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Auctions vs. Negotiations: The Role of Communication in an Experiment With Procurement Managers

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Auctions vs. Negotiations: The Role of Communication in an Experiment with Procurement Managers

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Abstract

We investigate how buyer-supplier communication affects procurement prices, comparing auctions without direct communication to negotiations allowing it. In controlled experiments involving students and procurement professionals, we find communication increases prices, disadvantaging buyers. Negotiation analyses show lower initial offers, negotiation-focused dialogue, and emphasizing competition help reduce prices. Contrary to conventional wisdom, auctions without communication often yield better procurement outcomes, especially in competitive markets. Our results suggest managers should reconsider assumptions about experienced negotiators achieving superior deals and instead favor procurement auctions with limited communication to secure lower prices.

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1 Introduction

Auctions and negotiations are widely used to allocate and price goods and services. In areas such as real estate, financial markets, mergers and acquisitions, or procurement, neither method consistently prevails over the other. Despite their widespread use, the distinction between auctions and negotiations is elusive. The advent and progress of information technology have further complicated the distinction by enabling hybrid mechanisms that combine elements of both auctions and negotiations (Bichler et al. 2003). From a theoretical perspective, for a given set of exogenous factors, such as competition, information, or the asset being traded, both auctions and negotiations become alternative representations of a broader set of trading mechanisms. With optimal mechanisms clearly identified for each setting, labeling the process as auction or negotiation becomes seemingly irrelevant. Thus, the question of when to use auctions or negotiations seems mute.

Nevertheless, this question has sparked a large body of research. Previous studies on auctions and negotiations identify specific characteristics to distinguish between the two mechanisms and allow for an insightful comparison. For example, Bulow and Klemperer (2009) and Davis et al. (2014) consider sequential mechanisms as negotiations and compare their performance to English auctions in settings with endogenous entry. Gretschko and Wambach (2016) focus on corruption and distinguish between auctions and negotiations based on the transparency of the mechanism. They argue that the rules are transparent in an auction. In contrast, they suggest that only the outcome, not the process, is transparent in a negotiation. When Bulow and Klemperer (1996) and Shachat and Tan (2015) study the performance of auctions and negotiations, they consider the optimal mechanism as an upper bound for the performance of negotiations and compare it to an English auction with an additional bidder.

We follow the same approach of distinguishing between auctions and negotiations based on a specific characteristic. We distinguish between auctions and negotiations by looking at communication. We consider auctions as mechanisms where communication is limited to tangible offers only. In contrast, negotiations allow for richer communication. This distinction is motivated by Fisher et al. (2011), where the authors argue that *without communication there is no negotiation.* Moreover, a large industry that teaches communication skills to improve clients' negotiation outcomes highlights the importance of communication in negotiations. Many experienced procurement professionals firmly believe in their ability to persuade others to agree to better prices. (Before presenting this research to a large international procurement organization, we surveyed 41 experienced procurement managers from that organization and asked the question: *Can clever verbal and written language significantly*

improve supplier proposals?) Of these procurement managers, 32 agreed or strongly agreed. This belief has spawned numerous best-selling books, courses, and negotiation gurus, reflecting the recognized importance of communication in negotiations.

We compare a first-price procurement auction to a first-price procurement auction preceded by communication. We use a mechanism design approach to show that communication should not affect prices. In particular, from the buyer's perspective, the performance of the first-price auction is a lower bound on the performance of the negotiation. This is because the buyer can replicate the first-price auction by simply remaining silent in the chat.

We conduct a controlled experiment to isolate the causal effect of communication. Contrary to our theoretical prediction, we find that negotiations lead to higher costs for the buyer than a simple auction. In other words, allowing for communication inflates prices. This finding is particularly striking because our study includes not only a student population but also experienced procurement professionals. All of these professionals have received negotiation training and regularly negotiate with suppliers. These professionals work for a large German company with a more than 30 billion euros purchasing volume.

Our experiment has three treatments: an auction (Auction) and two negotiation treatments (NegPro and NegStu). The negotiation treatments differ in the background of the buyers. In NegPro, the buyers are experienced purchasing managers. In NegStu, buyers are recruited from the usual lab population, which consists mostly of students. In each treatment, two suppliers compete to supply a project. In the auction treatment, suppliers submit price offers without communicating with the buyer. In contrast, in the negotiation treatments, suppliers engage in private free-form chat communication with the buyer before submitting bids. Suppliers observe only their own chat, not the buyer's chat with the other supplier.

Our experimental design intentionally isolates the impact of pre-auction, non-binding communication ('cheap talk') between buyers and suppliers—mirroring the informal negotiation or 'exploratory' phase that often occurs in real-world procurement before any written commitments are made. In practice, procurement professionals frequently experience a disconnect between what is discussed verbally (or via email) and what ultimately appears in a binding contract: understandings or 'agreements' can shift, evaporate, or be strategically renegotiated during the formal commitment phase. Our experiment models this reality by allowing parties to communicate and attempt persuasion, but only binding them to the final submitted (written) offers.

Our experimental data show that prices in the auction treatment are significantly lower than in both negotiation treatments. Moreover, the prices obtained by experienced procurement managers are not statistically different from those obtained by

students. (The similarity of student and manager behavior is consistent with observations by Bolton et al. (2012), who compare the behavior of students and managers in a newsvendor experiment and find the same pattern.) Thus, allowing communication in our setting inflates prices regardless of the buyer's bargaining experience.

In addition to investigating the causal effect of communication on prices, we examine the content of the chats to explore the role of different aspects of communication. We examine how initial offers, tangible communication, emphasis on competition, and attempts to establish a personal relationship with suppliers correlate with suppliers' final offers. Finally, we assess buyer sentiment. We compute all these metrics using the GPT-4 API.

Consistent with Galinsky et al. (2009), Park et al. (2010), and Leider and Lovejoy (2016), we find evidence for an anchoring effect of initial offers. A lower initial offer from the buyer correlates with a lower final offer from the supplier. We also observe self-anchoring: a higher initial offer from a supplier correlates with a higher final offer from that supplier even when controlling for costs. Tangible communication also correlates with final offers; the more negotiation-oriented messages the buyer sends, the lower the final offer from the supplier. Similarly, highlighting competition correlates with lower final bids. However, the respective correlations of tangible communication and highlighting competition with final bids are only significant at the 10% level.

Our findings challenge the prevailing notion that trained negotiators consistently secure better prices through communication with their counterparts. Specifically, our data show that in the presence of supplier competition, communication can inflate prices. In our experimental setup, buyers who can communicate to obtain better prices achieve just the opposite.

Our results have direct implications for managerial decision-making in competitive environments. Our study suggests caution when deciding to engage in additional negotiations in environments characterized by supplier competition. In our experimental framework, a competitive auction mechanism without communication proves more effective in achieving low prices. This is consistent with Warren Buffett's famous statement that Berkshire Hathaway does not participate in auctions (Berkshire Hathaway 2009) and a survey by Stephenson et al. (2006), which finds that firms try to avoid participating in auctions as bidders but like to conduct auctions themselves.

However, our study does not imply that communication skills are never beneficial. It may well be that communication skills enable buyers to achieve better outcomes in bilateral interactions, which we do not cover in our study. Therefore, the value of negotiation training may be context-specific, and its evaluation requires careful consideration of the environment.

Our study adds to the discussion about the optimal choice of procurement mech-

anisms: the choice between auctioning and negotiating. It advises caution for proponents of negotiations and advocates a nuanced approach that considers both the competitive environment and the potential drawbacks of communication. If negotiations are unavoidable, our analysis of the chat data provides some practical advice. First, the initial offer seems to anchor the final price. Thus, starting the negotiation with a low initial offer typically positions the buyer for a more favorable outcome. Conversely, a higher initial offer from the supplier correlates with a higher final offer even when controlling for costs. Therefore, making the initial offer and choosing a low value are critical to the buyer's success. Second, the buyer's communication should focus on the deal and mention competition to achieve low prices. These strategies can offset some of the price increases that result from communication.

2 Literature

Our research is grounded in the experimental bargaining literature, which encompasses a wide variety of bargaining protocols, from ultimatum bargaining to more unstructured approaches. (For a comprehensive review, see Karagözoğlu and Hyndman 2022). A significant body of work in operations management draws on experimental economics to study bargaining behavior. As Davis (2022) highlights, operations management often incorporates experimental economics methods, although it typically contextualizes bargaining roles in a supply chain setting, labeling actors as buyers, sellers, or suppliers. This differs from experimental economics, which tends to focus on abstract settings and distributional concerns (see Roth et al. 1995, for an overview of the roots of bargaining research in experimental and behavioral economics). In addition, bargaining research in operations management often considers bargaining in a broader context, examining its interplay with other elements of buyer-supplier interaction, such as different types of contracts. Moreover, some of the research considers negotiations that are not only about price.

In contrast to our study, most of the bargaining literature in operations management considers bilateral negotiations. Davis and Leider (2018) investigates a setting in which buyers and suppliers make multiple, back-and-forth offers over contract terms and provide feedback on the offers they receive. The experiment shows that most of the focus is on the wholesale price and that the parties seem to overlook every other aspect, leading to outcomes that the authors describe as superficial fairness. In Davis and Hyndman (2019), the authors analyze a situation where buyers and suppliers negotiate price and demand risk allocation. They find that allowing the parties to also negotiate the order quantity leads to a Pareto improvement. In addition, they find that the party facing demand risk earns lower profits, contrary to the theoretical

prediction. They argue that their results can be explained by anchoring. Haruvy et al. (2020) vary contract types and bargaining protocols. Comparing ultimatum bargaining to structured bargaining, where parties can make multiple offers, they find that structured bargaining significantly improves channel efficiency but does not change rejection rates. Brosig-Koch and Heinrich (2018) and Heinrich (2012) explore the role of communication in a procurement setting with follow-up interactions characterized by moral hazard. In their setting, communication signals that the supplier will not exploit the moral hazard situation. Their results suggest that in the absence of specific *non-binding* promises, establishing a personal connection increases the likelihood that a supplier will be selected. When such promises are available, the importance of a personal connection diminishes, and these promises increase the likelihood that a supplier will be selected. This underscores that communication can be beneficial in certain contexts. Feng et al. (2015) examine a setting in which the buyer receives a private signal about demand. They find that increasing accuracy benefits the buyer at the expense of the supplier when demand forecast accuracy is low. However, when accuracy is already high, an increase benefits both parties. Davis et al. (2022) Consider suppliers with private cost information. In their setting, the buyer must source from two suppliers, i.e., there are multiple suppliers that do not compete. They compare simultaneous to sequential bargaining and distinguish between dynamic bargaining with back-and-forth offers and ultimatum bargaining where the buyer makes a take-it-or-leave-it offer.

The focus of the literature on bilateral bargaining does not imply that bargaining occurs only in bilateral settings. Rather, it is a useful abstraction, and some findings may extend to multilateral, competitive contexts. Our study compares auctions and negotiations and focuses on a competitive setting because auctions are impossible in bilateral settings. Our results suggest that conclusions drawn from bilateral negotiations are not always easily applicable to competitive settings. These settings require careful analysis because they introduce new options, such as auctions, that must be considered.

Some previous studies examine competitive bargaining environments with free-form communication, which are more directly comparable to our setting. For example, Bolton et al. (2003) examine three-party coalition bargaining and show that communication regimes affect outcomes, with weaker parties benefiting from restricted communication. Similarly, Leider and Lovejoy (2016) analyze bargaining in a multi-tier supply chain and find significant anchoring effects, consistent with our findings on the influence of initial offers in bargaining. In contrast to these studies, we explicitly introduce auctions as a possible mechanism and focus on comparing auctions and negotiations. Thus, the second main strand of literature relevant to our study compares

auctions with negotiation-based mechanisms.

Davis et al. (2014) experimentally test the model of Bulow and Klemperer (2009) which predicts that auctions outperform sequential mechanisms for buyers. Here, sequential mechanisms can be interpreted as bargaining. The experimental test shows systematic behavioral deviations from the predictions. These deviations imply that buyers should prefer the sequential mechanism, i.e. negotiation.

The closest to our research is Thomas and Wilson (2002), who compare first-price auctions with what they call *multilateral negotiations*. Similar to our study, they consider free-form chats for multilateral negotiations, where suppliers can only communicate privately with the buyer and not with each other. Unlike our study, in their model suppliers can make binding offers and the buyer can conclude the negotiation by accepting one of these offers. Furthermore, their study sample consists only of students and does not include a systematic analysis of chat content. Thus, our study differs in three important ways. First, as Thomas and Wilson (2002) acknowledge, it is impossible to derive the equilibrium in their treatment of multilateral negotiation. Our research design allows for a theoretical comparison between auctions and negotiations, demonstrating that any observed differences are due to communication. Second, the inclusion of professional procurement managers in our sample enhances external validity by showing that inflated prices in negotiations are not merely the result of inexperienced student participants. Third, we systematically analyze the chat content to shed light on negotiation tactics and their effectiveness in improving prices.

In Thomas and Wilson (2005), the authors add second-price auctions and *verifiable multilateral negotiations* to their analysis. Verifiable multilateral negotiations work as described above, but with the added feature that the buyer can credibly disclose the lowest standing offer to suppliers. They find that verifiable multilateral negotiations outperform second-price auctions when two suppliers are involved, but underperform non-verifiable negotiations and first-price auctions. This finding underscores that communication, even beyond cheap talk, can be detrimental to procurement outcomes.

3 Theory

We use a parsimonious model to analyze the role of communication in procurement mechanisms. A buyer is searching for an indivisible project from a set of suppliers with privately known costs. We compare two purchasing mechanisms: a first-price auction and a process we call negotiation. In the first-price auction, each supplier submits a bid, and the buyer selects one of the bids. In the negotiation, suppliers first communicate privately with the buyer, modeled as cheap talk. Then, they submit their

bids, and the buyer selects one of the bids. Our goal is to provide a framework in which communication is the only difference between the mechanisms we call auctions and those we call negotiations. In this way, we can isolate the role of communication.

We show that, in theory, the buyer's profit does not differ between the auction and negotiation mechanisms. One side of this argument is straightforward. In the negotiation, the buyer can replicate the outcome of the first-price auction by ignoring communication and selecting the lowest bid. As a result, the auction serves as a lower bound on the buyer's profit in the negotiation. The other side of the argument is more complicated. In general, even in a pure conflict situation, cheap talk can change the outcome of a game. Thus, we use an indirect mechanism design argument to show that bargaining cannot lead to better prices for buyers than auctions.

3.1 Model

A buyer (she) purchases an indivisible project from n ex-ante identical suppliers (he). Each supplier $i \in \{1, \ldots, n\} = N$ has a cost $c_i \in [\underline{c}, \bar{c}]$ to deliver the project. The cost is private knowledge of the supplier and is identically and independently distributed according to a distribution function $F(c)$ with $f(c) > 0$ for all $c \in [\underline{c}, \bar{c}]$. The distribution function F is common knowledge of the supplier and the buyer. Let $\mathcal{C} = [\underline{c}, \bar{c}]^n$ and $\mathcal{C}_{-i} = [\underline{c}, \bar{c}]^{n-1}$ denote the relevant cost-type spaces. Let $V > \bar{c}$ denote the value of the project to the buyer. If supplier i provides the project to the buyer at price p, the buyer's profit is $V - p$, and the profit of the chosen supplier is $p - c_i$. All other suppliers earn zero profit.

We compare two different procurement mechanisms: a first-price auction and a mechanism we call negotiation. In the *first-price auction*, each supplier i submits an offer b_i^f. The buyer observes all bids and selects one of the suppliers or rejects all. The project is then delivered by the selected supplier at the offered price. In the *negotiation*, the buyer and each of the suppliers first engage in cheap-talk communication, which will be explicitly modeled below. Each supplier observes only its communication with the buyer but not the buyer's communication with the other suppliers. In addition, suppliers cannot communicate with each other. After the communication phase, each supplier i submits an offer b_i^{neg}. The buyer observes all offers and selects one or none of them.

Before we formally model strategies and equilibria in the resulting games, we make the following observation: By backward induction, the buyer always selects the lowest bid in both procurement mechanisms. Thus, we can abstract from this part of the buyer's strategy and simply assume that she always selects the lowest bid and randomizes with equal probability when two or more suppliers make the same lowest

bid. Thus, the price is $p = \min_i b_i^{(f,neg)}$. In particular, the buyer cannot credibly commit to not buying the project.

3.2 Auction

The auction mechanism is a standard first-price reverse auction. Strategies and equilibria can be defined in the usual way. A (pure) strategy of supplier i is a function $\beta_i^f : [\underline{c}, \bar{c}] \to \mathbb{R}$ mapping its costs onto an offer. Denote by φ_i^f the inverse of β_i^f.

Since the buyer selects the supplier with the lowest bid, the auction game reduces to a first-price auction with no reserve price. A Bayes-Nash equilibrium of the first-price auction is a tuple $(\beta_1^{f,*}, \ldots, \beta_n^{f,*})$ such that for all $i \in N$ and all $c_i \in [\underline{c}, \bar{c}]$ it holds that

$$\beta_i^{f,*}(c_i) \text{ solves } \max_b \prod_{i \neq j} \Big(1 - F(\varphi_j^{f,*}(b)\Big) (b - c_i). \tag{1}$$

In equilibrium, all suppliers submit a bid that maximizes their expected profit given the strategies of their competitors.

3.3 Negotiation

In the negotiation, suppliers can exchange cheap-talk messages with the buyer. An important concept in this context is the extensive form of a game. The extensive form is a way of describing the sequence of moves in a game, including who moves when, what actions are available at each stage, and what information is available to the players as they make decisions. When modeling communication as part of the negotiation, the extensive form defines the order in which the buyer and suppliers send messages and the types of messages they can send. For example, the suppliers could send messages first, followed by the buyer, or all parties could send messages simultaneously or in any other order.

However, if we were to choose a particular extensive form, we would need to specify a particular order in which messages are sent and received. This specification would limit our theoretical analysis to that particular communication structure. The analysis would then only apply to scenarios where communication unfolds exactly as described by that extensive form. It would not capture the full range of possible communication structures.

Instead, we can model communication in a more general way by considering all possible extensive form communication games at once. In any extensive form game, players–both suppliers and buyers–choose strategies. A strategy defines how a player will act in a given situation, which includes deciding what messages to send. Suppliers, for example, choose strategies that dictate the content and timing of their messages.

The buyer, in turn, chooses a strategy that determines how to respond based on the messages received from both suppliers. Notably, the buyer's strategy can consider all messages received. At the same time, each supplier can only consider the buyer's messages.

At the end of the game, each combination of strategies results in a particular sequence of messages exchanged between the players. These messages can affect the outcome of the negotiation, such as the agreed price or the allocation of goods. We simplify the analysis by using the revelation principle and considering the normal form of the communication game, which simply lists all possible strategies that each player can choose. In the normal form, we represent each strategy with a unique message within a message space rich enough to capture all possible strategies. Thus, instead of analyzing each communication step in the extensive form of the communication game, we can focus on the overall strategies and the messages they produce. The outcome of the negotiation–such as the price or terms agreed upon–can then be written as a function of the messages exchanged between the buyer and the suppliers. This approach allows us to generalize across different communication structures and focus on the strategic elements of cheap talk in negotiations.

More formally, each supplier i chooses a message $m_i \in M_i$ to submit to the buyer, where M_i is the message set and includes the option to remain silent. Denote the vector of selected messages as $\mathbf{m} = (m_1, \ldots, m_n)$. The buyer chooses a set of signals S_i for each supplier. Denote by $\mathcal{S} = \times_{j \in N} S_j$ and by $\mathcal{S}_{-i} = \times_{j \in N \setminus \{i\}} S_i$. Furthermore, the buyer chooses a joint probability measure $\sigma(\cdot \mid \mathbf{m})$ on S. That is, given $\mathbf{m}$, σ (randomly) produces a vector of signals $\mathbf{s} = (s_1, \ldots, s_n) \in \mathcal{S}$. Each supplier i observes only its signal s_i. Without loss of generality and to simplify the notation, we assume that the S_i are exogenously given and sufficiently rich that the buyer chooses only σ.

A (pure) strategy of supplier i is a tuple (μ_i, β_i^{neg}) with $\mu_i : [\underline{c}, \bar{c}] \to M_i$ mapping his cost to a message and a function $\beta_i^{neg} : [\underline{c}, \bar{c}] \times S_i \to \mathbb{R}$ mapping his cost and the received signal to an offer. Denote by $\varphi_i^{neg}(b, s_i)$ the inverse of $\beta_i^{neg}(c_i, s_i)$ with respect to the first variable. A buyer's strategy is a mapping $\sigma : \times_{i \in N} M_i \to \Delta(\mathcal{S})$ from messages to probability measures over signals. For a given communication strategy σ of the buyer, communication strategies μ_{-i} of other suppliers, message m_i, and realized signal s_i, let $F(\cdot \mid s_i)$ be the updated belief of supplier i.

A Bayes-Nash equilibrium of the negotiation is a tupel $(\mu^*, \beta^{neg,\star}, \sigma^*)$ such that for all $i \in N$, all $s_i \in S_i$, and all $c_i \in [\underline{c}, \bar{c}]$, the supplier's offer strategy $\beta_i^{neg,*}(c_i, s_i)$ solves

$$\max_b \int_{\mathcal{C}_{-i}} \int_{\mathcal{S}_{-i}} \prod_{i \neq j} \left(1 - F\left(\varphi_j^{f,*}(b, s_j) \mid s_i\right)\right) (b - c_i)\, d\sigma^*\left(s \mid \mu^*(c_i), \mu_{-i}^*(\mathbf{c}_{-i})\right) dF(\mathbf{c}_{-i}),$$

solves the supplier's communication strategy $\mu_i^{neg,*}(c_i)$.

$$\max_m \int_{\mathcal{C}_{-i}} \int_{\mathcal{S}} \prod_{i \neq j} \left(1 - F\left(\varphi_j^{f,*}\left(\beta_i^{neg,*}(c_i, s_i), s_j\right) \mid s_i\right)\right) \cdot \\ \cdot \left(\beta_i^{neg,*}(c_i, s_i) - c_i\right) d\sigma^*\left(s \mid m, \mu_{-i}^*(\mathbf{c}_{-i})\right) dF(\mathbf{c}_{-i}).$$

The buyer's strategy $\sigma^*(\mu^*)$ solves over all Borel measures σ on $\mathcal{S}$.

$$\min_\sigma \int_{\mathcal{C}} \int_{\mathcal{S}} \min_{i \in N} \{\beta_i^{neg,*}(c_i, s_i)\} d\sigma(\mathbf{s} \mid \mu^*(\mathbf{c})) dF(\mathbf{c}) \tag{2}$$

In equilibrium, suppliers choose messages and offers that maximize expected profits, given the buyer's communication strategy and other suppliers' communication and offer strategies. The buyer optimizes her communication strategy given the suppliers' strategies and selects the lowest offer with probability one.

3.4 Comparing Auction and Negotiation

First-price auctions are known to have a unique equilibrium (Chawla and Hartline 2013) and the negotiation is modeled as a first-price auction preceded by cheap-talk communication. Hence, the negotiation is a Bayesian game with cheap talk. Such games are notoriously difficult to analyze. These communication games can have equilibria that differ from the Bayesian equilibria of the underlying game. This is true even for pure conflict and pure cheap-talk games, as Pavlov (2023) shows for all-pay auctions. Thus, instead of explicitly deriving the equilibrium of the negotiation, we use a indirect mechanism-design argument.

Proposition 1. *For the buyer's expected profit in the two mechanisms, it holds that*

(i) The negotiation profit is not less than the auction profit.

(ii) The negotiation profit is not greater than the auction profit.

Proof. The first-price auction has a unique equilibrium (Chawla and Hartline 2013). This equilibrium is symmetric, and the lowest cost supplier wins the project (Krishna 2009). Moreover, according to Myerson (1981), the first-price auction maximizes the buyer's profit among all mechanisms that always allocate the project.

ad (i). In the negotiation, the buyer can implement the same outcome as in the first-price auction simply by refusing to communicate. The buyer can, e.g., achieve this by sending the same signal irrespective of the suppliers' messages. In particular, an equilibrium of the negotiation exists.

ad (ii). Take any equilibrium $(\mu^*, \beta^{neg,\star}, \sigma^*)$ of the negotiation. There is an incentive-compatible direct revelation mechanism that implements the outcome of the negotiation equilibrium. A direct mechanism is defined by (x, t) with the allocation rule $x : \mathcal{C} \to \Delta([0,1]^n)$, which determines the winning probability of each supplier given all cost reports, and the transfer $t : \mathcal{C} \to \mathbb{R}^n$, which determines the payment each supplier receives given the vector of cost reports. The mechanism works like this. Each supplier i reports its cost c_i to the mechanism, the mechanism generates a vector of signals $\mathbf{s}$ using $\sigma^*(\mu(\mathbf{c}))$, for each realization of $\mathbf{s}$, assign the object to supplier i with positive probability if and only if $\beta_i^{neg,*}(c_i, s_i) = \min_{j \in N} \beta_j^{neg,*}(c_j, s_j)$. If the project is allocated to supplier i, he receives a payment equal to $\beta_i^{neg,*}(c_i, s_i)$. Since $(\mu^*, \beta^{neg,\star}, \sigma^*)$ is an equilibrium, the mechanism is incentive compatible. As in the final stage, the buyer always selects the lowest bidder; the project is always allocated in equilibrium. The first-price auction maximizes the buyer's expected profit among all mechanisms. Thus, negotiation cannot achieve a higher expected buyer profit. □

In summary, the negotiation cannot achieve a lower buyer profit than the auction because the buyer can refuse to communicate and thus implement the auction outcome in the negotiation. On the other hand, the negotiation cannot produce a higher expected profit than the auction because the auction is an optimal mechanism given that the project must be allocated. The overall result is that the buyer's expected profit is the same in the auction and in the negotiation.

Nevertheless, we decided to split the proposition into two parts to highlight the different levels of robustness of the findings. The result that the buyer's profit in the first-price auction is a lower bound on the negotiation profit is more general because the proof would work in the same way in all settings. However, the proof that the buyer profit in the first-price auction is an upper bound on the negotiation profit relies on the optimality of the first-price auction, which depends on our independent private-values setting.

4 Experimental Design and Hypothesis

In this section, we present our experimental design and formulate our hypothesis.

4.1 Procedures and Parameters

We design an experiment to identify the causal effect of communication on prices in a procurement interaction with one buyer and two suppliers. Our experiment consists of three treatments: two negotiation treatments (NegPro and NegStu) and one auction treatment (Auction). The negotiation treatments differ with respect to

the background of the buyers. In the NegPro treatment, all buyers are experienced procurement managers from one of the largest German companies. In contrast, the buyers in the NegStu treatment come from the regular subject pool of the Laboratory for Experimental Research in Economics of a large German university, which consists mainly of students. Most of these students have a background in economics or related fields. Buyers in the Auction treatment and suppliers in all three treatments are also recruited from the laboratory's regular subject pool.

In each interaction, two suppliers compete for one contract. The buyer's valuation for the contract is publicly known and set to $V = 250$. The suppliers' costs are private information and are randomly drawn from a uniform distribution on the interval $[100, 200]$. In the case of trade, the price is equal to the selected supplier's offer, i.e., if the buyer selects supplier i, the price is given by $p = b_i$. The buyer's profit is the difference between her valuation and the price p, i.e., $250 - p$. The selected supplier's profit is the difference between its bid and its cost, i.e., $p - c_i$. The other supplier makes zero profit. If there is no trade, all parties make zero profit. In the negotiation treatments, NegPro and NegStu, the buyer communicates privately with the two suppliers in two separate chat windows for three minutes. The suppliers know their own costs when entering the chat. After the chat suppliers submit offers, and the buyer selects one of the offers or rejects both. The auction treatment is identical to the negotiation treatment, except that there is no communication before suppliers submit their bids.[1]

In the experiment, subjects participate in a series of 10 procurement interactions. We consider the first interaction as practice; participants should get used to the setting and can communicate for five minutes instead of three minutes in the negotiation treatments. We have 216 participants, 72 per treatment. Of these 72 participants per treatment, 24 assume the role of a buyer and 48 the role of a supplier. Participants keep their roles throughout the experiment, and we use stranger matching, i.e., we randomly create new triples of one buyer and to suppliers for each interaction. Unknown to the participants, we do this within cohorts of six subjects (two buyers and four suppliers). We consider each cohort to be a statistically independent observation in our analysis. As a result, we have twelve independent observations per treatment. To maximize comparability across cohorts, we use the same cost realizations (60 random draws) for all cohorts.

After the experiment, one round is randomly selected to determine the earnings of the participants. Suppliers' earnings in this period are converted at a rate of 60 cents per experimental currency unit (ECU). Since we are not allowed to pay participating procurement managers money, we run a lottery in which six Apple iPads are allocated

[1]The screens showed to the participants can be found in the online appendix.

among the 72 buyers. For every ECU a buyer earns in the experiment, he or she receives one lottery ticket. Out of all the lottery tickets that buyers receive, we draw 12 winning tickets. This alternative compensation method ensures that buyers have an incentive to achieve low prices and that the expected value of the ECU is similar for buyers and suppliers.

4.2 Hypothesis

In this section, we state the hypothesis that we will test in the experiment. The theoretical analysis implies that allowing buyers to communicate with suppliers does not affect prices, i.e., all three treatments should lead to the same prices.

Hypothesis 1. *Prices in the Auction treatment do not differ from prices in the NegPro and NegStu treatments.*

The prediction that all three treatments lead to the same prices also implies that experienced procurement managers should perform as well as students in the role of buyers. However, we refrain from formulating a hypothesis about the relative performance of procurement managers and students as buyers in our negotiation treatments. We do so for two reasons. First, our theoretical model does not consider buyers' different backgrounds. Second, we could not say anything about causal effects because we could not distinguish between the effects of experience, training, and (unobserved) selection effects.

5 Analysis

We divide the analysis of our experimental data into two parts. In the first part, we examine our experimental variation. This allows us to establish causal relationships and test our hypothesis. In the second part, we focus on our negotiation treatments. We examine the interplay between buyer behavior during chat interactions and the corresponding final offers from suppliers.

5.1 Analysis of the Consequences of the Experimental Variation

Table 1 provides an overview of participant behavior across our treatments and compares these results to the risk-neutral Nash equilibrium (RNNE) predictions. According to the RNNE, suppliers in all treatments should bid according to the following bidding function $\beta(c) = 150 + (c - 100)/2$. The table reports the average price, the average offer, the average offer difference, the average proportion of efficient trades, and

the average inefficiency per trade. Along with these averages, the table also reports the associated standard errors in parentheses. We compute the standard errors based on the cohort means, i.e., they reflect the heterogeneity of the cohort means within each treatment. Since we use the same pre-generated cost draws for each cohort, the standard error of each prediction is zero.

In addition, the table reports the results of statistical tests comparing the observed behavior with the theoretical predictions and the results of the negotiation treatments with those of the auction treatment. For both comparisons, we consider each cohort as an independent observation. We use the Wilcoxon signed-rank (SR) test to compare observed and predicted outcomes. For the pairwise comparison of behavior in the negotiation and auction treatments, we use the Wilcoxon-Mann-Whitney (WMW) test.

Prices. Consistent with most experimental research on first-price auctions, we find that offers in our auction treatment, as well as in our negotiation treatments, are more aggressive than predicted by the RNNE ($p < 0.01$, SR for all three treatments). Prices in the auction treatment are significantly lower than those in the negotiation treatments, suggesting that the ability to communicate with suppliers harms buyers, whether they are students or experienced procurement professionals. Comparing prices in our negotiation treatments shows no statistically significant difference between professionals and students ($p = 0.6707$, WMW).

Result 1. *Prices in the Auction treatment are lower than in the NegPro ($p = 0.0196$, WMW) and NegStu ($p = 0.0432$, WMW) treatments.*

Note that the proof of part (i) of Proposition 1 does not depend on any specific assumptions about the suppliers' preferences. The proof relies solely on the key observation that, in the negotiation process, the buyer can replicate the outcome of an auction by choosing to remain silent. In other words, the buyer can ignore any messages from the suppliers and proceed as if the negotiation were an auction with no communication. This observation is crucial because it allows us to eliminate the possibility that the outcome described in Result 1 is influenced by omitted or implicit assumptions about the suppliers' preferences.

Instead, the outcome can be directly attributed to communication itself. Therefore, any difference between the auction and negotiation outcomes must be due to the use of communication rather than differences in the underlying preferences of the suppliers.

Average offers. Looking at the average offers in the different treatments, we observe that the average offers are more aggressive than predicted ($p < 0.01$, SR for all

three treatments). At the same time, we find no significant difference between the auction and negotiation treatments (Auction vs. NegPro: $p = 0.9886$ and Auction vs. NegStu: $p = 0.7873$, both WMW).

Offer differences. Looking at the difference between the higher and lower offer, we see that the average offer difference is larger than predicted in all treatments (SR: $p < 0.01$ Auction and NegPro, $p < 0.02$ NegStu), which is consistent with the finding that bidding is more aggressive than predicted. Comparing the bid difference in the auction treatment to that in the negotiation treatments, we find that the difference is significantly larger in the auction treatment. This suggests that allowing the buyer to communicate with suppliers allows her to elicit lower offers from the weaker of the two suppliers. However, communication also inflates offers from the stronger suppliers, which ultimately disadvantages the buyer in the negotiation relative to the auction.

Result 2. *The average difference between the higher and lower offers is significantly larger in the auction treatment than in the negotiation treatments (Auction vs. NegPro:* $p = 0.0036$ *and Auction vs. NegStu:* $p = 0.0000$*, both WMW).*

Efficiency. Finally, Table 1 reports two measures of efficiency. The measure *Share of Efficient Trades* shows that in all treatments, the buyer sources from the lowest-cost supplier in about 88 percent of the interactions. The measure of inefficiency is defined as the difference between the actual production cost and the production cost of the low-cost supplier. When the buyer sources from the lowest-cost supplier, inefficiency is zero. If the buyer sources from the supplier with the higher production cost, inefficiency is the difference between the selected supplier's production cost and the lowest-cost supplier's production cost. If the buyer does not source from any supplier, the difference is between the buyer's production cost of 250 ECU and the production cost of the lowest-cost supplier. This measure ranges from 1.81 to 2.14 ECU per interaction and does not differ significantly between the auction and negotiation treatments. Since theory predicts that the buyer will always source from the cheapest supplier, both efficiency measures significantly differ from the theoretical prediction in all treatments.

Regression analysis. In Table 2, we present panel regression outcomes from our dataset of 648 procurement interactions, using Price as the dependent variable to complement our non-parametric tests based on cohort averages reported above. Consistent with theoretical expectations that suggest the price is set by the cost-efficient supplier, i.e., the supplier with the lowest costs, we include the variable Lowest Costs in all regression models. This variable represents the costs of the cost-efficient supplier

Table 1: Observed and Predicted Outcomes

	Auction	NegPro	NegStu	Prediction
Price	151.7***	156.3***,++	158.3***,++	166.5
	(1.36)	(1.68)	(2.45)	(0.00)
Offer	167.8***	169.3***	168.5**	175.1
	(1.24)	(1.50)	(1.92)	(0.00)
Offer Difference	33.5***	26.9***,+++	21.6**,+++	17.1
	(1.46)	(1.22)	(1.38)	(0.00)
Share of Efficient Trades	0.88***	0.87***	0.87***	1.00
	(0.02)	(0.03)	(0.02)	(0.00)
Inefficiency per Trade	1.81***	1.97***	2.14***	0.00
	(0.51)	(0.57)	(0.39)	(0.00)
Number of Cohorts	12	12	12	
Number of Participants	72	72	72	

** $p < 0.05$, *** $p < 0.01$; H_0 : Observed = Predicted; SN test.
++ $p < 0.05$, +++ $p < 0.01$; H_0 : Observed = Observed Auction; MW test.

in any given interaction. The dummy variable Auction is set to one for the Auction treatment and is zero otherwise. Since we observe no significant differences between our two negotiation treatments, we merge the data of NegPro and NegStu for the subsequent analysis. The variable Period is one in the first period and equals 9 in period 9. Finally, Auction × Period represents the product of Auction and Period.

In line with the results from Table 1, Model 1 confirms that prices in our Auction treatment are significantly lower than in our negotiation treatments. It also shows that, in line with theory, prices significantly correlate with the cost-efficient supplier's cost. Considering Period in Model 2 allows us to examine potential learning effects. However, Model 2 provides no evidence for a general learning effect, indicating that prices do not change significantly over time. Model 3 incorporates the term Auction × Period. This new variable enables us to explore treatment-specific time trends. The model shows that prices in auctions and negotiations are initially indistinguishable. It also shows that prices do not change over time in the negotiation treatment but decrease in the Auction treatment.

Result 3. *Initially, prices in the Auction and the negotiation treatment do not differ ($p = 0.873$, Model 3). While there is no significant time trend in the negotiation treatments ($p = 0.626$, Model 3), prices decrease significantly stronger in the Auction treatment ($p = 0.006$, Model 3).*

Table 2: Random-Effects Panel Regressions of Price

	(1) Price	(2) Price	(3) Price
Lowest Costs	0.719***	0.718***	0.718***
	(0.0222)	(0.0222)	(0.0223)
Auction	-5.581***	-5.581***	0.481
	(1.658)	(1.659)	(3.003)
Period		-0.285	0.120
		(0.214)	(0.245)
Auction × Period			-1.213***
			(0.441)
Constant	61.67***	63.27***	61.24***
	(3.732)	(3.921)	(4.127)
Observations	648	648	648
Pseudo R^2	0.6187	0.6198	0.6243

Standard errors in parentheses.
*** $p < 0.01$

5.2 Analysis of the Chat Content

This section examines the relationship between chat content and supplier offers in our negotiation treatments. In contrast to our previous analysis, this investigation takes a more exploratory approach. While it identifies correlations between chat content and supplier offers, it cannot establish causal relationships.

To better understand the effects of communication, we identified a set of metrics that serve as reasonable approximations for different negotiation tactics. Based on our review of the literature and discussions with practitioners, we focus on the following three aspects of communication:

1. The role of anchors in shaping suppliers' offers.

2. The impact of specific negotiation tactics used by buyers, such as the use of tangible communications, mention of competitors, or attempts to build a personal relationship with suppliers.

3. The sentiment conveyed in the buyer's messages.

Since a supplier's final offer is closely tied to the underlying costs, it is critical to control for these costs when examining the impact of communication issues on bids. To do this, we start our analysis with a simple regression model. The dependent variable

Table 3: Chat Content and Supplier Offers

#	Aspect	Mean (Std. Dev.)	Coefficient (Std. Err.)	Description
1	Buyer Anchor	0.222 (0.416)	0.997 (1.146)	Binary variable that is one if the buyer is the first to mention a number and zero otherwise.
2	Buyer Anchor Value	134.3 (26.159)	0.102** (0.046)	Value of number if the buyer was the first to mention a number.
3	Supplier Anchor Value	186.0 (25.461)	0.147*** (0.021)	Value of number if the supplier was the first to mention a number.
4	Tangible Communiaction	3.995 (1.817)	-0.470* (0.250)	Reflects how often the buyer used tangible communication in a chat.
5	Mention Competition	0.566 (0.496)	-1.355* (0.819)	Binary variable that is 1 if the buyer mentioned competition and zero otherwise.
6	Personal Relation	0.537 (0.888)	-0.025 (0.520)	Reflects how often the buyer tried to build a personal relationship with the supplier in a chat.
7	Sentiment TextBlob	0.188 (0.249)	2.551 (1.681)	The sentiment of buyer's chat messages was classified using TextBlob. Values range from -1 to 1. Zero represents a neutral sentiment, positive (negative) values a positive (negative) sentiment.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

is the final offer, and the independent variable is the supplier's cost. By calculating the residuals from this initial regression, our goal is to neutralize the influence of underlying cost differences and to allow a more precise analysis of the correlation between communication aspects and offers.

We then run a panel regression for each communication aspect. In these simple regression models, the previously calculated residuals are the dependent variable and the communication aspect is the independent variable. The aim is to investigate how each feature correlates with the offer, net of cost effects. Table 3 reports the results of this analysis, including the estimated coefficients for each communication aspect and their corresponding standard errors. We find that supplier offers are significantly correlated with anchors. We also find that the buyer's tangible communication and mentioning competition are correlated with lower bids. In the following, we describe in more detail the analysis of the individual aspects of the communication.

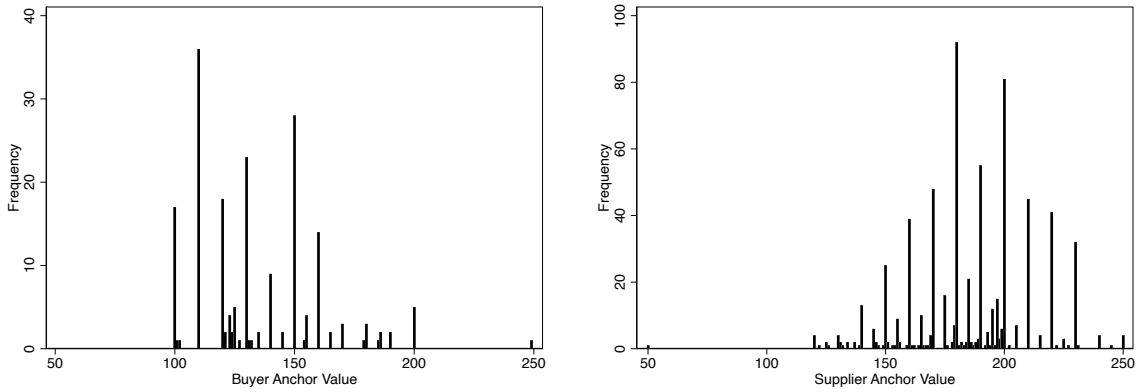

Figure 1: Distribution of Anchors set by Buyers and Suppliers.

5.2.1 Anchors

Traditional negotiation tactics often suggest that buyers open with a low offer and suppliers open with a high offer. This initial number serves as an anchor, supposedly influencing the course and outcome of the negotiation. In our dataset, we observe that the buyer is the first to mention a number in 192 out of 864 chats, or 22.2% of the time. The supplier is the first to mention a number in 670 chats (77.5%) and in 2 chats (0.2%) no number is mentioned. In the following, we will refer to the first number mentioned in a chat as the anchor. Consistent with common wisdom, the anchors set by buyers are significantly lower than those set by suppliers. The average buyer anchor is 134.3 ECU, while the average supplier anchor is 186.0 ECU. Figure 1 illustrates the distribution of anchors set by buyers and suppliers.

The variable Buyer Anchor takes the value one if the buyer sets the anchor and zero otherwise. For the 192 interactions where the buyer sets the anchor, the variable Buyer Anchor Value represents the numeric value of the anchor. Similarly, for the 670 interactions where the supplier sets the anchor, the variable Supplier Anchor Value represents the numeric value of that anchor. The first three rows of table 3 show that whether the buyer sets the anchor is not significantly correlated with the supplier's final offer. However, when we look at the interactions where either the buyer or the supplier set the anchor, we observe a significant correlation between the anchor and the supplier's final offer. On average, a one ECU increase in the Buyer Anchor Value increases the supplier's final offer by 0.1 ECU, and a one ECU increase in Supplier Anchor Value increases the final offer by 0.25 ECU, controlling for the supplier's costs. Thus, while the act of anchoring itself is not significantly correlated with the supplier's final offer, the value of the anchor is.

Result 4. *a) When the buyer sets the anchor, the supplier's final bid positively correlates with that anchor ($p = 0.027$, Table 3).*

b) If the supplier sets the anchor, the supplier's final bid is positively correlated with this anchor ($p < 0.001$, Table 3).

Comparing the variables Buyer Anchor, Buyer Anchor Value, and Supplier Anchor Value between the two negotiation treatments, NegPro and NegStu, we find no evidence of significant treatment differences for any of the three variables.

5.2.2 Communication Tactics

According to procurement practitioners, tangible communication, mentioning the existence of competing suppliers, and building a personal relationship with a supplier are important determinants of the buyer's success in a negotiation. Therefore, we investigate whether and how often buyers use these tactics in our conversations. We use GPT 4.0 to identify the tactics. The exact prompts are provided in the online appendix.

For each chat, the variable Tangible Communication expresses how often a buyer makes a tangible statement. We observe that buyers make an average of around 4 tangible statements per chat. There is a weakly significant negative correlation between tangible statements and supplier offers. Each tangible statement reduces the supplier's offer by around 0.5 ECU on average.

The variable Mention Competition indicates whether a buyer mentioned competition in a chat, i.e., it takes the value of one if the buyer mentions competition and zero otherwise. On average, buyers mention competition in around 57 percent of the chats. We find a weakly significant correlation with supplier quotes.

Result 5. *The buyer making concrete statements or mentioning competition weakly significantly correlates with lower final offers from suppliers ($p = 0.060$ and $p = 0.098$, Table 3).*

The Personal Relation variable expresses how often a buyer tries to build a personal relationship in a chat. On average, a buyer makes around 0.5 attempts per chat, and we find no significant correlation with suppliers' offers.

Comparing the variables Tangible Communication, Mention Competition, and Personal Relation across negotiation treatments, we find no evidence of significant treatment differences for any of the three variables.

5.2.3 Sentiment Analysis

We analyze our chat data using the TextBlob sentiment analysis library in Python. It uses a pre-trained Naive Bayes classifier that categorizes text as either positive, neutral, or negative based on the words it contains. TextBlob returns a tuple containing

polarity and subjectivity scores when you run sentiment analysis on a text snippet. The polarity score ranges from -1 to 1, where -1 indicates a negative sentiment, 1 indicates a positive sentiment, and 0 is neutral. The subjectivity score ranges from 0 to 1, where 0 is very objective, and 1 is very subjective. Our variable TextBlob is equal to the estimated polarity score.

The regression results in table 3 show no significant correlation between buyer text sentiment and supplier offers. Comparing the Sentiment TextBlob variable across negotiation treatments, we find no evidence of treatment differences ($p = 0.6297$, WMW).

6 Conclusion

Our research contributes to the ongoing debate about optimal procurement mechanisms–specifically, whether to use auctions or negotiations–by investigating the role of communication in a competitive setting. Contrary to conventional wisdom, we find that even experienced procurement managers, on average, do not achieve better prices through communication. Instead, our experimental evidence indicates that, in competitive supplier environments, communication can lead to higher prices. This finding urges managers and procurement professionals to reconsider the widespread assumption that negotiation inherently yields cost benefits compared to auctions.

By construction, our negotiation treatment does not allow for richer forms of negotiation—such as enforceable promises, multi-attribute contracting, or reputation-building across repeated interactions—that can be present in other procurement contexts. As such, our findings are most relevant to procurement situations where communication is limited to pre-contractual, non-binding discussions and where all that ultimately matters is the formal offer. In environments where richer negotiation mechanisms are available, our results may understate the potential advantages of negotiation. We thus view our findings as identifying a boundary condition: when negotiation is limited to non-binding, pre-auction communication about price, buyers may actually fare worse than in a standard auction. This complements existing research on negotiation in richer or repeated-contracting settings, where communication may yield additional benefits.

From a managerial perspective, our results suggest critical implications. Firstly, buyers must carefully assess the competitive context before deciding on the procurement mechanism. In competitive environments, limiting direct communication through a structured auction is likely to result in lower prices for the buyer. When negotiation is necessary, our analysis of chat data offers practical advice. First, the initial offer sets the tone for the final price. Therefore, starting with a low initial

offer may put the buyer in a better position. Second, the buyer's communication should focus on the competition to achieve lower prices. However, simply mentioning the competition has a limited impact on final offers. These strategies may help counteract some of the price increases resulting from communication.

Importantly, our findings do not negate the potential benefits of strong communication skills altogether. Indeed, in bilateral negotiations, where direct competition is absent or limited, adept communication may significantly improve buyer outcomes. Therefore, organizations investing in negotiation training should carefully tailor such programs, recognizing that the effectiveness of communication depends on the specific procurement context.

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