying optimal agreement scopes) rather than mere surplus division. In addition to testing these predictions, we study the emergence of bargaining conventions and the impact of behavioral preferences in our environment.

We design a series of multi-issue bargaining lab experiments to examine the above 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). However, trade failures should be mitigated under complete information. 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) requires 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 only the aggregate surplus, as opposed to information about bargainers' valuations for individual items, 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 because it helps negotiators identify optimal agreement scopes. This finding demonstrates the importance of integrated negotiations that allow bargainers to link multiple issues in bundles. Indeed, we find that going from no information to intermediate information leads to *fewer* agreements when bundling is *not* possible. We offer two further crucial insights about bargaining strategies and behavioral effects. First, more 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. Second, we identify a prevalent and efficient bargaining convention where players endogenously alternate in making price offers such that each offer closes half of the remaining gap between the two negotiators' most recent demands.

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 incompleteness, which is why more information is beneficial in small-surplus situations. The second cause, however, relates to behavioral factors, particularly conflicting views on a fifty-fifty division norm and differences in risk preferences. Better information conditions—i.e., intermediate and complete information—have a detrimental effect on trade because, in large-surplus situations, they cause brinkmanship: an insistence on one's bargaining terms by delaying agreement in the face of a possible negotiation breakdown. Better information conditions also activate 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 (with bundling) and complete information.

We next 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. 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 bundled negotiations can alleviate informational asymmetries. Bundled negotiations are successful because a specific set of offers allows bargaining parties to identify the optimal

[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.

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 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 allowing for flexible agreement scopes essential. 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, 2014; Hughes and Ertel, 2020).

Another motivation for the intermediate information structure comes from the bargain-

[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.

ing 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 our work 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 bargaining 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 (see also, Chakraborty and Harbaugh, 2003).

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—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.

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*

[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).

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]

(iv) Bundling & Known Total Surplus: *If bundling is possible and the surplus is commonly known, the buyer's optimal set of offers is $(\{A\}, 0.3)$, $(\{B\}, 0.3)$, $(\{C\}, 0.3)$,*

[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 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.

$(\{A,B\},0.8)$, $(\{A,C\},0.8)$, $(\{B,C\},0.8)$, 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 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

[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; Dariel et al., 2021; Kamm and Siegenthaler, 2022).

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.

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 $c_K = \sum_{i \in K} c_i$.

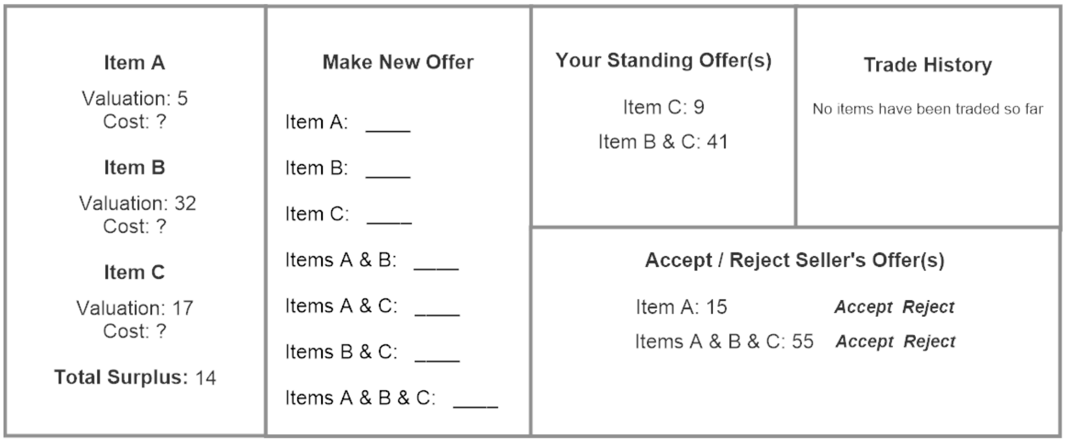
4.2 Information Structures

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.

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

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.

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.

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

[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.

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 of the latter treatments 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. See Dave et al. (2010) for a discussion of different risk elicitation tasks. The main advantage of our task is that it is simple, and responses are less noisy than those from more complicated elicitation tasks. 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

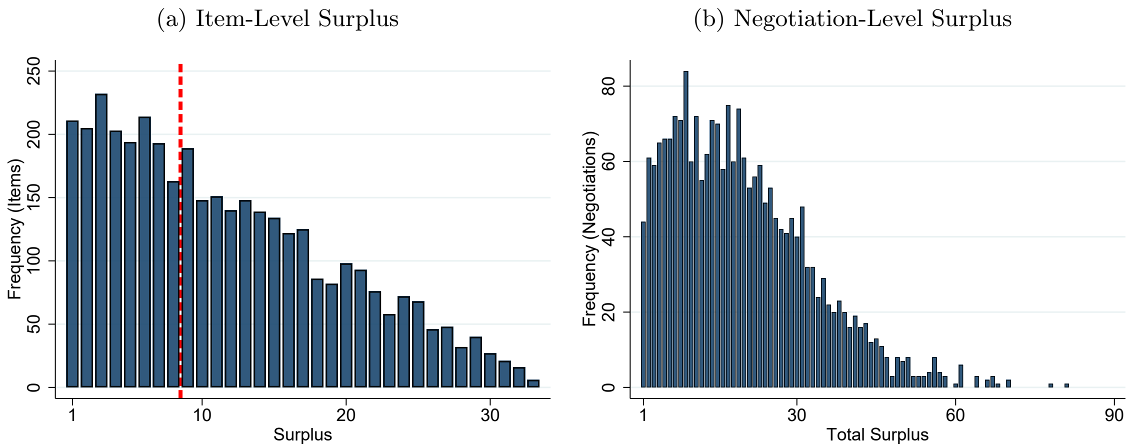
Section 5.1 contains the main results and hypotheses tests. Section 5.2 provides an analysis of the bargaining process.

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

[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 $TS > 0$.

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 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]

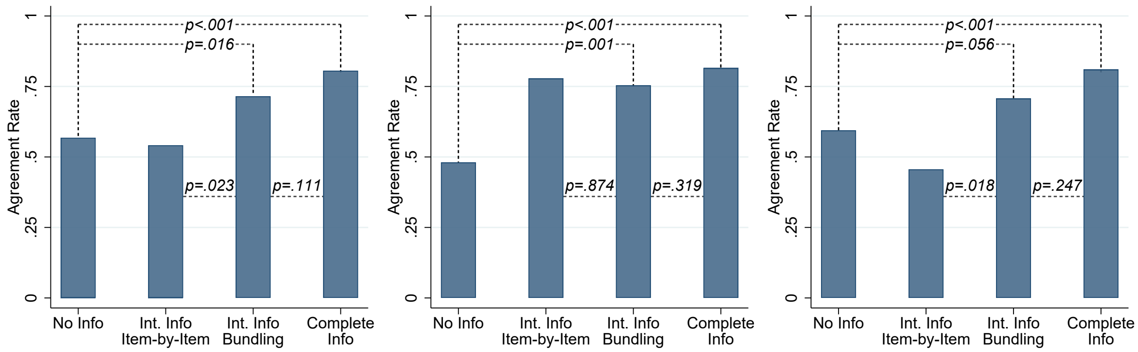
Figures 3b and 3c, respectively, show the agreement rates for small-surplus items for the subset of negotiations with an efficient scope of one (i.e., one positive-surplus item) or

[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.

[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.

Figure 3: Agreement Rates for Small-Surplus Items

(a) All Negotiations (b) Efficient Scope = 1 Item (c) Efficient Scope > 1 Item



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.

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 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]

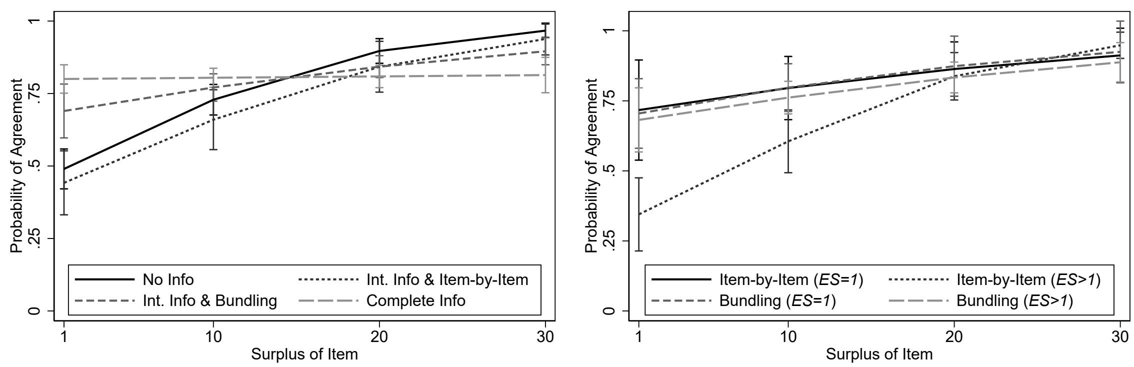
Result 1 *The agreement rate for small-surplus items ($S \leq 8$) is significantly higher in the Complete Information treatments than in the No Information treatments.*

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

[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 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 & 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 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 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] We focus on buyers only such that each item data point is used only once in the regression. The treatment effect (relative to the reference group No Info & Bundling) at any surplus size $S \geq 1$ is the non-interacted treatment coefficient (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

[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.

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: we find that, 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 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.

[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.

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.

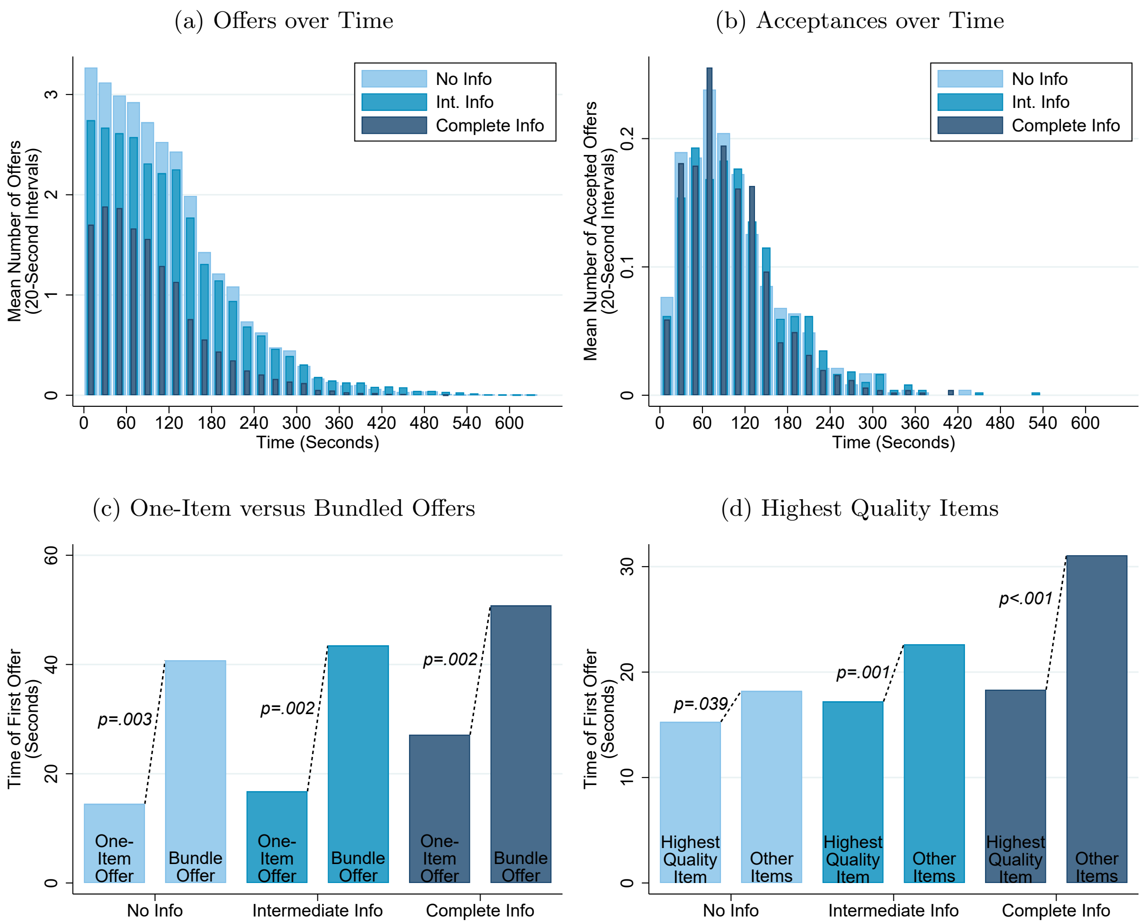
5.2.1 Price Discovery: Timing and Strategies

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 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.

[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.

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

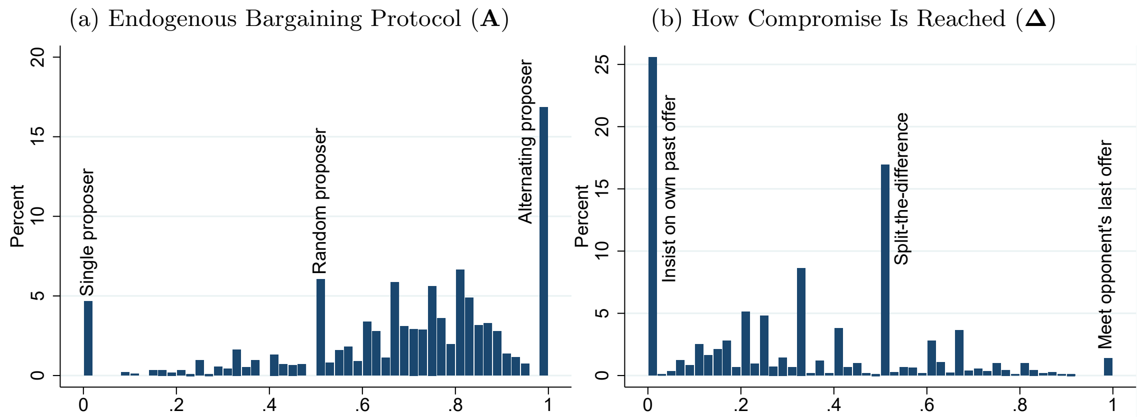
	No Information			*Intermediate Information*			*Complete Information*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total Surplus (TS)	0.576***	0.206***	0.153***	0.524***	0.308***	0.268***	0.487***	0.417***	0.410***
	(0.0248)	(0.0238)	(0.0207)	(0.0273)	(0.0281)	(0.0220)	(0.0265)	(0.0445)	(0.0473)
Two-Item Bundle ∗ 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.

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 in bundled offers are not in line with the theoretical predictions.[18] The results for the No Info and Complete Info treatments confirm bargainers' tendency to make more aggressive demands in bundled offers. We summarize these findings in the following result.

[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 ($\boldsymbol{\Delta}$).

Result 4 *While bundling is common and effective, the empirical price discovery process differs from the theoretically predicted offers. 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 **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 **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 t. Then, the numerator of $\mathbf{\Delta}$ 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 $\mathbf{\Delta}$ 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 $\mathbf{\Delta}$. 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.

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

[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.

Table 4: Convention, Behavioral Preferences, and Trade

Dep. Var.: **Accept Offer**	No Info (1)	Int. Info (2)	Comp. Info (3)	*Dep. Var.:* **Trade**	No Info (4)	Int. Info (5)	Comp. Info (6)
Demanded Share	0.219***	0.174***	0.0316***	Total Surplus	1.038***	1.009	1.005
	(0.0447)	(0.0295)	(0.0123)		(0.00925)	(0.00759)	(0.00860)
Split-the-Diff.	4.130***	3.780***	3.871***	Split-the-Diff.	3.810***	3.783***	2.532***
	(0.685)	(0.672)	(0.462)		(1.413)	(1.015)	(0.614)
Risk Tolerance	1.050	0.928	0.970	Risk Tolerance	1.111	0.703***	0.760**
	(0.0722)	(0.0540)	(0.0481)		(0.131)	(0.0960)	(0.0842)
Violates 50-50 Norm	0.954	0.819	0.585***	Violates 50-50 Norm	0.830	0.686*	0.688**
	(0.150)	(0.133)	(0.0768)		(0.118)	(0.154)	(0.121)
Counteroffer	1.471***	1.165	1.128	Alternating (**A**)	6.583***	9.306***	4.715***
	(0.212)	(0.144)	(0.134)		(2.363)	(4.418)	(1.918)
Bundle	2.644***	1.939***	1.297	Bundle	0.734	0.647	0.569**
	(0.559)	(0.264)	(0.217)		(0.221)	(0.386)	(0.156)
Constant	0.196***	0.470**	0.835	Constant	0.196***	1.420	1.857
	(0.0645)	(0.148)	(0.312)		(0.115)	(1.022)	(1.122)
Offers (N)	6524	6016	5467	Offer Sequences (N)	929	894	786
Matching Groups	17	17	17	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.

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 in No Info, even if they do not split the difference.[20] In all treatments, split-the-difference offers (i.e., the specific counteroffers that meet the other's demand halfway) are significantly more likely to be accepted despite controlling for demanded shares of the total surplus. 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.

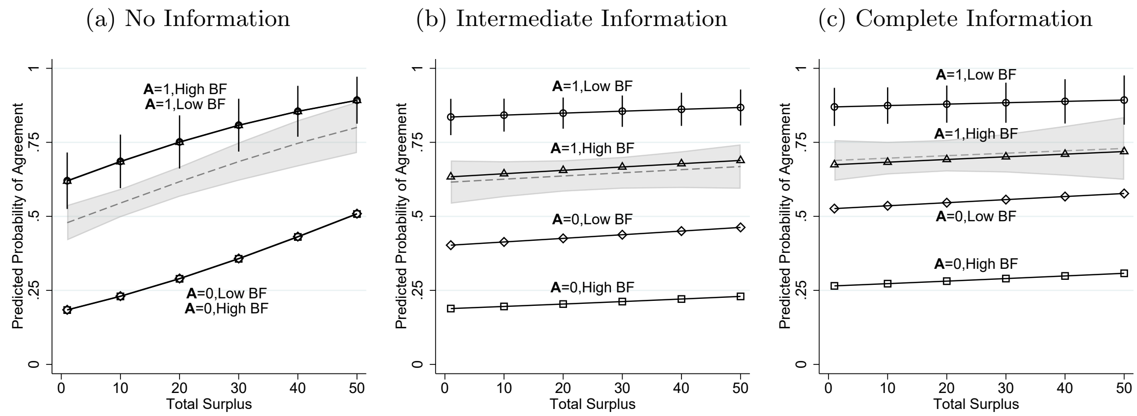
The unit of observation in regression models (4) to (6) is an offer sequence. The dependent variable is whether a sequence concludes in a trade. The independent variables are the total surplus, a split-the-difference dummy equal to 1 if the sequence contains at least one such offer, the average risk 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 beneficial exchange.[21]

To assess the magnitude of the behavioral effects, Figure 7 shows some interesting counterfactual agreement probabilities based on models (4) to (6) in Table 4. 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.

[20] We define the split-the-difference dummy in line with Figure 6b, where the bar at 0.5 reflects all offers with $\mathbf{\Delta} \in [0.475, 0.525]$. Alternatively, defining the split-the-difference dummy to be 1 only if $\mathbf{\Delta} = 0.5$ reduces the total number of split-the-difference offers by only three, from 900 to 887, without affecting the regression results.

[21] 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.

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, as implied by the positive slope of the predicted agreement probabilities and the null effects of risk and fairness preferences. 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 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

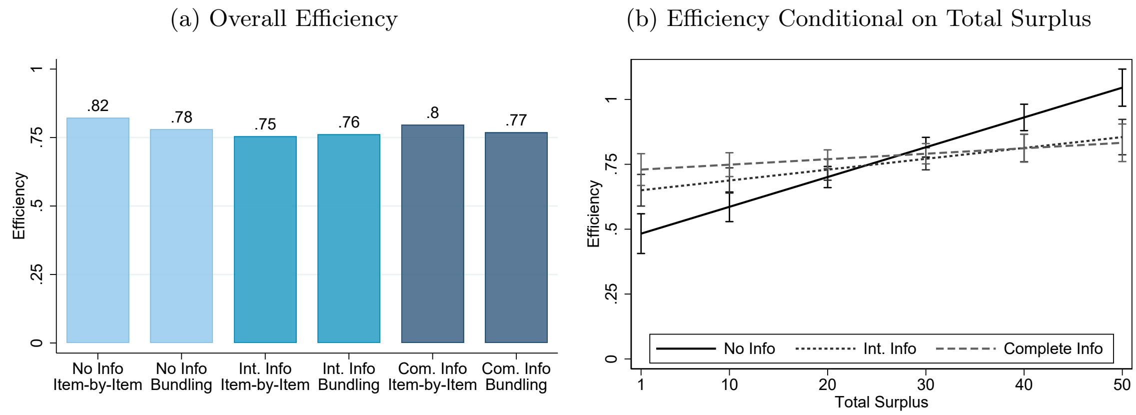
We have established that improved information raises agreement rates when item surpluses are small but hampers beneficial exchange when item surpluses are large. This section looks at how this translates to efficiency as an alternative measure of bargaining success. We define efficiency as the sum of 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.

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.[22] 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)

[22]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.

Figure 8: Efficiency



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.

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. We 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 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 only the total surplus available in a negotiation often suffices to promote rates of trade. Complete information about bargainers' valuations for individual items is not needed 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.

We extend the discussion of our results to two other multi-issue bargaining environments in online Appendix B. One is the multi-issue ultimatum bargaining game, which is 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.

Finally, our study also raises a number of open questions about important variants of the multi-issue bargaining setting. For example, how do complementarities between issues (e.g., two aspects are valuable only when traded together) affect multi-issue bargaining? Another crucial question—both on the theoretical and empirical side—is how multiple issues affect environments hampered by interdependent values and adverse selection.

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Data Availability Statement

The data and code underlying this article are available on Zenodo at the following DOI: https://doi.org/10.5281/zenodo.7604133