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The Hold-Up Problem and Communication: Experimental Evidence

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Abstract

The hold-up problem plays a central role in organizational and institutional economics. According to standard theory, an investor may have insufficient incentives to invest in a relationship with a trading partner when the investor anticipates that in future negotiations the trading partner might behave opportunistically, so the investor's costs might not be recouped. In a prominent paper-and-pencil experiment, Ellingsen and Johannesson (2004a) have shown that communication can mitigate the hold-up problem. They allow either the investor or the trading partner to send a single text message to the other player. In order to study the robustness of their findings, we replicate their setup in an online experiment, allowing for a larger number of observations and a different subject pool. Moreover, we extend the original setup by adding a treatment with bilateral communication in order to find out whether or not the possibility of arguing back and forth can further alleviate the hold-up problem.

JEL Classification: C72; C91; D23; D86; L14

Keywords: Hold-up problem; communication; relationship-specific investments; incomplete contracts; experiments

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1 Introduction

Economic relationships both in the private and the public sector often cannot be governed by complete contracts. In such situations, a hold-up problem may occur. Specifically, an investor may have insufficient incentives to make non-contractible investments, because the investor anticipates that in future negotiations the returns of the investment must be shared with a trading partner. The hold-up problem plays a central role in the incomplete contracting approach, which has been widely applied in order to analyze the pros and cons of vertical integration, privatization, firm-specific training, offshoring, and many other important topics.¹

In the past three decades, various economic experiments have been conducted in order to explore the real behavior of human beings in the context of the hold-up problem.² In particular, Ellingsen and Johannesson (2004a) have shown that communication can mitigate the hold-up problem. To the best of our knowledge, the present paper is the first direct replication of their influential experiment.

Ellingsen and Johannesson (2004a) have conducted a paper-and-pencil experiment with 206 participants, who were undergraduate business and economics students. Each of their three treatments consists of a one-shot interaction between two subjects, a potential investor (the seller) and a trading partner (the buyer). In the first treatment (no communication), the seller can decide whether or not to invest an amount of 60 Swedish kronor in order to generate a potential revenue of 100 kronor. Subsequently, the buyer can make a take-it-or-leave-it proposal regarding the division of the revenue. Finally, the seller can decide whether or not to accept the proposal. If the seller rejects, the revenue is not realized. In the second treatment (seller communication), when making the investment decision, the seller can send a written message to the buyer (e.g., the seller may threaten to reject certain proposals). In the third treatment (buyer communication), the buyer can send a written message to the seller before the investment decision is made (e.g., the buyer may promise to make a certain proposal).

¹The incomplete contracting approach was developed by Grossman and Hart (1986), Hart and Moore (1990), and Hart (1995), building on the pioneering work by Coase (1937) and Williamson (1975, 1985). See also Aghion et al. (2016), who discuss the fundamental impact of the incomplete contracting approach in numerous areas of economics.

²For example, Hackett (1993) studies whether negotiators disregard sunk investment costs, Sonnemans et al. (2001) and Fehr et al. (2008) investigate the role of different ownership structures, and Hoppe and Schmitz (2011) explore whether suitable contracts can solve the hold-up problem. For a literature survey, see Yang (2021).

According to standard theory, which assumes that decision makers are rational and self-interested, no investment would be made, because the buyer's offer would not cover the seller's costs, and non-binding communication would have no impact. Yet, Ellingsen and Johannesson (2004a) find that even in the no-communication treatment investments are made in more than a third of the cases, and communication increases the investment frequency (significantly so only if the seller can send a message). Moreover, communication increases the offers made in the negotiation stage (significantly so only if the buyer can send a message).

In the present paper, we make two contributions. First, we test the robustness of Ellingsen and Johannesson's (2004a) findings by conducting an online experiment instead of a paper-and-pencil experiment. The online experiment allows for a larger number of participants and for a different subject pool using Prolific.³ Second, we extend the original study's experimental design by adding a fourth treatment (bilateral communication). In this treatment, both players can send messages, which seems to be a realistic scenario. In particular, we want to find out if the possibility of arguing back and forth can further alleviate the hold-up problem or if it may lead to unproductive haggling and thereby reduce the beneficial effects of unilateral communication that were identified by Ellingsen and Johannesson (2004a).

Our main findings are as follows. First, even though there are some differences in detail, our results reinforce Ellingsen and Johannesson's (2004a) central insights. Without communication, approximately one-third of the sellers invest. With either form of unilateral communication, investment rates and offers are substantially higher than in the absence of communication. Second, we find that bilateral communication results in higher investment rates compared to seller communication only and higher offers compared to both forms of unilateral communication.

Related literature. Experimental research has shown that communication can enhance cooperative behavior in a variety of games.⁴ Specifically, Agranov (2025, Section 3.2) has recently emphasized that free-form communication by

³In particular, the number of observations regarding the bargaining stage is relatively small in Ellingsen and Johannesson's (2004a) study, since the bargaining stage is reached only if an investment has been made. Moreover, the behavior of business and economics students may differ from the behavior of other economic players in real-world interactions; see, e.g., Fehr et al. (2006).

⁴Recent literature surveys on experimental results regarding communication in games include Casoria et al. (2020), who focus on employer-employee interactions, and Drouvelis (2021, Section 5.2), who discusses public good games.

both players can be highly effective in the trust game (Berg et al., 1995), while restrictions imposed on communication, e.g., by dictating who can speak, diminish its beneficial impact.⁵ While the trust game is related to the hold-up problem that we study in the present paper, there are important differences. In the basic trust game, the investor's trading partner can always realize the return on the investment and can freely decide how much money to keep. In contrast, in the hold-up problem we consider, following Ellingsen and Johannesson's (2004a) design, the investor can punish the trading partner in the negotiation stage by rejecting the trading partner's offer, so that the return on the investment is not realized.⁶ It is therefore not obvious that results from standard trust game experiments automatically carry over to the present setting.⁷

Moreover, Agranov (2025, p. 177) points out that in experiments on the hold-up problem, only one-way communication has been examined so far, and she explicitly notes that it remains "an open question" whether, in games such as the hold-up problem, two-way communication between players can lead to efficiency gains comparable to those achieved in the basic trust game. Our paper directly addresses this open question by introducing a bilateral communication treatment. Note that it is not clear a priori that two-way communication is superior to one-way communication. For instance, Cabrales et al. (2026) have recently shown in a coordination game with private information that the payoffs may be higher under one-way than under two-way communication.⁸

Organization of the paper. The remainder of the paper is organized in the following way. In Section 2, we describe the design of the experiment. In

⁵Cf. Ben-Ner and Putterman (2009), Lev-On et al. (2010), Ben-Ner et al. (2011), and Servátka et al. (2011).

⁶In general, there are many different ways in which one could model the bargaining stage of a hold-up problem. For example, Ellingsen and Johannesson (2004b) report about a hold-up experiment in which the bargaining stage is given by the Nash demand game instead of the ultimatum game. Here, we focus on Ellingsen and Johannesson's (2004a) setting, which has turned out to be particularly influential in the subsequent literature.

⁷Indeed, Fehr et al. (2020) have shown that free-form communication can have detrimental effects when sellers can communicate desired prices to buyers and have an opportunity to punish them. Sellers may become particularly disappointed when their share of the surplus is small after unsuccessfully attempting to induce generosity, leading to an increase in inefficient punishments. However, Fehr et al. (2020) study a different setting without investments but with cost uncertainty. See also the mixed results on communication in standard ultimatum games reported by Rankin (2003) and Zultan (2012).

⁸The effects of one-way versus two-way communication have also been explored in various other settings; see, for example, Cooper et al. (1989, 1992), Harbring (2006), Brandts and Cooper (2007), Bjedov et al. (2016), and Agranov (2024).

Section 3, we report the main results. Section 4 concludes. Additional results and the instructions for the experiment can be found in the Appendix.

2 Design

We implemented four treatments, the first three of which were direct replications of the design used by Ellingsen and Johannesson (2004a). The basic setup was the same across all four treatments. Two agents (a seller and a buyer) were matched, and there were up to two stages.⁹ In the first stage, the seller had to decide whether or not to invest 6 GBP. If the seller did not invest, the game ended. If the seller invested, a revenue of 10 GBP could be created, provided that in the second stage the seller and the buyer agreed on a division of the revenue.¹⁰ In the second stage, the buyer had to make a take-it-or-leave-it proposal on how to divide the revenue. The seller then had to decide whether to accept or reject the proposal. If the proposal was accepted, the 10 GBP revenue was divided according to the proposal. If the proposal was rejected, no revenue was created.

The first treatment (No comm.) did not allow for any communication. In the second treatment (Seller comm.), the seller could send a message to the buyer along with the investment decision. In the third treatment (Buyer comm.), the buyer could send a message to the seller before the investment decision was made. Finally, in the fourth treatment (Bilateral comm.), the seller and the buyer could communicate with each other via chat before the investment decision was made.¹¹

Participants, Payments and Procedures. The experiment was conducted on Prolific with a total of 890 participants from the United Kingdom, randomly

⁹Following Ellingsen and Johannesson (2004a), we did not use the seller/buyer terminology in the experiment. See Yang (2021) for a discussion of different framings in experimental studies of the hold-up problem.

¹⁰Note that in Ellingsen and Johannesson (2004a) the investment cost was 60 SEK and the potential revenue was 100 SEK.

¹¹Participants could chat for five minutes and end the chat at any time unilaterally. If a participant decided to end the chat unilaterally, the other party was informed about this. There was no joint ending option: either participant could end the chat, or the chat ended when five minutes had expired. Participants typically concluded their conversation before the time had expired and then one ended the chat. Inspection of the conversation content reveals that in only 10 out of 108 conversations the chat was abruptly ended by one side. Hence, we do not interpret who clicked first as a measure of cooperativeness. An individual message was allowed to contain 500 standard characters. No other limitations were imposed.

matched into 445 groups of two.^{12,13} Fifty-one percent of the participants were female. The participants' ages ranged from 18 to 81, with an average of 39. The most common occupation type was white collar (58 percent). In total, 21 sessions were conducted, and it took most participants around 15 minutes to complete the study. On average, participants were paid 8.66 GBP, which included a base payment of 1.70 GBP. The experiment was programmed and conducted using SoPHIE (see Hendriks, 2012).

Upon entering the study, participants were presented with the instructions and informed about their role, as well as the fact that they would start with an initial account balance of 6 GBP.¹⁴ The instructions were supplemented by a calculator that participants could use to familiarize themselves with the monetary consequences of different decisions. After reading the instructions, participants had to answer seven comprehension questions correctly, each with no more than two attempts and within three minutes, before they were eligible to take part in the experiment.

3 Results

The aggregate outcomes for each treatment are reported in Table 1, while Table 2 reports the p-values for the corresponding pairwise comparisons.¹⁵ For ease

¹²Twelve subjects and their matched partners were excluded from the analysis because they encountered substantial technical problems during the experiment.

¹³We conducted a power calculation for the statistically significant primary contrasts in Ellingsen and Johannesson (2004a) that we target for replication. Among these, the difference in the proportion of investors between the No Communication and Seller Communication treatments is the most demanding in terms of required sample size, as it corresponds to the smallest effect size among the significant findings we seek to reassess. In Ellingsen and Johannesson (2004a), the proportion of investors is $14/40 = 0.35$ under No Communication (NC) and $21/33 = 0.636$ under Seller Communication (SC), with significance based on a two-sided Pearson chi-squared test of independence in a 2×2 table ($p = 0.015$). This comparison implies an effect size of Cohen's $w = \sqrt{\chi^2/N} \approx 0.285$ ($df = 1$). To allow for possible upward bias in the original estimate, we based our calculations on two-thirds of this effect size, i.e., $w \approx 0.19$. For a two-sided test with $\alpha = 0.05$, a total sample size of approximately $N = 218$ yields 80% power to detect an effect of this magnitude. Our replication uses $N_{NC} = 110$ and $N_{SC} = 112$ (total $N = 222$), corresponding to power of approximately 0.81 for the prespecified discounted effect under the same test.

¹⁴This is analogous to the 60 SEK participation fee in Ellingsen and Johannesson (2004a) and was implemented to prevent the realization of losses.

¹⁵Observations in the communication treatments were analyzed regardless of whether a message was sent. The p-values were obtained from Pearson's chi-square tests for the investment rates, and from two-sided Mann-Whitney U tests for the offers and the profits.

of reference, the values reported in Ellingsen and Johannesson (2004a) are provided in square brackets.

The proportion of investors (i.e., the share of sellers who decided to invest) in the treatment without communication was 36 percent. Thus, our results confirm Ellingsen and Johannesson's (2004a) rejection of the standard theoretical prediction that there should be no investment. Consistent with their findings, we also observe that investment rates are higher with communication than without. In our data, the differences between the baseline treatment and each of the unilateral communication treatments are statistically significant (at the 5 percent level or better).¹⁶ Moreover, we find that the share of investors is significantly higher (at the 5 percent level) in the buyer-communication treatment than in the seller-communication treatment.¹⁷

	No comm.	Seller comm.	Buyer comm.	Bilateral comm.
Number of pairs	110 [40]	112 [33]	111 [30]	112
Proportion of investors	0.36 [0.35]	0.52 [0.64]	0.65 [0.53]	0.71
Mean offer	5.9 [48.57]	6.7 [63.33]	6.9 [70.00]	7.4
Mean profit of investor	-0.68 [-12.86]	0.48 [-6.43]	0.86 [8.75]	1.25

Note: The numbers in brackets refer to Ellingsen and Johannesson's (2004a) data.

Table 1. Investments, Offers, and Profits.

	Proportion of investors	Offer	Profit
No comm. vs Seller comm.	0.021 [0.015]	0.0282 [0.125]	0.0209 [0.562]
No comm. vs Buyer comm.	<0.001 [0.125]	0.0012 [0.017]	0.0006 [0.033]
No comm. vs Bilateral comm.	<0.001	<0.0001	<0.0001
Seller comm. vs Buyer comm.	0.048 [0.407]	0.2529 [0.229]	0.2259 [0.048]
Seller comm. vs Bilateral comm.	0.004	0.0020	0.0022
Buyer comm. vs Bilateral comm.	0.365	0.0459	0.0524

Note: The numbers in brackets refer to Ellingsen and Johannesson's (2004a) data.

Table 2. The Probability that Two Treatments Yield Statistically Indistinguishable Averages.

¹⁶In contrast, in Ellingsen and Johannesson (2004a) the difference was statistically significant only in the case of seller communication.

¹⁷Ellingsen and Johannesson (2004a) report the opposite pattern, although it was not statistically significant.

The highest proportion of investors, 71 percent, is observed in our additional treatment with bilateral communication. This is significantly higher (at the 1 percent level) than the 36 percent without communication and the 52 percent with seller communication, but not significantly higher than the 65 percent with buyer communication.

Next, consider the offers made by the buyers. The mean offers are higher with communication than without. Pairwise comparisons show that all communication treatments differ significantly from the no-communication treatment at the 5 percent level or better.¹⁸ Corroborating Ellingsen and Johannesson's (2004a) results, we find that among the original three treatments, offers are highest with buyer communication, and, like them, we cannot confidently reject the null hypothesis of independence when comparing seller and buyer communication.

Comparing the bilateral communication treatment with the original three treatments reveals that bilateral communication yields the highest offers, averaging 7.4 GBP. The differences between the offers in the bilateral communication treatment and each of the other treatments are statistically significant (at the 5 percent level or better).

The mean profit of investors is negative in the no-communication treatment, consistent with Ellingsen and Johannesson (2004a). While they also report a negative mean profit in the seller-communication treatment, in our data the mean profits of the investors are positive in all communication treatments. Regarding statistical significance, we find that investor profits in all communication treatments are significantly higher (at the 5 percent level or better) than in the no-communication treatment.¹⁹ Furthermore, under bilateral communication, investor profits are significantly higher than under seller communication, at the 1 percent level.

Figures 1 and 2 show the proposals and acceptance decisions whenever the seller chose to invest. The figures are analogous to those in Ellingsen and Johannesson (2004a). Numbers in the format z/y above a point indicate that there were z such proposals, of which y were accepted. If only one number is shown, it means all proposals with that division of the revenue were accepted.

¹⁸In contrast, Ellingsen and Johannesson (2004a) report significant differences only between the no-communication and buyer-communication treatments.

¹⁹Ellingsen and Johannesson (2004a) report that only the difference between no communication and buyer communication is significant. In contrast, the difference between seller and buyer communication, which is significant at the 5 percent level in their data, is not statistically significant in ours.

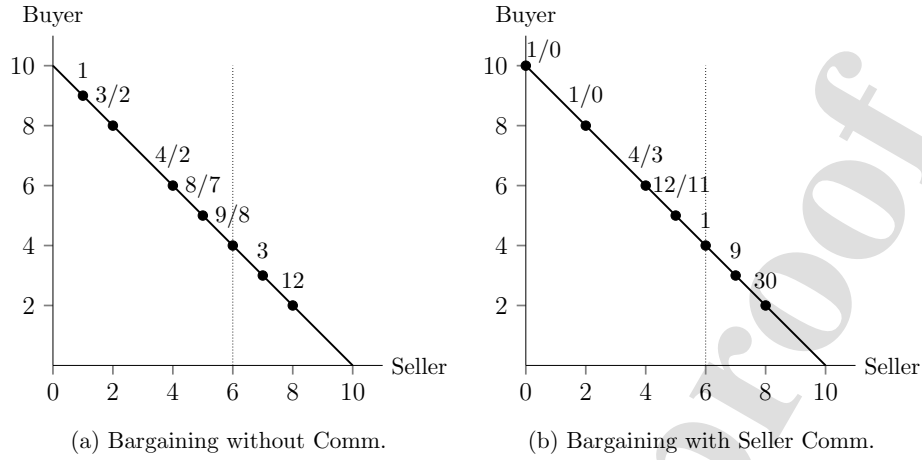


Figure 1. Bargaining without Communication and with Seller Communication.

From Figure 1a, we can clearly see that, without communication, the most common offer (made in 30 percent of the cases) was 8:2; that is, 8 GBP of the 10 GBP revenue was allocated to the seller and 2 GBP to the buyer, implying an equal split of the net surplus. This is consistent with Ellingsen and Johannesson's (2004a) findings. In total, 13 percent of the proposals were rejected. Taken together, these results demonstrate that buyers took the seller's sunk investment costs into account and that sellers were not solely motivated by maximizing their own monetary payoffs.

Figure 1b shows that in the seller-communication treatment, the most frequent offer (made in 52 percent of the cases) was again 8:2, while 21 percent of the offers split the second-stage revenue equally (5:5). Clearly, buyer offers were substantially more generous in the seller-communication treatment than in the no-communication treatment. The rejection rate was 7 percent.

Figure 2a shows the treatment with buyer communication, where the investment rate is higher than in the no-communication and seller-communication treatments. Notably, the relative frequency of 8:2 proposals was also higher (63 percent). As with seller communication, the second most frequent proposal was 5:5 (14 percent). In line with Ellingsen and Johannesson (2004a), proposals in the buyer-communication treatment were even more generous than in the seller-communication treatment. A closer look also reveals that the rejection rate was lower (4 percent).

Finally, Figure 2b presents the distribution of proposals for the bilateral-communication treatment. Here, 8:2 proposals made up the vast majority (79

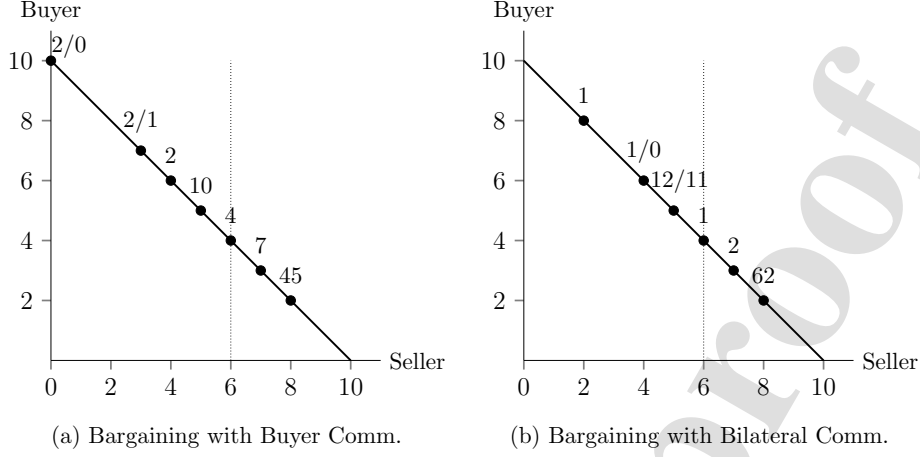


Figure 2. Bargaining with Buyer Communication and with Bilateral Communication.

percent). The second most frequent offer was 5:5, accounting for 15 percent. Rejections were very rare, with a rate of less than 3 percent.

Inspection of the messages reveals a nuanced picture of communication. Table 3 reports the aggregated classification of message content.²⁰ Turning to the prevalence of communication first, in the seller-communication treatment, 74 of 112 sellers (66.1 percent) sent a message before deciding whether to invest. All 111 buyers in the buyer-communication treatment sent a message. In the bilateral-communication treatment, 108 of 112 pairs (96.4 percent) engaged in a two-sided conversation.

²⁰We employ a zero-shot, two-pass automated content-analysis procedure using a local large language model (QWEN3.5:27b, run via Ollama with temperature 0 and a fixed seed for reproducibility). In the first pass (dimension discovery), the model receives all communication messages from all three treatments jointly and inductively identifies coding dimensions that capture meaningful variation in message content, analogous to an open-coding phase in qualitative research. In the second pass (classification), each message is presented individually to the model along with the discovered coding scheme, and the model assigns values for each dimension. The second pass is conducted separately for each treatment to accommodate differences in message structure (unidirectional messages versus bidirectional chat transcripts). Because the coding scheme is derived from the pooled messages in the first pass, the dimensions remain comparable across treatments. The automated classifications were independently reviewed by a research assistant not otherwise involved in the study, who verified their plausibility and consistency against the original messages. The full classification script and raw codings are available upon request. Dimension definitions are provided in the Appendix.

Dimension	Seller comm.	Buyer comm.	Bilat. seller	Bilat. buyer
Threat	5 (6.8%)	-	3 (2.8%)	-
Promise	14 (18.9%)	61 (55.0%)	13 (12.0%)	65 (60.2%)
Proposed Offer	7.48 (1.07) (<i>N</i> = 28)	7.36 (1.17) (<i>N</i> = 46)	7.58 (1.11) (<i>N</i> = 44)	7.69 (0.84) (<i>N</i> = 71)
Investment Declaration	34 (45.9%)	-	18 (16.7%)	-
Fairness	30 (40.5%)	19 (17.1%)	24 (22.2%)	30 (27.8%)
Equity	18 (24.3%)	47 (42.3%)	42 (38.9%)	59 (54.6%)
Trust	5 (6.8%)	2 (1.8%)	15 (13.9%)	10 (9.3%)
Math. Explanation	8 (10.8%)	23 (20.7%)	19 (17.6%)	33 (30.6%)
Small Talk	7 (9.5%)	7 (6.3%)	19 (17.6%)	16 (14.8%)
Risk	4 (5.4%)	0 (0.0%)	12 (11.1%)	6 (5.6%)
Questions	4 (5.4%)	5 (4.5%)	37 (34.3%)	39 (36.1%)
Identity	0 (0.0%)	0 (0.0%)	4 (3.7%)	4 (3.7%)
Agreement	-	-	75 (69.4%)	-
Message Count	-	-	9.51 (5.33)	-
Word Count	-	-	74.35 (45.15)	-
Chat Duration (sec)	-	-	141.37 (78.77)	-
Observations	74	111	108	

Note: All dimensions are binary except *Proposed Offer*, *Message Count*, *Word Count*, and *Chat Duration*, which are continuous. For *Proposed Offer*, we also report the number of observations in which an amount was proposed. Standard deviations are reported in parentheses for continuous measures; for binary measures, parentheses report percentages corresponding to the absolute numbers. In the seller-communication and buyer-communication treatments, columns report the number and share of messages containing the respective category. In the bilateral-communication treatment, columns report the number and share of conversations in which at least one message by the respective party contained the respective category.

Table 3. Content of Communication by Treatment.

Considering threats, as well as proposals by sellers, we find that threats were rare in both settings in which sellers could communicate. Only 5 of 74 seller messages (6.8 percent) in the seller-communication treatment and 3 of 108 conversations (2.8 percent) in the bilateral-communication treatment contained a seller threat. This contrasts with Ellingsen and Johannesson (2004a), who report threats in 9 of 21 messages (42.9 percent). Seller age, gender, experience, and occupation show no clear associations with the use of threats (see Table A4 in the Appendix).

Of the 74 sellers who sent a message in the seller-communication treatment, 56 (75.7 percent) subsequently invested. Sellers also frequently referred to their intended investment decision: 34 messages in the seller-communication

treatment and 18 bilateral conversations contained an explicit investment declaration. Seller messages more commonly contained proposed divisions than threats. In the seller-communication treatment, 28 sellers proposed an amount. Of these, 20 proposed an offer of 8 GBP for the seller, while only three proposed less than 6 GBP. Sellers proposed an amount in 44 bilateral conversations; the average proposed offer to the seller was similar across the two communication settings (see Table 3).

Turning to promises, as well as proposals by buyers, we observe that promises were common in both settings in which buyers could communicate and also present in the seller-communication treatment. In our classification scheme, a promise need not contain an explicit proposal; it may, for example, consist of a promise to make the investment “worthwhile.” Buyer promises were nevertheless frequently accompanied by explicit proposals, which usually centered on an equal division of the surplus. Table 4 summarizes the relationship between these commitments and subsequent behavior.

	Measure	Buyer comm.	Bilateral comm.
Promise accompanied by an explicit proposal		38/61 (62.3%)	53/65 (81.5%)
Explicit proposal of 8 GBP for the seller		33/46 (71.7%)	59/71 (83.1%)
Explicit proposal below 6 GBP for the seller		6/46 (13.0%)	2/71 (2.8%)
Investment with versus without			
...a buyer promise		45/61 (73.8%) vs.	50/65 (76.9%) vs.
		27/50 (54.0%)	27/43 (62.8%)
...an explicit buyer proposal		36/46 (78.3%) vs.	55/71 (77.5%) vs.
		36/65 (55.4%)	22/37 (59.5%)
...a proposal (cond. on a promise)		29/38 (76.3%) vs.	41/53 (77.4%) vs.
		16/23 (69.6%)	9/12 (75.0%)
...a bilateral agreement		–	65/75 (86.7%) vs.
		–	12/33 (36.4%)
Proposed division honored		27/29 (93.1%)	35/41 (85.4%)

Note: The investment rows compare the incidence of investment when the indicated feature is present and absent. The row reporting whether the proposed division was honored is conditional on a buyer promise accompanied by an explicit proposal and subsequent investment.

Table 4. Communication and Behavior.

In the buyer-communication treatment, messages containing a promise were more likely to be followed by investment than messages without one ($p = 0.030$).²¹ This pattern is qualitatively consistent with Ellingsen and Johannesson (2004a), who report that 10 of 17 promise messages (58 percent) and 6 of 13 non-promise messages (46 percent) were followed by investment. Messages containing an explicit proposal were also more likely to be followed by investment ($p = 0.013$). Conditional on the presence of a promise, however, an explicit proposal was not associated with a further increase in investment ($p = 0.561$). When investment followed a promise accompanied by a proposal, the proposed division was generally honored (see Table 4).

In the bilateral-communication treatment, conversations containing a buyer promise were not significantly more likely to result in investment than conversations without one ($p = 0.112$). Conversations containing an explicit buyer proposal were more likely to result in investment ($p = 0.050$), but this difference disappears once attention is restricted to conversations containing a buyer promise. Proposed divisions were again generally honored following investment.

Finally, consider other characteristics of communication. Fairness and equity were the most frequent additional themes across the communication treatments (see Table 3). Their conditional associations with behavior, however, differ across treatments and senders. Seller appeals to fairness are positively associated with investment under bilateral communication, whereas buyer appeals to fairness are negatively associated with investment in the buyer-communication treatment. Buyer references to equity in that treatment are positively associated with proposed offers. Despite the prevalence of fairness and equity in the seller-communication treatment, the joint tests provide no overall evidence that seller-message content is associated with either sellers' investment decisions or buyers' subsequent proposals.²²

²¹All p -values reported in this and the following paragraph refer to two-sided Pearson chi-square tests.

²²These conditional associations are obtained from the exploratory specifications reported in Tables A2 and A3 in the Appendix. The associations involving seller fairness and seller small talk are significant at the 1 percent level. Buyer fairness, mathematical explanations, and seller and buyer questions are significant at the 5 percent level. Buyer small talk is significant at the 1 percent level in the investment specification and at the 5 percent level in the offer specification. Buyer equity is significant at the 1 percent level in the offer specification. Because message characteristics are self-selected, correlated, and sometimes rare, and because these estimates are in some cases based on smaller estimation samples, they should not be given a causal interpretation but should instead be interpreted as exploratory conditional associations. The specifications, controls, estimation samples, and joint tests are

Mathematical explanations were common in both the buyer-communication and bilateral-communication treatments. In the buyer-communication treatment, they are positively associated with investment. Questions were particularly common under bilateral communication, where seller questions are positively and buyer questions negatively associated with investment. The associations with small talk similarly depend on the sender: in bilateral communication, seller small talk is negatively associated with both investment and proposed offers, whereas buyer small talk is positively associated with both outcomes.

Bilateral communication further allowed the parties to reach explicit agreements. Of the 108 bilateral conversations, 75 (69.4 percent) yielded an agreement. Investment followed in 65 of these cases (86.7 percent), while sellers invested in a further 12 conversations without an explicit agreement. Together with the frequent use of questions and mathematical explanations, the emergence of agreements indicates that bilateral communication involved not only promises and proposals but also clarification and coordination.

Finally, none of the applicable communication-intensity measures is significantly associated with investment. Among observations in which investment occurred, longer chat duration is associated with lower proposed offers. Holding message count and sender-specific word counts constant, an additional 10 seconds is associated with an approximately 0.09 GBP lower offer. None of the remaining communication-intensity measures is statistically significant at the 5 percent level. This isolated duration result should therefore be interpreted cautiously.

4 Conclusion

In an influential experiment, Ellingsen and Johannesson (2004a) showed that communication can mitigate the hold-up problem. We replicated their design and extended it with a treatment allowing for bilateral communication.

Our study yields two principal conclusions. First, our results corroborate the key findings of Ellingsen and Johannesson (2004a) with a substantially larger number of observations and a different subject pool. Specifically, both seller and buyer communication lead to higher investment rates and larger offers. Second, our additional treatment demonstrates that bilateral communication does not hinder agreement through haggling. Instead, proposals, promises, and a shared understanding of the payment mechanisms facilitate

described in the notes to Tables A2 and A3.

explicit agreements, leading sellers to invest more often than under seller communication and buyers to make more generous offers than under either form of unilateral communication.

In future research, it might be worthwhile to explore the role of communication in more complex hold-up problems (e.g., those involving more than one investment decision). It could be particularly interesting to investigate whether, in such environments, more traditional means of alleviating hold-up problems (e.g., ownership allocations as studied by Sonnemans et al., 2001, and Fehr et al., 2008, and contractual arrangements as studied by Hoppe and Schmitz, 2011) become more effective when combined with opportunities for bilateral communication.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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