Talking Behind Your Back: Communication and Team Cooperation*

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Abstract

Communication is one of the most effective devices in promoting team cooperation. However, asymmetric communication sometimes breeds collusion and hurts team efficiency. Here, we present experimental evidence showing that excluding one member from team communication hurts team cooperation: the communicating partners collude in profit allocation against the excluded member, and the latter reacts by exerting less effort. Allowing the partners to reach out to the excluded member partially restore cooperation and fairness in profit allocation; but it does not stop the partners from talking behind that member's back even when they could have talked publicly. The partners sometimes game the system by tricking the excluded member into contributing but then grabbing all profits for themselves.

Keywords: communication, fairness, collusion, allocation, team cooperation, laboratory experiment

JEL Classification: D62, H41, C79, C90, D63,

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1 Introduction

Pre-play communication among economic agents frequently leads to improved collective decisions. Numerous studies show that open communication powerfully promotes cooperation in social dilemma games (Dawes et al. 1977; Balliet 2009). For example, He et al. (2017) found that communication allows players to assess the degree of cooperativeness in other participants and also serves as a way to secure commitment by eliciting promises, thus improving cooperation.

However, not all communication is well-intentioned. In fact, in everyday life, communication is often exclusionary, with significant repercussions for the wellbeing of those in focus of (or eliminated from) such discussions. At the workplace, exclusionary communication can be harmful to a team's unity and efficacy. For example, senior employees may reach backroom deals that disfavor newcomers in remuneration allocations. Consequently, anticipation of exploitation is likely to damage the exploited member's motivation to contribute for the team effort.

Studying the effect of exclusionary communication on team cooperation in field settings is difficult since, by its nature, such communication is hard to observe. A selection problem that arises from individuals' choosing to communicate privately or publicly can also make causal inferences difficult. To gain some insight into this phenomenon, we conducted laboratory experiments that allowed us to tightly control communication channels available to the participants. We studied communication within three-member teams where only two team members (henceforth denoted as the partners) could exchange private pre-play messages. The third member (designated as the loner) was aware that the other team members were engaging in a private conversation, but was blind to its content. Our experimental setup also included scenarios in which, in addition to using the private communication channel, the partners could exchange messages via a public communication channel where the content is accessible to the loner.

The team setting in focus of this work was recently studied by Dong et al. (2019), who proposed a simple mechanism which exploits players' meritocratic fairness ideal (Adams 1965; Konow 2000; Cappelen et al. 2007) and showed that it strongly promotes team cooperation in anonymous interactions. In Dong et al.'s experiment, three players were allowed to independently decide on their investments toward a team project. Then, after observing individual investments, each had the discretion to distribute a third of the total team profit between the other two players. Each player's profit was thus equal to the amount that was not invested toward the team project incremented by the sum of the amounts received from the other two players. The authors found that the cooperation rate in the investment stage was nearly 90% and that participants allocated according to each team member's relative investment about 90% of the time.

In practical applications, this mechanism can be especially useful to corporate managers who often have to make decisions about employees' compensations based on limited information about their respective performance. In such cases, equally compensating individuals as if their contributions were the same will inevitably encourage free-riding and will hurt team performance. This problem is even more acute in certain types of business partnerships in which no single figure can act as an ultimate decision maker. Examples of such partnerships include accounting firms, law firms, management consultants, medical groups, and architects' consortia. Dong et al.'s (2019) mechanism allows the principal(s) to achieve team efficiency, fair compensation, and a balanced budget in a decentralized manner, relying on the judgments of every employee who would have better knowledge about their coworkers' efforts than a manager.[1]

This mechanism has proven to have an overwhelming tendency toward proportional

[1]While originally developed as a novel solution to team cooperation problems, this mechanism is also applicable to some real-world profit arrangements. For example, partners in a bank are allowed to decide how to allocate the bonus share among themselves as noted by John Galbraith (1955) in his book *The Great Crash 1929*. Each partner signs a ballot giving an estimated share of the bonus pool to each of the other eligible partners, himself/herself excluded. The average of these shares then guides the final bonus allocation to each of the partners. Grading group coursework is another example of this mechanism. Since professors can only observe the final output but wish to award marks based on individual students' inputs, students are asked to propose a fraction of the total marks to be given to each of the remaining students in their group. Yang et al. (2018) studied a similar mechanism in which the allocation of a portion (but not all) of group profit is determined by the group members and the rest is shared equally.

profit allocation and high cooperation within a homogeneous team.[2] However, collusion in profit allocation can occur when a subset of coworkers can engage in exclusionary conversations and reach some under-the-table agreements, whereby they would do each other a favor by allocating more than proportional amounts to each other. The exploited workers would respond by withdrawing their investments, and the cooperation would consequently break down. In theory, if the partners collude by allocating their entire share to each other, it is a subgame perfect equilibrium for the partners to invest fully and for the loner to invest nothing. Importantly, the partners' expected payoff under the *collusion equilibrium* is no higher than the *full investment equilibrium*. Hence, there is little *ex post* incentive for the partners to collude against the loner.

In the present study, the goal is to elucidate how players react to the tension between team efficiency and collusive temptation—which features in many team cooperation problems—and how communication channels should be configured to restore team performance. Our experimental design exploits the conflict of interest between the partners and the loner by allowing the partners to talk behind the loner's back (via free-form online text chat), thus isolating the loner from any communication. The ultimate goal is to answer the following questions: Will the partners talk behind the loner's back? How will the partners' exclusionary communication affect the loner's investment? Will their investment and allocation decisions conform to the collusion equilibrium?

Our experimental findings suggest that partners engaged in exclusionary communications over 95% of the time, which was detrimental to team cooperation. Specifically, the partners allocated much less fairly toward the loner than when they could not talk privately. In fact, about half of the time, the partners coordinated on allocating nothing to the loner. As a result, while the partners consistently invested at almost full level, the loner signifi-

[2]In contrast to the standard voluntary contributions mechanism used in many economics experiments, this mechanism generates highly cooperative outcomes in its canonical form. This makes it a particularly useful benchmark for the study of factors that are potentially detrimental to cooperation, such as talking behind someone's back. The standard public good game, in the absence of punitive mechanisms like punishment, reliably leads to the rapid collapse of cooperation, thus allowing little room to make things even worse (see Chaudhuri 2010 for a survey).

cantly reduced her investment (to under 20% by the last round). These findings suggest that the participants' behavior tends to conform to the collusion equilibrium. As a result, the loner only earned about half of what the partners earned.

Having established that staged exclusionary communication harms team cooperation, we next investigated whether providing the opportunity for the partners to reach out to the loner and for the loner to respond can restore fair profit allocation and high investment. For this purpose, we introduced two additional treatments. In the first treatment, in addition to the private channel, we allowed the partners to exchange messages via a public communication channel in which the loner could see the messages but could not respond. In the second treatment, we opened up all communication channels, both private (bilateral) and public (three-way), thus ensuring symmetric communication opportunity between the partners and the loner. By comparing these treatments to the private communication only condition, our aim is to identify any differences in the way the partners communicated via private and public channels, as well as establish whether they made fairer profit allocations and if the loner made higher investment. The availability of the public channels does not necessarily promote team cooperation because *endogenously* choosing to talk privately might signal intention to collude and could further undermine team cooperation and also because the partners might speak publicly solely with the aim of tricking the loner to invest.

Our findings indicate that while the partners utilized the public communication channel about 90% of the time, in 60% of the cases, they continued to talk behind the loner's back via their private channel. This seems surprising given that the loner would know about the partners' exclusionary communication and might react by lowering her investment. Nevertheless, the loner increased her effort considerably, especially when she could also participate in the public communication. Further, when the public communication opportunity was available, the partners on average allocated significantly more fairly toward the loner than when they could only talk privately. As a result, the loner earned significantly more, suggesting that public communication leads to a fairer and more cooperative team outcome.

We also analyzed the content of messages exchanged via all communication channels to understand how they affect group members' investment and allocation decisions. Our findings revealed that, when the partners could only talk privately, they proposed unfair allocation toward the loner 70% of the time. By contrast, when the public communication channel was available, they talked less often about unfair allocation in the private channel and mostly focused on fair allocation and high investment when exchanging messages via the public channel. Moreover, the loner's investment increased with the partners' promises of fair allocation and high investment in the public communication channel. Finally, although the partners generally allocated in accordance with the intent expressed in their own messages, they sometimes played tricks whereby they encouraged the loner to make a high investment in the public channel while plotting against her in the private channel.

2 Contributions to the Literature

Our study contributes to the broad literature about the role of communication in social interactions, including the effect of communication media such as face-to face, audio chat or written messages (e.g., Brosig et al. 2003; Balliet 2009) and of communication channels such as private, public, or through a mediator (e.g., Bolton et al. 2003; Agranov and Tergiman 2014). More specifically, we contribute to the nascent body of evidence on the harmful effects of communication in strategic situations. In a group contest, Cason et al. (2012) demonstrated that within-group communication leads to more aggressive group competition and lower overall efficiency. Similarly, Agranov and Yariv (2018) found that communication in an auction setting facilitates collusion among bidders, leading to lower winning bids and decreased auction efficiency. In these studies, however, social efficiency is not the main goal of contest or auction designers. By contrast, we focused on an organizational situation in which social efficiency, achieved by full cooperation, is compatible with a principal's goal, aiming to elucidate the influence of communication on social efficiency. Our further goal was to establish whether the content of communication (collusive vs. cooperative) systematically depends on the channel through which communication is transmitted (thus augmenting the findings yielded by a recent survey on communication effects in organizational settings conducted by Casoria et al. 2020).

In a broader set of practical applications, harmful effects of communication have also been studied in online market settings in which buyers and sellers communicate by providing feedback. Bolton et al. (2018) observed that buyers and sellers may strategically use the feedback withdrawal option by leaving negative feedback to improve their bargaining positions in dispute resolution negotiations. According to their findings, this behavior eventually leads to distorted reputational information and less trust in the whole market, thus adversely affecting all other market participants. In an earlier study, Bolton et al. (2013) investigated several mechanisms that improve on the existing feedback information system and help repair trust in online markets. In a similar spirit, our study illustrates that, in an organizational setting, access to different communication channels can have unintended consequences on team cooperation.

Our work is also related to literature on communication in legislative bargaining in that we manipulated a similar set of communication channels (Agranov and Tergiman 2014; Baranski and Kagel 2015; Baron et al. 2017; Merkel and Vanberg 2020). All those studies used Baron and Ferejohn's (1989) bargaining game. In the study conducted by Agranov and Tergiman (2014), for example, players were allowed to send private messages via different channels to any subset of group members. Compared to no communication, such a communication structure allows proposers to form coalitions and extract a higher fraction of the resource. On the other hand, in their research, Baron et al. (2017) compared bilateral communication and public communication. They found that the majoritarian allocation—completely excluding one of the group members—is more likely with bilateral communication, whereas universal allocation—whereby all three team members receive equal share—is more likely with public communication. Our results echo the findings yielded by these bargaining studies by suggesting that private communication causes more collusion and unequal allocations than public communication.

Our investigation marks a substantive departure from these bargaining studies in that team efficiency is our main concern, which is absent in legislative bargaining. In our game, team members produce prior to redistributing the team profit, which, as our measure of team efficiency, is endogenous to members' expectations about their gains from the team profit. Thus, our study highlights the importance of the interplay between team efficiency and profit redistribution.

3 Experimental Design

3.1 Basic Setup and Theory Prediction

The basic game adopted in our study is based on the experiment conducted by Dong et al. (2019). In each round, participants were assigned to groups of three and were asked to make two decisions:

Investment Decision: Players were endowed with 10 Experimental Currency Units (ECUs) at the beginning of each round. Each participant had to decide independently how many ECUs, e_i, to contribute to a group project, keeping any remainder.

Allocation Decision: After all players had made their investment decisions, ECUs in the group project were summed up and multiplied by 1.8, i.e., $\Pi = 1.8 \cdot \sum_{i=1}^{3} e_i$. Players were informed of other group members' individual investments and the total value of the group project. Next, they decided how to divide $\frac{1}{3}\Pi$ between the *other* two group members. That is, each player i decided on an allocation of a_{ij} to player j and a_{ik} to player k, where $a_{ij} + a_{ik} = \frac{1}{3}\Pi$. A player could divide this amount in anyway she liked as long as full $\frac{1}{3}\Pi$ was allocated to others.

Player i's share of the group profit in each round was thus equal to the amount received from the other two group members, that is, player i's earnings in that round were $\pi_i =$

$10 - e_i + a_{ji} + a_{ki}$. At the end of each round, players were informed about the contributions and earnings of all group members.

The game described above has multiple subgame perfect equilibria (SPEs) because a player's allocation decision cannot affect her own payoff in any way. Thus any allocation decision can be part of an SPE. For example, if every player allocates equally between the other two players irrespective of their investment decisions, each individual will best respond by investing nothing. This strategy profile is an SPE in this game. However, some intuitive allocation rules can lead to an SPE in which all players fully invest and each earns 18 ECUs, i.e., *full investment equilibrium.* For example, they could allocate proportionally to the other player's relative investment (Konow 2000; Cappelen et al. 2007; Baranski 2016; Dong and Huang 2018), or could allocate everything to one of the players who invested a greater amount (see Dong et al. 2019 for a complete theoretical analysis of this full investment equilibrium). Lab participants in previous experiments frequently used these rules, leading to high overall investment.

Many other outcomes can be sustained as SPEs. Of specific interest for the present investigation is a strategy profile in which two players collude by allocating their entire assigned share ($\frac{\Pi}{3}$) to each other. Consequently, the third player who receives nothing (as she cannot allocate anything to herself) will best respond by investing nothing. In this case, the colluding members receive the same expected payoff (18 ECUs) as in the full investment equilibrium. Hence, playing the *collusion equilibrium* is no more profitable for the two colluding members than playing the full investment equilibrium. While this kind of collusive behavior was rarely observed in the experiment conducted by Dong et al. (2019), in the present study, we adopted various communication conditions under which collusion may or may not arise. Our hypothesis was that communication serves as a coordination device, and different communication structures can make one of the two SPEs (i.e., full investment equilibrium or collusion equilibrium) focal. It is worth noting that, empirically, if two colluding members invested fully and the third player invested non-zero amount, the colluding members could in principle earn more than 18 ECUs. Thus, collusion, albeit inefficient, can yield some short-term benefit for the colluders. Still, efficient full cooperation is easy and intuitive to achieve. If we observe detrimental effects of communication in this robust environment, it is a stronger result than if they occur in an already fragile situation which features explicit monetary incentives to collude in equilibrium.

3.2 Matching Protocol

We commenced our investigation by first investigating the effect of asymmetric or exclusionary communication. To bolster its potential effect, we created asymmetry among three players in the matching protocol, which is used for all main treatments (in Section 4.1.4 we will discuss the validity of this asymmetric matching for answering our research question and will present supporting evidence from a set of robustness treatments using the standard symmetric matching protocol). In each session, participants were randomly assigned to the role of Person A, Person B or Person C at the beginning of the experiment. Therefore, in each session, a third of the participants played the role of Person A, Person B, Person C, respectively. Their roles were *fixed* for all rounds throughout the experiment. Moreover, Persons A and B were designated as *partners* and they were always paired in the same group for the entirety of the experiment, while Person C was *the loner* and she was matched with a different pair of partners in different rounds, without encountering the same pair more than once. Such asymmetric matching captures the nature of certain organizational situations in which senior employees, whose ties have been strengthened through repeated interactions, might collude against newcomers by assigning them disproportionally heavy workloads. They might also exclude newcomers from important conversations on corporate strategies and profit sharing plans.

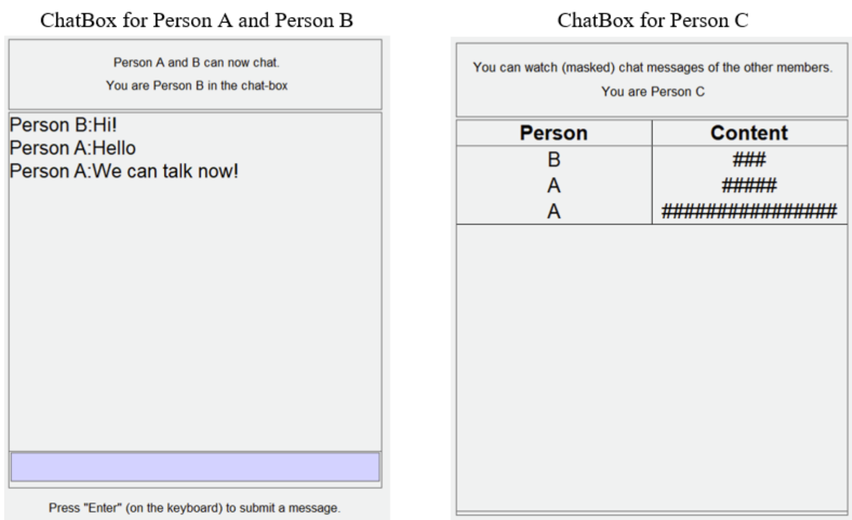
3.3 Treatments

3.3.1 Baseline No Communication Treatment

For the baseline *No Communication* (or NoCom) treatment, we adopted the asymmetric matching protocol described earlier. The game was repeated for eight rounds and no communication was allowed between any group members.

3.3.2 Private (Exclusionary) Communication Treatment

Figure 1: Screenshot of the private chatbox



Notes: The left panel shows the private chatbox the partners could use to communicate, while the right panel shows what the loner saw. The hashtag string length equals the message length, including spaces and punctuation.

In the *Private Communication* (or PrivCom) treatment, based on the NoCom design, the partners were allowed to utilize a private communication channel. At the beginning of each round, the partners had 90 seconds to send free-form messages to each other. Whenever a message was exchanged between the partners, the loner saw a string of hashtags corresponding to the message length (including spaces and punctuation). Figure 1 shows a sample screenshot of private communication. As a result of this feature, the loner was aware that the other two group members were talking behind her back whenever hashtags appeared on the screen. In another private communication treatment, the partners are actual friends outside the lab and the loners were aware of that. Since the results from these two treatments were very similar, they are not distinguished here and are simply referred to as PrivCom.

In sum, in PrivCom, the loner was excluded from the partners' repeated interactions and their private communication. Hence, a comparison with the NoCom treatment allows us to *causally* identify the effects of exclusionary communication on collusion and cooperation. We hypothesized that, if the partners can talk behind the loner's back, the outcome will be closer to the collusion equilibrium than the full investment equilibrium.

3.3.3 Private and Public Read-Only Treatment and All-Channels Communication Treatment

The first two treatments were designed to test how exclusionary communication affects team efficiency. For that purpose, we deliberately isolated confounding factors such as the capacity to engage in public communication. Yet, the partners might want to reach out to the loners to encourage them to contribute to team production, and the loners might also want to participate in team conversation to pledge allegiance or persuade the partners to give them their fair share. Allowing communication in a public sphere can potentially promote team productivity and restore fair allocation. On the other hand, the partners might continue to collude and even play tricks on the loner by asking her to contribute to the team profit only to later distribute all proceeds among themselves. We thus introduced two additional treatments featuring public communication, whereby the first allowed the partners to reach out to the loner, and the second permitted the loner to fully engage in team communication.

The first treatment, the *Private and Public Read-Only* (or PubReadOnly) treatment, is based on the same protocol as PrivCom, except that the partners could either chat in a private channel, in a public channel, or in both. To facilitate comparison with the PrivCom treatment, public communication was read-only for the loner and its sole purpose was to allow the partners to reach out to the loner. For example, the partners may use it to persuade the loner to invest more in the group project and they may make real or fake promises of fair allocation. We want to know whether providing such an opportunity will improve team efficiency.

In the second treatment, denoted as the *All-Channels Communication* (or AllChanCom) treatment, we opened both private and public communication channels for *all* group members. Each player could choose to send messages via a public channel in which all players could read and send messages, or via each of the two private channels in which only the targeted member could read and send messages. In line with the PrivCom design, whenever a message was exchanged in a private channel, the untargeted member received a string of hashtags. This is the *only* treatment in which the loner could send messages to the partners (privately and publicly). Note that, with the exception of the asymmetric matching protocol adopted at the outset of the experiment, AllChanCom is otherwise completely symmetric with respect to players' communication opportunities. Table 1 (panel a) summarizes the experimental design of our main treatments.

Table 1: Experimental design

(a) Main Treatments	**Matching Protocol**	**Communication Mode**	**No. of Participants**
NoCom	Asymmetric	No Communication	96
PrivCom	Asymmetric	Private chatbox for partners	216
PubReadOnly	Asymmetric	Private *and* public chatboxes for partners	90
AllChanCom	Asymmetric	Private and public chatboxes for *all* players	96
(b) Robustness Treatments			
SymNoCom	Symmetric	No Communication	72
SymCom	Symmetric	Private chatbox for partners	96
HalfCom	Asymmetric	Private chatbox for *50%* partners	96

Notes: In all treatments except SymNoCom, each session consisted of 24 participants, interacting for 8 rounds. Each session of SymNoCom consisted of 18 participants. Since only 21 participants took part in two sessions of PubReadOnly, in these two sessions, 7 pairs of partners and 7 loners interacted for 7 rounds.

3.4 Procedures

The experiment was conducted at the Monash Laboratory for Experimental Economics (MonLEE) with students recruited from a university-wide subject pool using the online recruitment software SONA. The experiment, programmed in z-Tree (Fischbacher 2007), included a total of 498 participants in 21 sessions.

Participants were randomly assigned to partitioned computer terminals upon arrival. The experimental instructions (see Online Appendix A) were provided to each participant in paper form and were read aloud by the experimenter. The experiment started once all participants answered their comprehension questions about the instructions. At the end of each session, participants completed a post-experiment survey including demographic questions. Participants were then privately paid AU$1 for every 8 ECUs they accumulated plus AU$5 for taking part in the study (with decimals in the final amount rounded to the nearest tenth). They left the laboratory one at a time. A typical session lasted about one hour with average earnings of AU$21.8 (16.8 USD).

4 Experimental Results

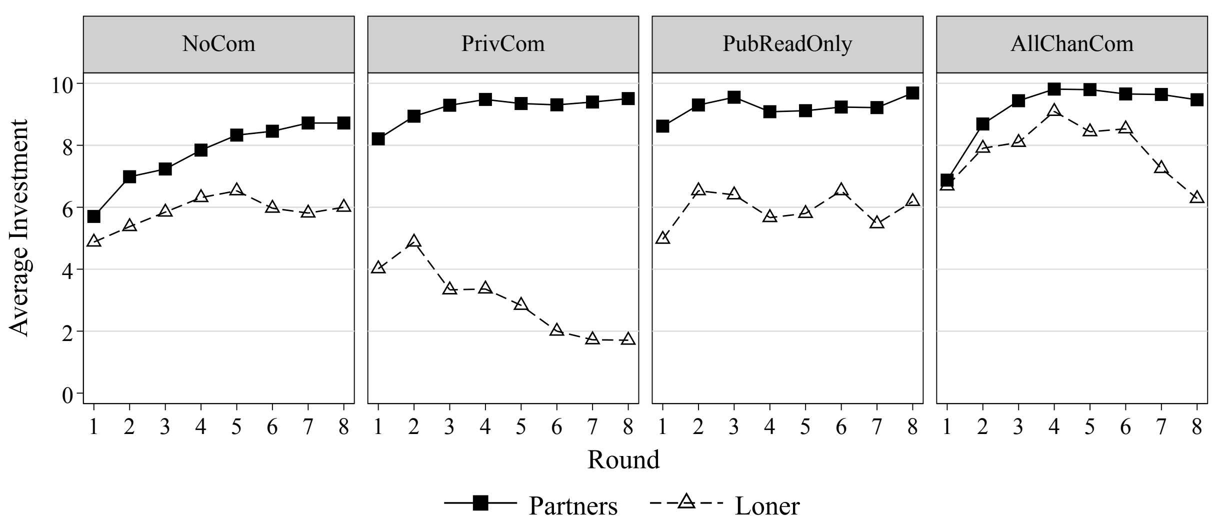
We begin our analysis by studying how exclusionary communication affects investment and allocation (Section 4.1). We then explore the effect of the additional public communication opportunity (Section 4.2). Finally, we briefly summarize our analyses of communication messages to elucidate how different communication structures affect collusion and investment (Section 4.3).

4.1 No Communication and Private Communication

4.1.1 Investment

Figure 2 shows the average investment over eight rounds. In the baseline NoCom treatment, the loner invested less than the partners in every round (5.84 vs. 7.75, $p < 0.001$, all p values in this subsection are produced from the panel data regression of the partners' and loner's investment difference reported in column 3 of Table B1 in Online Appendix B).[3] When the partners could communicate privately, the loner invested even less, only about a third of the partners' investment: 2.98 vs. 9.18 in PrivCom ($p < 0.001$). Of particular interest are the loners' investment decisions in the first round, as the investment gap between the partners and the loners was negligible in NoCom ($p = 0.15$) but significant in PrivCom ($p < 0.001$). This result may suggest that the loner, aware that the partners could "talk behind her back," anticipated exploitation and thus invested less in the first round, even without experiencing exploitation. While most partners (83.3%) invested fully in PrivCom, only 15.1% of loners made full investments; in fact, 49.6% of the time, loners made no investment (see Figure 3). Compared to NoCom, the investment gaps between the partners and the loner were significantly greater in PrivCom ($p < 0.001$). These results suggest that the partners' capacity to talk behind the loner's back was detrimental to team cooperation.

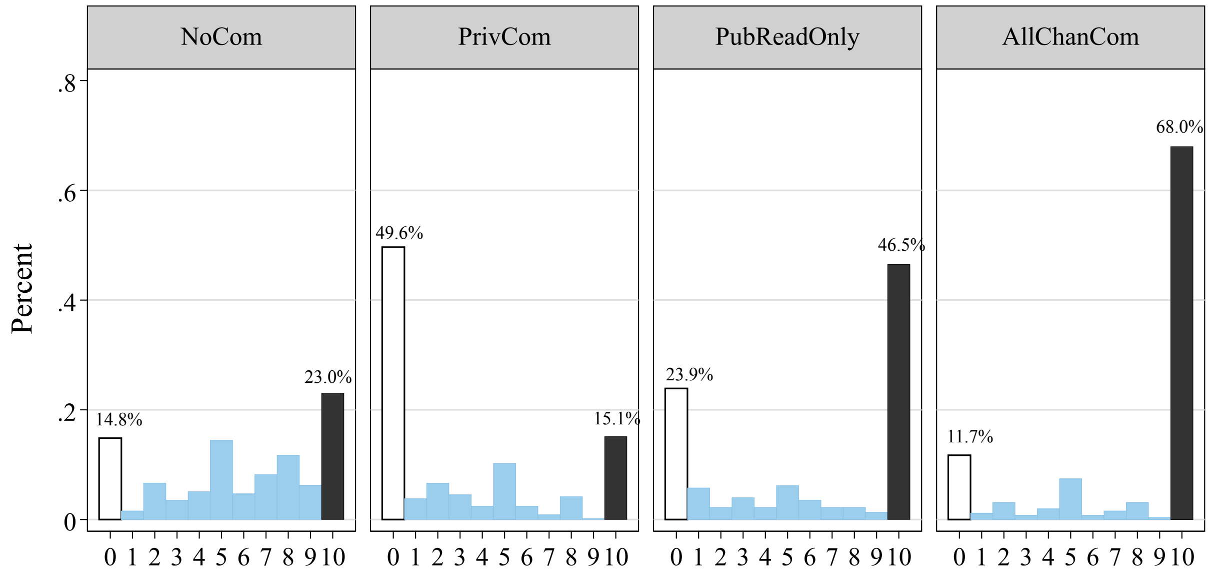
Figure 2: Time-path of the average investment by treatment



Result 1. *The loner invested significantly less than the partners. When the partners could*

[3]Table B1 also reports panel data regressions of the partners' investment and the loner's investment as well as treatment comparison test results.

Figure 3: Distribution of the loner's investment



communicate privately, the investment gap widened, as the loner invested only about one third of the partners' investment.

4.1.2 Partners' Allocations

Why did the loner underinvest? Did the partners collude against the loner? To answer these questions, we estimated a random effects regression model of partners' allocation decisions, whereby the relative share of the group profit player i allocates to her partner j was the dependent variable, and the independent variable was j's investment relative to the loner k:

$$\frac{a_{ij}}{a_{ij} + a_{ik}} = \beta_0 + \beta_1 \frac{e_j}{e_j + e_k} + \varepsilon_i$$

In this specification, β_0 represents a fixed amount of the share allocated to j, regardless of j's relative investment, and β_1 denotes the proportional share based on j's investment relative to k. Under the proportional allocation, players allocate strictly according to others' relative investment, i.e., $\beta_0 = 0$ and $\beta_1 = 1$. At the other end of the spectrum, players allocate everything to their partner regardless of the relative investment (signifying full collusion), i.e., $\beta_0 = 1$ and $\beta_1 = 0$. In the intermediate case where the partners partially collude, they reserve a fixed share, β_0, where $0 < \beta_0 < 1$, to one another, and allocate less than proportionally ($0 < \beta_1 < 1$). A pair of larger β_0 and smaller β_1 indicates a greater degree of favoritism from player i to her partner j. Note that as β_0 increases β_1 naturally decreases and vice versa. Hence, this pair of parameters captures the degree of favoritism in the partners' allocation decisions.

The model estimates are provided in Table 2. As can be seen from the data, in both NoCom and PrivCom treatments, β_0 is significantly higher than zero ($p < 0.001$), indicating that a positive fraction of the group profit was received by the partner regardless of the partner's relative investment. The estimated fraction was 34.6% in NoCom, increasing to 63.6% in PrivCom, indicating stronger favoritism when the partners could communicate privately. The interactions between treatment dummies and the relative share to the partner reported in the last column in Table 2, further show that private communication led to fewer proportional allocations than NoCom: the coefficient estimate of PrivCom $\times \frac{e_j}{e_j+e_k}$ is significantly negative, indicating smaller β_1 for PrivCom, whereas the coefficient estimate of PrivCom is significantly positive, indicating larger β_0 for PrivCom.

Favoritism, which can be only unilateral, does not necessarily imply collusion. Adopting the terms defined in the regression model, we use $\frac{a_{ij}}{a_{ij}+a_{ik}} - \frac{e_j}{e_j+e_k}$ to measure the degree of favoritism a partner showed to the other. We then estimated the correlation between the favoritism each of the partners shows to the other using a random effects regression. To avoid double counting, for each pair of partners, we randomly selected one of the partners' favoritism measure as the dependent variable while treating the favoritism measure of the other partner in the pair as the independent variable. If favoritism is only unilateral, that is, only one partner favored the other partner in allocation, the correlation should be zero. On the other hand, if favoritism is mutual, which would imply collusion, the correlation should be one. Furthermore, if collusion is stronger when the partners communicate privately, the correlation should be stronger in PrivCom relative to NoCom. Our findings revealed that the partners' degrees of favoritism were highly correlated in both NoCom ($r = 0.416, p < 0.001$) and PrivCom ($r = 0.777, p < 0.001$). The regression in which the interaction between treatment dummies and the favoritism measure is also included also shows that the correlation in PrivCom was significantly stronger than in NoCom ($p = 0.001$). Hence, favoritism in allocation was the result of collusion between partners, and collusion was more severe when the partners were permitted to communicate via private channel.

To further support the claim that the partners' unfair allocations caused the loner's low investment, we estimated a random effects regression to determine how the way the loner was treated in the previous round affected her investment in the current round. In this regression model, one round change in the loner's investment was the dependent variable, while dummies indicating how much the loner received in the previous round (from a different pair of partners) served as the independent variables, with the following values: "Receive nothing," "Receive less than proportional share" (but not nothing), and "Receive more than proportional share" ("Receive a proportional share" serves as the benchmark). The estimates are reported in Table 3, revealing that receiving less than proportional share (or nothing) from the partners had no significant impact on the loner's next round investment in NoCom, but had significantly negative effects in PrivCom. However, receiving more than proportional share did not significantly increase the loner's investment in the next round in either treatment. These results provide further evidence for the adverse impact of the "talking behind one's back" environment on the loner's investment by highlighting that the loner's investment was more negatively affected by the partners' private communication even in response to the same allocation behavior of the partners.[4]

[4]In Table B2 in Online Appendix B, we report a similar regression analysis for the partner's investment, showing that the partners' investments were largely unaffected by how they were treated by their partner or by the loner in the previous round.

Table 2: Random effects model on the share allocated to the partner

Dependent variable:	Share allocated to the partner $\frac{a_{ij}}{a_{ij}+a_{ik}}$				
Treatments:	NoCom	PrivCom	PubReadOnly	AllChanCom	Pooled
β_1: Partner's relative	0.602***	0.349***	0.488***	0.760***	0.603***
investment $\frac{e_j}{e_j+e_k}$	(0.037)	(0.041)	(0.073)	(0.048)	(0.033)
PrivCom $\times \frac{e_j}{e_j+e_k}$					-0.259***
					(0.053)
PubReadOnly $\times \frac{e_j}{e_j+e_k}$					-0.112
					(0.072)
AllChanCom $\times \frac{e_j}{e_j+e_k}$					0.154***
					(0.053)
β_0: Constant	0.346***	0.636***	0.461***	0.238***	0.346***
	(0.033)	(0.038)	(0.057)	(0.030)	(0.029)
PrivCom					0.295***
					(0.048)
PubReadOnly					0.113*
					(0.058)
AllChanCom					-0.106***
					(0.039)
H0: β_1 PrivCom=PubReadOnly					$p = 0.053$
H0: β_1 PrivCom=AllChanCom					$p < 0.001$
H0: β_1 AllChanCom=PubReadOnly					$p < 0.001$
H0: β_0 PrivCom=PubReadOnly					$p = 0.004$
H0: β_0 PrivCom=AllChanCom					$p < 0.001$
H0: β_0 AllChanCom=PubReadOnly					$p < 0.001$
Clusters	4	9	4	4	21
Observations	512	1152	452	512	2628

Notes: This table uses random effects models to estimate a player's allocation to her partner. Loners' allocations are excluded. In the last column, NoCom serves as the base category. * and *** denotes 10% and 1% significance levels, respectively. Standard errors are clustered at the session level.

Finally, it is worth noting that the loner was more likely to allocate in an all-or-nothing manner (i.e., one partner received everything and the other received nothing) in PrivCom than in NoCom (39.6% vs. 9.6%), even when the partners invested the same amount. More detailed analyses can be found in Online Appendix E. These findings may suggest that the loner tried to "punish" one of the partners even though this would not have any bearing on her own profit. However, such loner's allocation behavior made the partners' collusion more risky, leading to higher variation in earnings among team members. Hence, the partners' collusion not only discouraged the loner's cooperation in team production but also encouraged the loner to deviate from the fairness norm in profit allocation. Both effects could be detrimental to rebuilding trust and trustworthiness between the partners and the loner.

Table 3: Share received in the last round and the one round change in loner's investment

Dependent variable:	One round change in loner's investment			
Treatment:	NoCom	PrivCom	PubReadOnly	AllChanCom
Receive nothing	-1.227	-3.208***	-2.664***	-1.431
	(1.315)	(0.313)	(0.959)	(0.994)
Receive less than proportional	-0.573	-1.447***	-1.615**	0.104
	(0.375)	(0.273)	(0.732)	(0.560)
Receive more than proportional	0.106	-0.189	5.681***	3.186**
	(0.369)	(0.231)	(1.169)	(1.411)
Constant	0.477***	0.780***	0.764***	0.014
	(0.119)	(0.136)	(0.266)	(0.355)
Cluster	4	9	4	4
Observations	224	502	196	224

Notes: This table uses random effects models to estimate how the way a loner was treated in the previous round affected her one round change in investment. ** and *** denote 5% and 1% significance levels, respectively. Standard errors are clustered at session level.

Result 2. *Compared to the no communication treatment, exclusionary private communication resulted in more collusion between the partners. The loner's low investment was the* *result of receiving less than proportional share of the group profit from the partners.*

4.1.3 Earnings

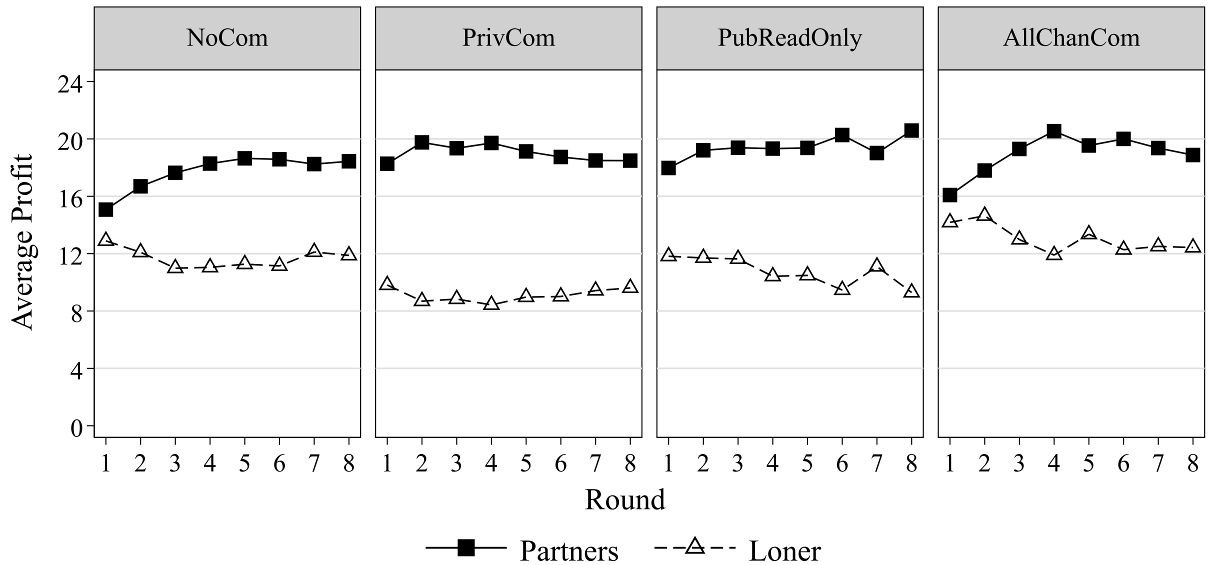
As the loner underinvested when the partners colluded, as would be expected, she earned significantly less than the partners. In NoCom, the loner on average earned 11.65 ECUs while the partners earned 17.59 ($p < 0.001$, the p value is produced from the panel data regression of the partners' and loner's earning difference reported in column 3 of Table B3 in Online Appendix B).[5] As shown in Figure 4, the earnings gap widened in PrivCom, whereby the loner earned less than half of the partners' earnings (9.02 vs. 19.06, $p < 0.001$, as shown in column 3 of Table B3). It is worth noting that the partners' empirical earnings are higher than 18 ECUs which is their theoretical payoff in the collusion equilibrium, suggesting that the partners exploited the loner's sub-optimal non-zero investment. Indeed, the partners earned significantly more in PrivCom than in NoCom (19.06 vs. 17.59, $p < 0.001$, as shown in column 1 of Table B3).

When we calculated the percentage of investments resulting in a positive return (i.e., those in which the share received was greater than the amount invested), the partners' investment almost always yielded positive returns ($> 96\%$, see Table 4). By contrast, the loner received a positive return in only 65.2% of the rounds in NoCom and the percentage declined to 20.3% in PrivCom. When private communication between the partners was permitted, about one-third of the time loners received a negative return on their investment (i.e., the share received was less than their invested amount), whereas almost no partner received a negative return.

Result 3. *The loner earned significantly less than the partners. Due to exclusionary communication between the partners, the earnings gap widened, as the loner only earned half of what the partners earned. In a significant proportion of rounds, loners realized negative return on their investment.*

[5] Table B3 also reports panel data regressions of the partners' earnings and the loner's earnings separately with treatment dummies as independent variables.

Figure 4: Time-path of the average profit by treatment



4.1.4 Replication and Robustness Treatments

When interpreting the results reported in the preceding sections, it is important to note two potential issues arising from the experimental design. First, in our main treatments, the asymmetric matching protocol might have promoted formation of social ties between the partners, which might have triggered or amplified the exclusionary communication effect on collusion. While in reality social ties and exclusionary communication are often defining features of “talking behind one’s back” situations, the scientific question is whether, in the absence of social ties, exclusionary communication could still cause collusion.

To answer this question, we replicated the symmetric random matching setting originally studied by Dong et al. (2019) and introduced two new treatments (SymNoCom and SymCom) that resemble the communication structure in NoCom and PrivCom, respectively. SymNoCom (SymCom) differs from NoCom (PrivCom) only in that groups were randomly rematched in every round in a symmetric manner. Specifically, in SymNoCom, each participant was randomly assigned to the role of Person A, B or C at the beginning of

Table 4: Investments and returns

	Positive Returns		Negative Returns	
Treatment	Partners	loner	Partners	loner
NoCom	96.5%	65.2%	2.1%	24.6%
PrivCom	97.4%	20.3%	1.6%	33.7%
PubReadOnly	96.0%	45.6%	2.4%	33.2%
AllChanCom	97.7%	66.4%	2.1%	22.3%

the experiment with equal probabilities and assumed that role in all rounds. In each round, a trio of Person A, B and C was randomly assigned to a group. Importantly, in contrast to NoCom, we ensured that the same Person A and Person B would never be paired up more than once (thus ensuring that Person C would always encounter a new A & B pair). SymCom differs from SymNoCom only in that in each group Person A and B could privately converse for 90 seconds at the beginning of each round and Person C only saw a string of hashtags masking the messages exchanged between A and B. We conducted four sessions for each of the two new treatments as well as replicated two sessions for both NoCom and PrivCom. Table 1 (panel b) summarizes the experimental design of all robustness treatments. The new sessions were run at Nanjing Audit University with a total of 264 participants. Each session lasted about one hour with average earnings of 55 Chinese Yuan (8.1 USD).

As can be shown from Figure B1 and Table B4 in Online Appendix B, we successfully replicated NoCom and PrivCom: in both replication treatments the loner invested less than the partners and this difference was significantly larger in PrivCom than in NoCom ($p < 0.001$). We also successfully replicated SymNoCom and found that average investment increased to almost the full level over rounds. By contrast, in the new SymCom treatment, as in PrivCom, the loner invested less than the partners ($p < 0.001$). Importantly, in PrivCom (using replication data) and SymCom, which only differed in the matching protocol, the investment gaps between the partners and the loner were not significantly different

($p = 0.581$). Table B5 in Online Appendix B further shows that the partners' allocations to each other in SymCom did not differ significantly from those in PrivCom. These results strongly suggest that exclusionary communication led to collusion even in the absence of social ties between the partners.

The second concern relating to our design is that the mere presence of a private communication channel (and the loner's ability to see the hashtags masking the messages exchanged) might have prompted the partners to believe that the loner would suspect collusion and thus they would talk and act according to her perceptions. In other words, the partners might be less likely to collude if the loner were unaware of the presence of the private channel, because they would be less concerned about her perceptions. Consequently, such condition could serve as a test of the limits of the exclusionary communication effect on the loner's underinvestment and the partners' collusion.

To this end, we implemented another treatment, denoted as HalfCom, in which the loner only knew that there was a 50% chance that the partners had access to a private communication channel. As in the main experiment, partners were paired up for the entirety of the experiment, while loners were matched with a different pair of partners in each round and they would never meet the same pair of partners more than once. Moreover, four pairs of partners in each session could not communicate throughout the experiment, just as in NoCom, while the remaining four pairs could use the private channel in every round, in line with PrivCom. As channel allocation to the partners was not disclosed to the loners (due to which the hashtag feature of the original design was eliminated), in each round, there was a 50% chance of matching with a pair of partners who could communicate. This treatment consisted of four sessions, which were run at Nanjing Audit University with a total of 96 participants.

Figure B2 and Table B6 in Online Appendix B show that the loner's investment in HalfCom (irrespective of whether the partners could communicate) was significantly lower than that in NoCom (using replication data, $p < 0.05$), but was not significantly different from that in PrivCom (using replication data, see the first two hypothesis test results at the bottom of Table B6). The investment gap between the partners and the loner shows consistent results: the investment gap in HalfCom was significantly higher than that in NoCom ($p < 0.01$) but was not significantly different from that in PrivCom (see the first two hypothesis test results at the bottom of Table B6). Thus, even when the loner was unsure if the partners were able to talk behind her back, she behaved with the presumption of collusion. However, our findings revealed that the partners did not exploit the loner as much as in PrivCom. Table B7 in Online Appendix B shows that the partners' allocations to each other in HalfCom did not significantly differ from those in NoCom, but were (marginally) significantly fairer than those in PrivCom (see the hypothesis test results at the bottom of Table B7). According to these findings, the mere possibility of exclusionary communication was sufficient to discourage the loner from investing, yet the partners did not exhibit any additional propensity to collude relative to the baseline NoCom treatment. This is also consistent with our earlier finding that, in PrivCom, loners already invested less than partners in the first round before experiencing any unfair treatment.

4.2 Public Communication

The results reported thus far indicate that private communication damaged team cooperation. The partners colluded against the loner by allocating more than proportional shares to each other. As a result, the loner underinvested and earned less than the partners. This prompted us to investigate whether public communication helps the team ameliorate this collusive situation.

In PubReadOnly, the partners could send messages via a public channel to reach out to the loner, who could not respond. We found that the loners invested more in this treatment compared to PrivCom (5.93 vs. 2.98, $p < 0.001$, see Figure 2 and Table B1 in Online Appendix B), and that about half of the time (46.5%) they made a full investment (see Figure 3). The partners' investment was, however, very similar (9.20 vs. 9.18, $p = 0.942$).

Thus, the investment gap between the partners and the loner was significantly smaller in PubReadOnly than in PrivCom ($p < 0.001$), though still larger than in NoCom ($p = 0.052$).

In AllChanCom, the loner could send messages either privately or publicly to the partners and vice versa. The loner on average invested 7.79, and made full investment about 68.4% of the time. In fact, the loner's investment in AllChanCom was significantly higher than any other main treatments (ps < 0.003). Further, while the loner still invested significantly less than the partners (7.79 vs. 9.17, $p < 0.001$), the investment gap was similar to that in NoCom ($p = 0.203$).[6]

Result 4. *Compared to* PrivCom*, in* PubReadOnly *in which the partners could reach out to the loner via a public channel, the loner invested a greater amount. When the loner could also send messages back (*AllChanCom*), the invested amount was even higher.*

To ascertain whether the partners treated the loner fairly in allocation decisions when all three had access to public communication, We revisit Table 2, which shows that compared to PrivCom, β_1 in PubReadOnly was significantly larger and β_0 was smaller, indicating that the partners allocated more proportionally when they could reach out to the loner than when they could not (see hypothesis tests of β_1 and β_0 at the bottom of Table 2). Compared to PubReadOnly, β_1 increased significantly and β_0 decreased in AllChanCom. This result suggests that including the loner in group communication led to still fairer profit allocations. In fact, among all main treatments, allocations to the loner were fairest in AllChanCom.

Further, Table 3 shows that, similar to PrivCom, in PubReadOnly, the loner lowered her investment when she received nothing or less than proportional share in the previous round. In AllChanCom, however, unfair allocations did not appear to discourage the

[6] It is worth nothing that the loner's investment noticeably dropped in the last two rounds after a steady climb in previous rounds. However, focusing on the loner's one round change in investment in the last two rounds (the same regression as Table 3), we did not find that their investment changes were significantly correlated with the way they were treated in previous rounds. While noting that the evidence is only suggestive given the low number of observations in the last two rounds ($N = 64$), the drop might be mainly driven by the loner's anticipation that the partners would exploit them in the last few rounds.

loner from investing. Importantly, in contrast to PrivCom, the loner invested more in PubReadOnly and AllChanCom when she received more than her proportional share in the previous round. These results indicate that the loner tended to place more trust in the partners to treat her fairly when public communication was allowed. Being treated more fairly not only encouraged loners to invest more, but also reduced their propensity to allocate in the all-or-nothing manner that was observed frequently in PrivCom (see Online Appendix E for more detail). Both effects on loners' behavior could be valuable for building trust and establishing harmony among team members.

Turning to the earnings, as can be shown from Figure 4 and Table 4, the loner earned significantly more when public communication was permitted compared to PrivCom (PubReadOnly vs. PrivCom: 10.38 vs. 9.02, $p < 0.001$; AllChanCom vs. PrivCom: 13.03 vs. 9.02, $p < 0.001$, see Table B3 in Online Appendix B). Moreover, the loner was more likely to receive positive returns when allowed to partake in public communication (45.6% of the time in PubReadOnly and 66.4% in AllChanCom). Nevertheless, loners' investments yielded negative returns 33.2% of the time in PubReadOnly and 22.3% of the time in AllChanCom (the latter was similar to NoCom). The earnings gap between the loner and the partners narrowed, though it still remained significant (PubReadOnly: 10.38 vs. 19.32, $p < 0.001$; AllChanCom: 13.03 vs. 18.94, $p < 0.001$). The earnings gap in AllChanCom was, however, not significantly different from that in the baseline NoCom treatment ($p = 0.854$). This finding suggests that access to a private communication channel facilitates collusion between the partners whereas the public channel alleviates it.

Finally, it is worth noting that, while participation in public communication ensured that loners were treated more fairly and earned more, it did not completely eliminate exploitation. In particular, public communication channels created new risks as they allowed for new deceptive practices, such as partners making fake promises to the loner. We discuss this further in the next section and in Online Appendix D.

Result 5. *Compared to the private communication treatments, the partners allocated more* *proportionally when they could talk to the loner. When the loner could participate in the communication, the partners allocated even more proportionally. The loner earned significantly more in the public communication treatments than in the private communication treatments.*

4.3 Summary of Analysis of Conversations

The behavioral data have provided important insight into both partners' and loners' motivations. We thus analyzed the communications that took place to corroborate the above results and offer additional insights. The messages exchanged in each treatment were coded by a different pair of research assistants using a predefined codebook (reproduced in Online Appendix C). Here, we only summarize key findings and relegate detailed reports to Online Appendix D.

First, in PrivCom, the partners exchanged messages about 95% of the time, which in more than 50% of cases pertained to allocating the funds unfairly to the loner. When the public channel became available, the partners started to use both private and public channels. They talked privately about unfair allocations less often and suggested fair allocations about 69% of the time in public conversations. In 15% of the cases, however, the partners conspired against the loner by asking her to invest high amounts while talking privately about unfair allocations. These patterns were generally consistent with the earlier observation that allocations were fairer in public than in private communication treatments. The findings also confirmed our earlier assertion that public communication allowed the partners to deceive the loner by making fake promises.

Second, as expected, the volume of the partners' private conversations negatively affected the loner's investment, especially in PubReadOnly. Unsurprisingly, in this treatment, the loner's investment was positively correlated with the partners' suggestion of fair allocation and high investment in the public channel. In AllChanCom, the loner's own suggestion of fair allocation and high investment in the public channel was correlated with her higher investment. The content of the partners' private conversations was largely consistent with their actual allocation decisions. Interestingly, in this treatment, their public conversations did not correlate with their allocation decisions. Given that fair allocations were common in this treatment, this may imply that fair allocations might already be considered as a norm when every group member could freely converse with one another.

5 Conclusion

With a few exceptions, prior experimental studies consistently indicate that communication helps participants to coordinate to attain a Pareto efficient outcome. However, our findings suggest that communication can be detrimental to team cooperation if communication channels are not open to all team members. In our main experiment, we ensured that the same pair of connected agents (referring to partners in our experimental design) would encounter a different isolated agent (referring to loner) in each round. This repeated interaction between the connected agents even without communication opportunities already discourages isolated agents from cooperation. Nevertheless, exclusionary communication between the connected agents exacerbated collusion in profit allocation and further undermined the isolated agent's incentive to cooperate. Our robustness treatments revealed that the detrimental effect of exclusionary communication remained strong even without the repeated interaction between the connected agents. Furthermore, the mere expectation of exclusionary communication (even if absent in reality) was sufficient to discourage isolated agents from cooperation. All these findings consistently show that exclusionary communication or the expectation/perception of such communication can be harmful for harmony, trust, and cooperation in teams.

Our findings also show that cooperation can be partially restored by including the isolated agent in the connected agents' communication. In particular, the mere opportunity for the connected agents to talk to the isolated agent without allowing the latter to respond already helps rebuild trust between the connected agents and the wary isolated agent, leading to better cooperation and fairer profit allocation. Further, allowing all team members to talk both privately and publicly to one another moves the team in an even more desirable direction. However, all these efforts do not completely eliminate exploitation, as access to public communication channels allow connected agents to adopt deceptive practices, such as making fake promises to the isolated agent while plotting against her in the private channel. Therefore, it remains to be established if more effective communication channels or other mechanisms would counteract the effects of such collusive motivations.

Of particular interest to the organizational managers is our finding that the way communication is organized affects team cooperation and thus output. Achieving harmony at the workplace is not a trivial task, especially in teams comprising members with different personalities, backgrounds, and world views. Some members are naturally sociable and can easily form social bonds while others linger outside certain social cohorts. As our experiment has shown (by comparing NoCom and SymNoCom), such social ties, even without communication, already have a negative impact on team cooperation. Therefore, to promote cooperation, managers may need to actively monitor team communication flows, ensuring that no one feels excluded from important information exchanges. This is particularly relevant for the growing number of organizations relying on telecommunication systems derived from social media, such as Slack or Workplace. Numerous studies have shown that higher degree of social distance reduces prosociality and expectations of reciprocity (e.g., Hoffman et al. 1996; Chen and Li 2009). The remote online working environment may create higher expectations and/or more occurrences of collusive talks and actions with minimal risk of being detected. It may also be harder for administrators to fine-tune communication modes remotely to alleviate this problem.

A more positive implication of our findings is that connected agents do not endogenously choose to exclude the isolated agent from talks or behave unfairly as much as they can when public communication channels are available. It thus seems that connected agents do put some value on the involvement of other members, often to the benefits of all members, albeit sometimes for purely selfish purposes. Although beyond the scope of the present study, it would be valuable to further investigate the heterogeneity in connected agents' motivations under these circumstances. If managers were equipped with this knowledge, they could use more appropriate managerial measures to promote valuable motivations (e.g., fairness and mutual trust) and suppress harmful ones (e.g., exploitation and deception).

In large organizations' communication networks, and more generally in global social media, users are at liberty to decide which channels to follow, unfollow, block or mute. This freedom of choice provides an opportunity to extend the present study, in which communication channels were exogenous, as the sole aim was to establish casual inferences, while focusing on small teams. Though our AllChanCom treatment offers a glimpse into the endogenous emergence of communication channels, it is not clear how this translates into larger networks, where it is simply not possible for everybody to talk (and listen) to everybody else. Finding out whether, and if so how, endogenous channel choice in larger groups can also generate detrimental behind-your-back talking is, though beyond the scope of this study, a promising topic for future research.

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Online Appendix A. Experimental Instructions

[The NoCom *treatment]*

Welcome! You are taking part in a decision making experiment.

You have earned $5 for showing up on time. In addition, you can earn more money in this experiment. The amount of money you earn will depend upon the decisions you make and on the decisions other people make. Your earnings in this experiment are expressed in EXPERIMENTAL CURRENCY UNITS, which we will refer to as ECUs. At the end of the experiment you will be paid IN CASH using a conversion rate of $1 for every 8 ECUs of earnings from the experiment (final payment will be rounded to the nearest 10 cents). Everyone will be paid in private. Please do not communicate with each other during the experiment. If you have a question, feel free to raise your hand, and an experimenter will come to help you.

Your unique Participant ID number is shown on top of your instructions. To ensure anonymity, your actions in this experiment are linked to this Participant ID number and at the end of the experiment you will be paid by Participant ID number.

The experiment consists of 8 decision rounds. In each round, you will be divided into groups of three, so you will be in a group with two other participants. But you will not know which of the other two people in this room are in your group. At the beginning of the experiment, you will be either a Person A, B, or C. Your role will remain the same for the whole experiment.

If you are Person A (or B), you will ALWAYS be grouped with a SAME Person B (or A) for the whole experiment, and you will meet a DIFFERENT Person C from round to round, that is, you will never meet the same Person C again.

If you are Person C, you are to be grouped with DIFFERENT pairs (Persons A and B) from round to round.

In other words, each group consists of a pair of two persons and a different third person in each round.

Each decision round has two phases:

Phase 1: Contribution Choice

Each person is given 10 tokens at the beginning of EACH ROUND in their Individual Fund. Tokens in the Individual Fund are worth 1 ECU each.

Each three-person group begins with a Group Fund of 0 ECU each round. You decide independently and privately whether or not to contribute any of your tokens from your Individual Fund into the Group Fund. Tokens in the Group Fund are worth 1.8 ECU each.

In other words, each token that a person adds to the Group Fund reduces the value of his/her Individual Fund by 1 ECU. Each token added to the Group Fund by a group member increases the value of the Group Fund by 1.8 ECU.

Each person can contribute up to a maximum of 10 tokens to the Group Fund. Decisions must be made in whole tokens. That is, each person can add 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 tokens to the Group Fund.

Three examples illustrate how the tokens added to the Group Fund relate to the value of your Individual and Group Funds.

- If you add 0 tokens to the Group Fund, it means you add 0 ($0 \times 1.8 = 0$) ECU to the Group Fund and 10 ECUs remain in your Individual Fund.
- If you add 5 tokens to the Group Fund, it means you add 9 ($5 \times 1.8 = 9$) ECUs to the Group Fund and 5 ECUs remain in your Individual Fund.
- If you add 10 tokens to the Group Fund, it means you add 18 ($10 \times 1.8 = 18$) ECUs to the Group Fund and 0 ECU remains in your Individual Fund.

You must press the "Calculate" button to see how many ECU will remain in your Individual Fund, once you are ready, you can click the "Next" button to proceed.

Phase 2: Allocation Choice

After all participants have made their decisions for the round, the computer will show the results:

ECUs in Group Fund = 1.8 × (Sum of tokens in the Group Fund)

You then decide how to allocate ONE-THIRD of the ECUs in the Group Fund between the other two group members.

The sum of your allocations between the other two group members will be one-third of ECUs in the Group Fund. In other words, each person can only divide one-third of ECUs in the Group Fund for the other two group members, and their own share of the Group Fund will be determined by the allocation decisions of the other two group members. Specifically,

- Person A will divide one-third of ECUs in the Group Fund between Person B and Person C.
- Person B will divide one-third of ECUs in the Group Fund between Person A and Person C.
- Person C will divide one-third of ECUs in the Group Fund between Person A and Person B.

The other two group members' individual contributions to the Group Fund and their roles will be shown on the upper right table when you are making the allocation choices. Click the calculator button on the lower-right corner if you need assistance with calculation.

Feedback and Earnings

After all participants have made their decisions for the round, the computer will show the results. A person's share of the Group Fund will be determined at the end of phase 2. Your earnings from the Group Fund will be the sum of ECUs that the other two group members allocate to you.

Your Earnings = ECUs in Individual Fund + Your Earnings of ECUs in Group Fund

At the end of each round, you will receive information on your Group Fund earnings and your total earnings for that round. You will also be informed of all group members' contributions to the Group Fund, their allocation decisions and their earnings in ECUs for that round.

Your total earnings for the experiment will be the sum of the earnings in all rounds.

This completes the instructions. Before we begin the experiment, to make sure that every participant understands the instructions, please answer several review questions on your screen.

[The PrivCom, PubReadOnly *and* AllChanCom *treatments]*

Welcome! You are taking part in a decision making experiment.

You have earned $5 for showing up on time. In addition, you can earn more money in this experiment. The amount of money you earn will depend upon the decisions you make and on the decisions other people make. Your earnings in this experiment are expressed in EXPERIMENTAL CURRENCY UNITS, which we will refer to as ECUs. At the end of the experiment you will be paid IN CASH using a conversion rate of $1 for every 8 ECUs of earnings from the experiment (final payment will be rounded to the nearest 10 cents). Everyone will be paid in private. Please do not communicate with each other during the experiment. If you have a question, feel free to raise your hand, and an experimenter will come to help you.

Your unique Participant ID number is shown on top of your instructions. To ensure anonymity, your actions in this experiment are linked to this Participant ID number and at the end of the experiment you will be paid by Participant ID number.

The experiment consists of 8 decision rounds. In each round, you will be divided into groups of three, so you will be in a group with two other participants. But you will not know which of the other two people in this room are in your group. At the beginning of the experiment, you will be either a Person A, B, or C. Your role will remain the same for the whole experiment.

If you are Person A (or B), you will ALWAYS be grouped with a SAME Person B (or A) for the whole experiment, and you will meet a DIFFERENT Person C from round to round, that is, you will never meet the same Person C again.

If you are Person C, you are to be grouped with DIFFERENT pairs (Persons A and B) from round to round.

In other words, each group consists of a pair of two persons and a different third person in each round.

Each decision round has three phases:

[The following paragraph is only present in the PrivCom*:]*

Phase 1: Chat

At the beginning of each round, Persons A and B in each three-person group can chat via an online chatting program: they can type whatever they want in the lower box of the chat program (e.g., discussing game strategies). The messages will be only seen by Persons A and B. Meanwhile, Person C in the group will see a string of "#"s each time one of Persons A and B types a message. The length of "#"s equals the length of the message (including spaces and punctuations). This chat phase will last 90 seconds. (see the following screenshot *[see Figure 1 in the main text]*.)

[The following paragraph is only present in the PubReadOnly*:]*

Phase 1: Chat At the beginning of each round, Persons A and B in each three-person group can chat via an online chatting program: they can type whatever they want in the lower box of the chat program (e.g., discussing game strategies). This chat phase will last 90 seconds. There are two chat boxes: 1) In Private ChatBox, the messages will be only seen by Persons A and B. Meanwhile, Person C in the group will see a string of "#"s each time one of Persons A and B types a message. The length of "#"s equals the length of the message (including spaces and punctuations). 2) In Public ChatBox, the messages will be shared by all group members, that is, Person A, Person B and Person C can all see the message. But Person C cannot type messages. (see the following screenshot *[reproduced as in Figure A1 below]*.)

[The following paragraph is only present in the AllChanCom*:]*

Phase 1: Chat At the beginning of each round, all participants can chat via an online chatting program: they can type whatever they want in the lower box of the chat program (e.g., discussing game strategies). This chat phase will last 90 seconds. They can either chat via private chatbox or public chatbox: 1) In Private ChatBox, the messages will be only seen by the two persons indicated on top of the chat box. Meanwhile, the other person in the group will see a string of "#"s each time one of the pairs types a message. The length of "#"s equals the length of the message (including spaces and punctuations). 2) In Public

ChatBox, the messages will be shared by all group members. (see the following screenshot *[reproduced as in Figure A2 below].*)

[The rest of the instruction is the same for all treatments:]

Phase 2: Contribution Choice

Each person is given 10 tokens at the beginning of EACH ROUND in their Individual Fund. Tokens in the Individual Fund are worth 1 ECU each.

Each three-person group begins with a Group Fund of 0 ECU each round. You decide independently and privately whether or not to contribute any of your tokens from your Individual Fund into the Group Fund. Tokens in the Group Fund are worth 1.8 ECU each.

In other words, each token that a person adds to the Group Fund reduces the value of his/her Individual Fund by 1 ECU. Each token added to the Group Fund by a group member increases the value of the Group Fund by 1.8 ECU.

Each person can contribute up to a maximum of 10 tokens to the Group Fund. Decisions must be made in whole tokens. That is, each person can add 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 tokens to the Group Fund.

Three examples illustrate how the tokens added to the Group Fund relate to the value of your Individual and Group Funds.

- If you add 0 tokens to the Group Fund, it means you add 0 ($0 \times 1.8 = 0$) ECU to the Group Fund and 10 ECUs remain in your Individual Fund.

- If you add 5 tokens to the Group Fund, it means you add 9 ($5 \times 1.8 = 9$) ECUs to the Group Fund and 5 ECUs remain in your Individual Fund.

- If you add 10 tokens to the Group Fund, it means you add 18 ($10 \times 1.8 = 18$) ECUs to the Group Fund and 0 ECU remains in your Individual Fund.

You must press the "Calculate" button to see how many ECU will remain in your Individual Fund, once you are ready, you can click the "Next" button to proceed.

Phase 3: Allocation Choice

After all participants have made their decisions for the round, the computer will show the results:

ECUs in Group Fund = 1.8 × (Sum of tokens in the Group Fund)

You then decide how to allocate ONE-THIRD of the ECUs in the Group Fund between the other two group members.

The sum of your allocations between the other two group members will be one-third of ECUs in the Group Fund. In other words, each person can only divide one-third of ECUs in the Group Fund for the other two group members, and their own share of the Group Fund will be determined by the allocation decisions of the other two group members. Specifically,

- Person A will divide one-third of ECUs in the Group Fund between Person B and Person C.
- Person B will divide one-third of ECUs in the Group Fund between Person A and Person C.
- Person C will divide one-third of ECUs in the Group Fund between Person A and Person B.

The other two group members' individual contributions to the Group Fund and their roles will be shown on the upper right table when you are making the allocation choices. Click the calculator button on the lower-right corner if you need assistance with calculation.

Feedback and Earnings

After all participants have made their decisions for the round, the computer will show the results. A person's share of the Group Fund will be determined at the end of phase 2. Your earnings from the Group Fund will be the sum of ECUs that the other two group members allocate to you.

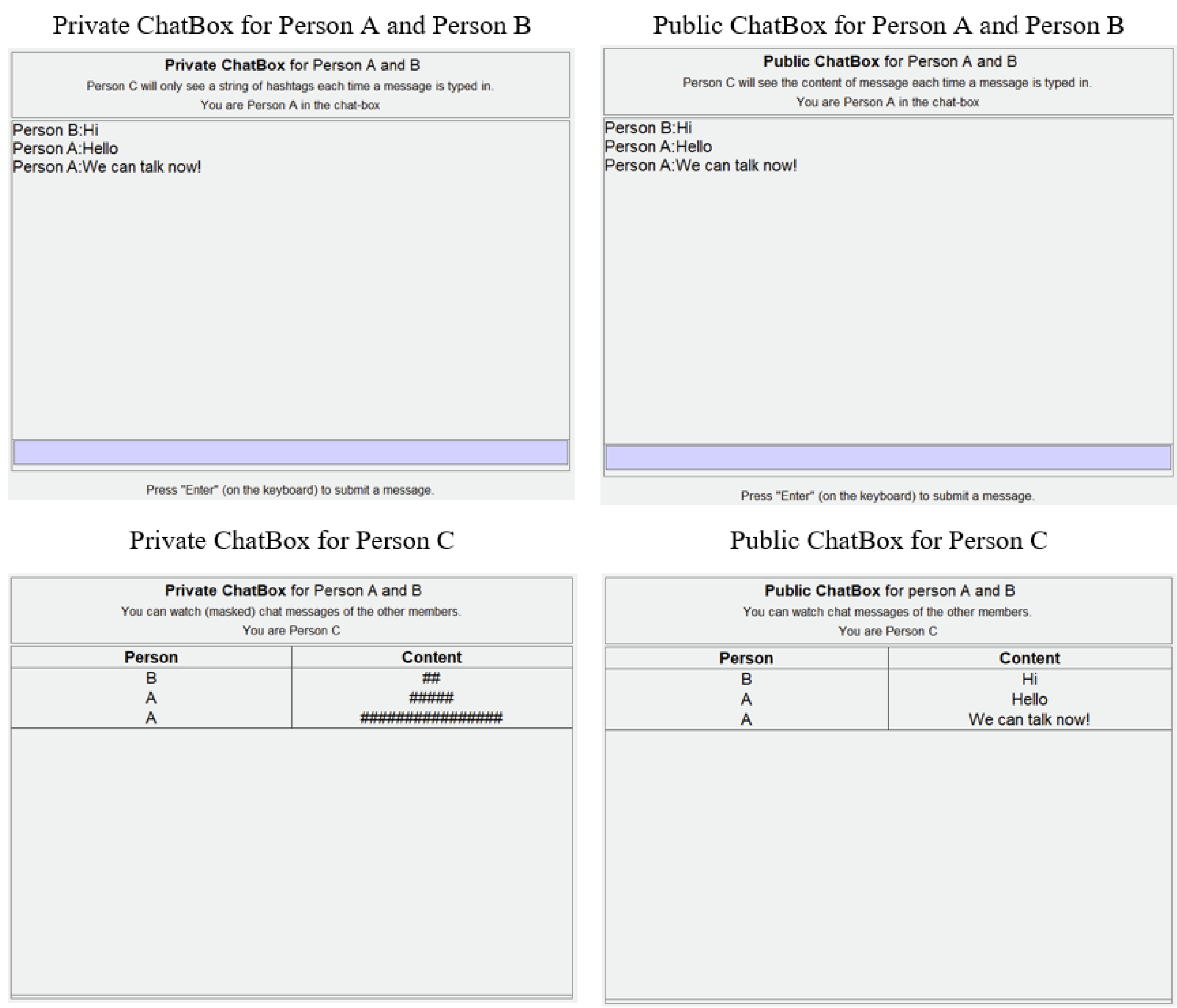
Your Earnings = ECUs in Individual Fund + Your Earnings of ECUs in Group Fund

At the end of each round, you will receive information on your Group Fund earnings and your total earnings for that round. You will also be informed of all group members' contributions to the Group Fund, their allocation decisions and their earnings in ECUs for that round.

Your total earnings for the experiment will be the sum of the earnings in all rounds.

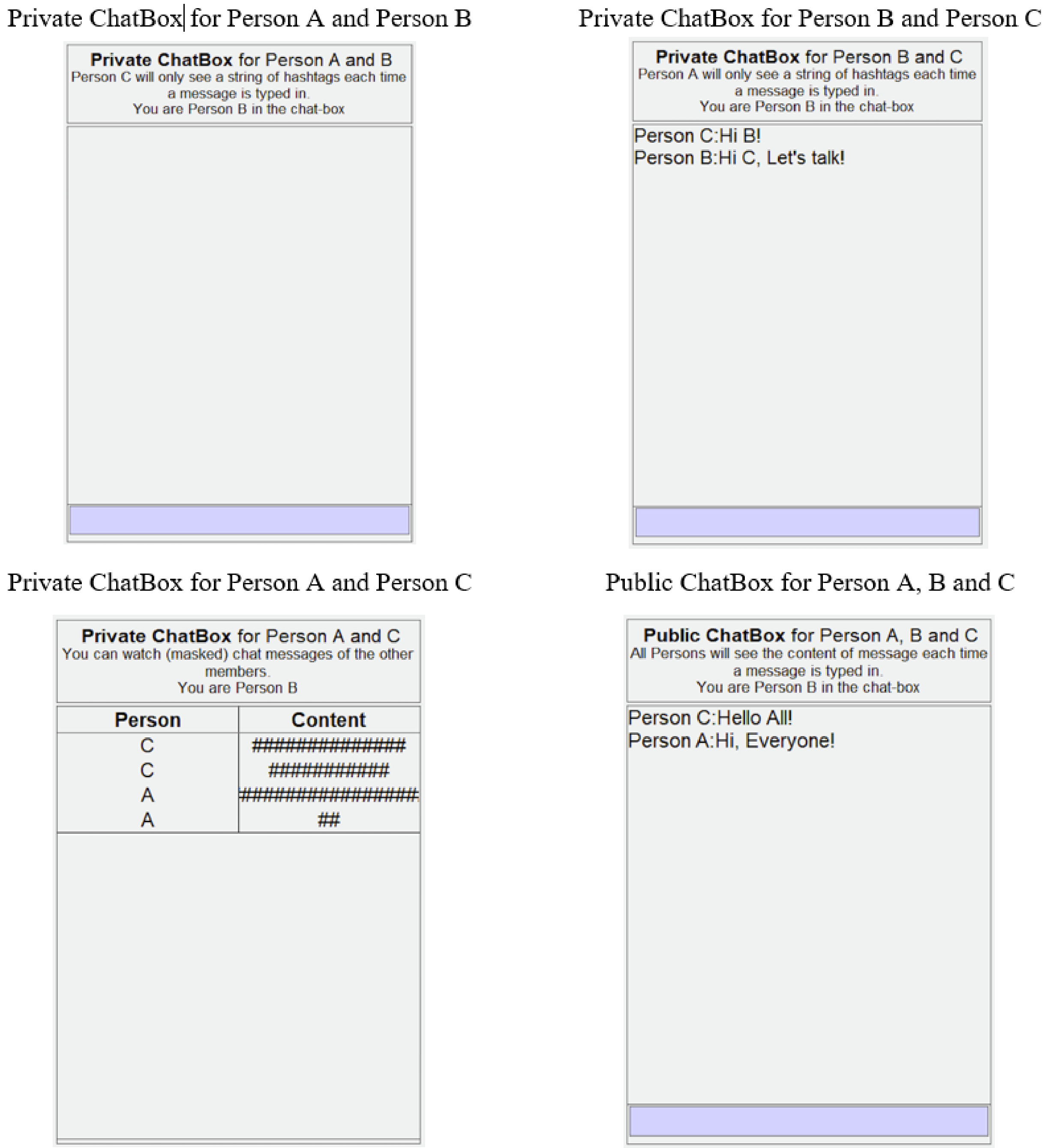
This completes the instructions. Before we begin the experiment, to make sure that every participant understands the instructions, please answer several review questions on your screen.

Figure A1. ChatBoxes for PubReadOnly



Notes: The upper two ChatBoxes are for Person A and Person B. They can choose whether to exchange messages in either Private ChatBox or Public ChatBox. The lower two ChatBoxes are what Person C sees. Person C only sees hashtags for the messages exchanged in Private ChatBox for Persons A and B. But Person C can read the content of the messages exchanged in Public ChatBox, though Person C cannot type any messages.

Figure A2. ChatBoxes for AllChanCom



Notes: The screenshot shows four ChatBoxes Person B sees. Person B can exchange private messages with Person A in Private ChatBox for Person A and Person B, and the messages exchanged there will be displayed as hashtags for Person C. Likewise, the private messages exchanged in Private ChatBox for Persons B and C will be displayed as hashtags for Person A; the private messages exchanged in Private ChatBox for Persons A and C will be displayed as hashtags for Person B. In Public ChatBox, all team members can type and read messages exchanged there.

Online Appendix B. Further statistical analysis

Table B1: Panel data regression of the partners' and loners' investments and their differences

	(1) Partner	(2) Loner	(3) Diff.
PrivCom	1.436***	-2.859***	4.295***
	(0.243)	(0.443)	(0.502)
PubReadOnly	1.412***	0.113	1.294*
	(0.345)	(0.613)	(0.666)
AllChanCom	1.424***	1.945***	-0.521
	(0.258)	(0.315)	(0.410)
Constant	7.748***	5.840***	1.908***
	(0.191)	(0.208)	(0.229)
H0: PrivCom=PubReadOnly	$p = 0.942$	$p < 0.001$	$p < 0.001$
H0: PrivCom=AllChanCom	$p = 0.958$	$p < 0.001$	$p < 0.001$
H0: PubReadOnly=AllChanCom	$p = 0.973$	$p = 0.003$	$p = 0.011$
Observations	1314	1314	1314

Notes: 1) The dependent variables in Columns (1)-(3) are the partners' investment, the loner's investment, and the difference between the partners' and loner's investments. The unit of observation is at the group-round level. That is, we take the average of each pair of partners in each group in each round. Similarly, the investment difference is the average investment of the partners minus the loner's investment. 2) The panel data regressions were estimated using population-averaged models instead of subject-specific random effects models. But random effects models produce very similar results. 3) NoCom is the base category in all regressions. 4) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

Table B2: How other players' previous allocations affect partners' one-round change in investment

Dependent variable:	One round change in one of the partner's investment			
Treatment:	NoCom	PrivCom	PubReadOnly	AllChanCom
Get less than proportional from their partner	-0.267	0.240	0.983	0.980**
	(0.366)	(0.411)	(0.602)	(0.468)
Get more than proportional from their partner	0.254	0.107	-0.012	0.189*
	(0.205)	(0.143)	(0.071)	(0.106)
Get less than proportional from the loner	-0.402	-0.224	0.023	0.736
	(0.255)	(0.180)	(0.153)	(0.606)
Get more than proportional from the loner	0.100	0.027	0.322	0.215
	(0.206)	(0.198)	(0.252)	(0.200)
Constant	0.384***	0.154	-0.030	0.150
	(0.120)	(0.206)	(0.152)	(0.142)
Observations	448	1004	392	448

Notes: 1) This table shows the determinants of partners' one round change in investment. The base categories are where the partner receives proportional share from her partner and where she receives proportional share from the loner. 2) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

Table B3: Panel data regression of the partners' and loners' earnings and their differences

	(1) Partner	(2) Loner	(3) Diff.
PrivCom	1.295***	-2.580***	3.876***
	(0.244)	(0.472)	(0.610)
PubReadOnly	1.592***	-0.849	2.468***
	(0.439)	(0.636)	(0.947)
AllChanCom	1.239***	1.355***	-0.116
	(0.227)	(0.488)	(0.630)
Constant	17.696***	11.676***	6.020***
	(0.143)	(0.442)	(0.525)
H0: PrivCom=PubReadOnly	$p = 0.518$	$p < 0.001$	$p = 0.097$
H0: PrivCom=AllChanCom	$p = 0.833$	$p < 0.001$	$p < 0.001$
H0: PubReadOnly=AllChanCom	$p = 0.434$	$p < 0.001$	$p = 0.003$
Observations	1314	1314	1314

Notes: 1) The dependent variables in Columns (1)-(3) are the partners' earnings, the loner's earnings, and the difference between the partners' and loner's earnings. The unit of observation is at the group-round level. That is, we take the average of each pair of partners in each group in each round. Similarly, the investment difference is the average investment of the partners minus the loner's investment. 2) The panel data regressions were estimated using population-averaged models instead of subject-specific random effects models. But random effects models produce very similar results. 3) NoCom is the base category in all regressions. 4) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

Table B4: Panel data regression of the partners' and loners' investments and their differences in replication and symmetric matching treatments

	(1) Partner	(2) Loner	(3) Diff.
PrivCom	0.914***	-1.938**	2.852***
	(0.106)	(0.797)	(0.752)
SymNoCom	1.217***	/	/
	(0.412)		
SymCom	1.732***	-1.676***	3.408***
	(0.169)	(0.592)	(0.688)
Constant	7.141***	4.422***	2.719***
	(0.104)	(0.213)	(0.106)
H0: PrivCom=SymCom	$p < 0.001$	$p = 0.782$	$p = 0.581$
H0: SymNoCom=SymCom	$p = 0.221$	/	/
Observations	704	512	512

Notes: 1) The dependent variables in Columns (1)-(3) are the partners' investment (except for SymNoCom in which we use all players' investment), the loner's investment, and the difference between the partners' and loner's investments. The unit of observation is at the group-round level. That is, we take the average of each pair of partners in each group in each round. Similarly, the investment difference is the average investment of the partners minus the loner's investment. 2) The panel data regressions were estimated using population-averaged models instead of subject-specific random effects models. But random effects models produce very similar results. 3) Replication of NoCom is the base category in all regressions. 4) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

Table B5: Random effects model on the share allocated to the partner in replication and symmetric matching treatments

Dependent variable:	Share allocated to the partner $\frac{a_{ij}}{a_{ij}+a_{ik}}$				
Treatments:	NoCom	PrivCom	SymNoCom	SymCom	Pooled
β_1: Partner's relative investment $\frac{e_j}{e_j+e_k}$	0.560*** (0.062)	0.418*** (0.033)	0.911*** (0.107)	0.432*** (0.074)	0.410*** (0.019)
NoCom $\times \frac{e_j}{e_j+e_k}$					0.132*** (0.051)
SymNoCom $\times \frac{e_j}{e_j+e_k}$					0.498*** (0.103)
SymCom $\times \frac{e_j}{e_j+e_k}$					0.024 (0.069)
NoCom					-0.150* (0.079)
SymNoCom					-0.524*** (0.060)
SymCom					-0.033 (0.066)
β_0: Constant	0.416*** (0.096)	0.571*** (0.049)	0.051 (0.054)	0.546*** (0.065)	0.577*** (0.032)
Clusters	2	2	4	4	12
Observations	256	256	576	512	1600

Notes: This table shows a player's allocation to her partner in a round. loners' allocations are excluded. In the last column, PrivCom serves as the base category. *** denotes 1% significance level. Standard errors are clustered at the session level.

Table B6: Panel data regression of the partners' and loners' investments and their differences in HalfCom

	(1) Partner	(2) Loner	(3) Diff.
PrivCom	0.914***	-1.937**	2.852***
	(0.109)	(0.797)	(0.752)
HalfCom(Chat)	1.469***	-0.953**	2.422***
	(0.324)	(0.423)	(0.584)
HalfCom(NoChat)	0.687	-1.070**	1.758***
	(0.538)	(0.527)	(0.675)
Constant	7.141***	4.422***	2.719***
	(0.106)	(0.213)	(0.106)
H0: PrivCom=HalfCom(Chat)	$p = 0.071$	$p = 0.247$	$p = 0.648$
H0: PrivCom=HalfCom(NoChat)	$p = 0.668$	$p = 0.339$	$p = 0.274$
H0: Chat=NoChat	$p = 0.076$	$p = 0.569$	$p = 0.186$
Observations	512	512	512

Notes: 1) The dependent variables in Columns (1)-(3) are the partners' investment, the loner's investment, and the difference between the partners' and loner's investments. The unit of observation is at the group-round level. That is, we take the average of each pair of partners in each group in each round. Similarly, the investment difference is the average investment of the partners minus the loner's investment. 2) The panel data regressions were estimated using population-averaged models instead of subject-specific random effects models. But random effects models produce very similar results. 3) Replication of NoCom is the base category in all regressions. 4) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

Table B7: Random effects model on the share allocated to the partner in HalfCom

Dependent variable:	Share allocated to the partner $\frac{a_{ij}}{a_{ij}+a_{ik}}$	
Treatments:	HalfCom	Pooled
β_1: Partner's relative investment $\frac{e_j}{e_j+e_k}$	0.554*** (0.033)	0.557*** (0.047)
PrivCom $\times \frac{e_j}{e_j+e_k}$		-0.136*** (0.054)
HalfCom $\times \frac{e_j}{e_j+e_k}$		0.005 (0.088)
PrivCom		0.151* (0.083)
HalfCom		0.019 (0.102)
Chat $\times \frac{e_j}{e_j+e_k}$	0.017 (0.111)	
Chat	-0.005 (0.109)	
β_0: Constant	0.440*** (0.026)	0.418*** (0.073)
H0: β_1 PrivCom=HalfCom		$p = 0.076$
H0: β_0 PrivCom=HalfCom		$p = 0.104$
Clusters	4	8
Observations	512	1024

Notes: This table shows a player's allocation to her partner in a round. Loners' allocations are excluded. In the last column, NoCom serves as the base category. *** denotes 1% significance level. Standard errors are clustered at the session level.

Figure B1: Time-path of the average investment in replication and symmetric matching treatments

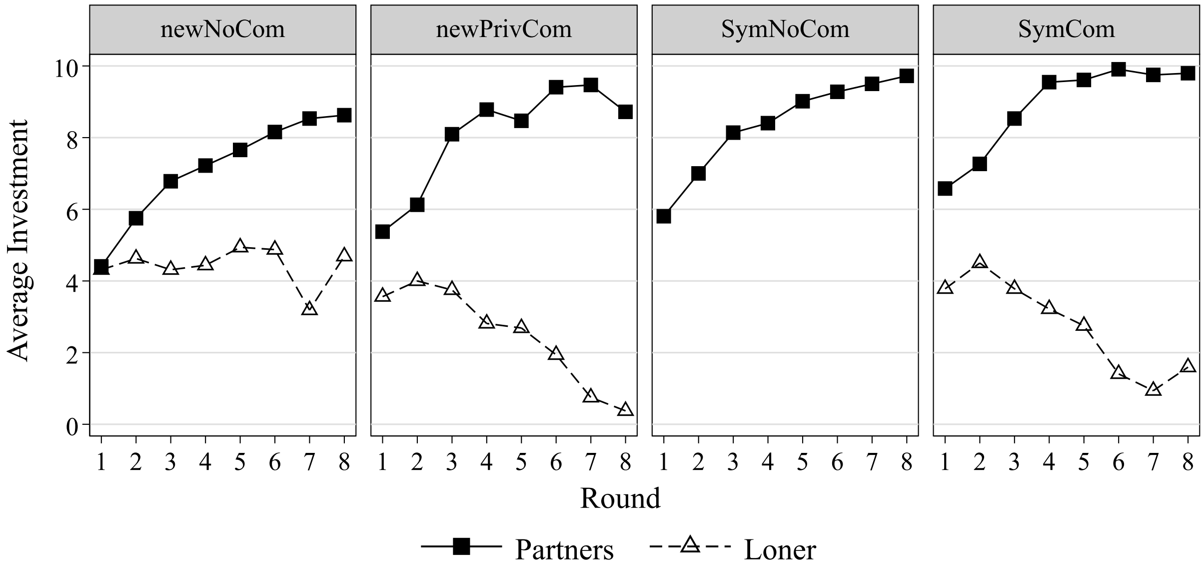
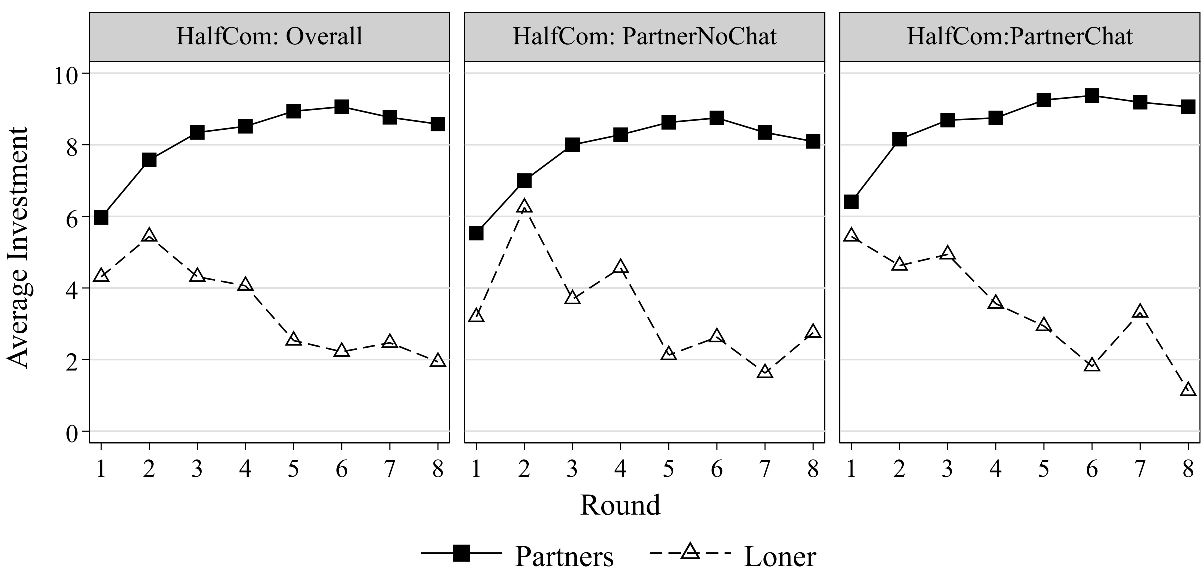


Figure B2: Time-path of the average investment in HalfCom



Online Appendix C. Instructions for Content Analysis

For each treatment, we employed two research assistants (who are unaware of our research purpose) to code participants' conversations. Below is the instructions given to the assistant who coded messages in the PrivCom*. Instructions for the other treatments are similar with additional categories (see main text).*

You will be given a list of messages. These messages were written by participants in an experiment. The following is a summary of the experiment:

1. Each group consists of three participants. They are randomly assigned to be Person A, Person B, and Person C. Their roles are fixed during the whole experiment.

2. There are in total 8 rounds, during which Persons A and B are always paired together. But Person C meets different pairs of Persons A and B every round.

3. Persons A and B have 90 seconds before each round to discuss (hence the list of messages) with each other, while Person C cannot see the content of the message.

4. After the 90 seconds, Persons A, B, and C play the following game: 1) each participant is endowed with 10 tokens at the beginning of each round; 2) each participant decides independently how many tokens to invest in a group fund, and keeps the tokens that are not invested; 3) the tokens invested to the group fund will be pooled together and multiplied by a factor of 1.8; 4) each participant allocates one third of the group fund between the other two group members. 5) each participant's payoff in a round is then the sum of the uninvested tokens and the share of the group fund received from the other two group members.

Your task is to classify the conversations between A and B in each round according to the categories given to you. While for coding the conversations, please use the following categories (you can pick multiple categories for the same conversation):

For Person A and B:

1. suggested a FAIR share to C (proportional to C's relative investment). Note that this includes suggesting fair allocation to all group members.
2. suggested a LESS THAN FAIR share (but more than nothing) to C.
3. suggested to allocate NOTHING to C.
4. suggested to use OTHER allocation strategies.
5. suggested to use the SAME STRATEGY as last round.
6. concerned about C's welfare. This includes any conversation mentioning C: either showing pity or laughing at C's misfortune.
7. talked about something else.

Note: In A and B's conservations, they may explicitly discuss the allocations to C or discuss the allocations to each other (A and B). In either case, please select the category according to their intent of allocations to C.

While for coding the conversations, please pay attention to the following:

- You should code all conversations independently. Please do not discuss with anyone else how to code the conversations.
- Your job is to evaluate how Persons A and B decided their allocations to C.
- The unit for coding is the whole conversation in each channel of each group in a round, not every message.
- When you complete the coding, please go through the entire list of messages a second time to (i) review all your codes and revise them if needed for accuracy; (ii) make sure that you have coded every conversation.

To evaluate the conversations, you need to first understand the experiment. The instructions attached below are the instructions the participants read in the experiment. Please read them carefully, answer the comprehensive questions, and email me the answers. Only after you answered all the questions correctly, can you begin to code the messages.

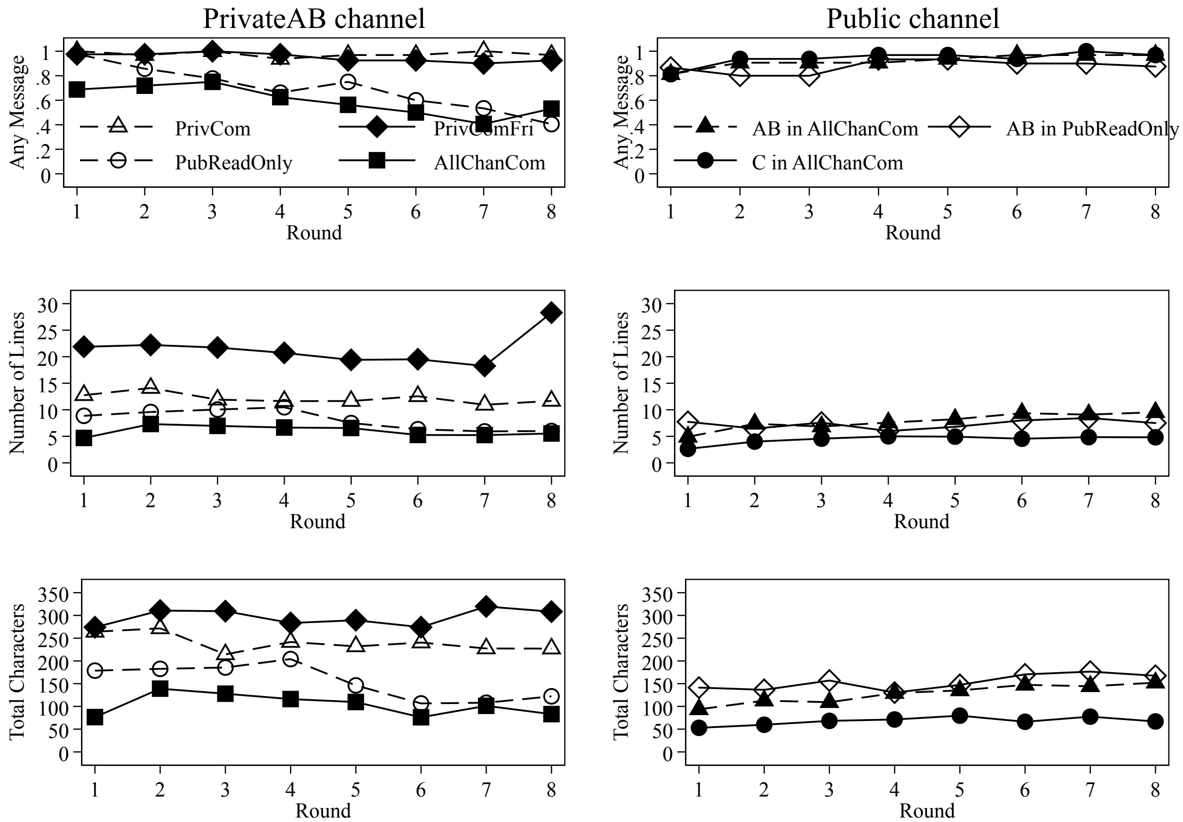
Online Appendix D. Detailed Analysis of Conversations

In this appendix, we present detailed analysis of players' messages in all communication channels to shed light on why private communication caused the partners to behave unfairly toward the loner and caused the latter to underinvest, and why public communication helped bring about fairer allocations from the partners and higher investment from the loner.

D1 Descriptive Statistics of Conversations

We first look at the volumes of messages exchanged in each communication channel. Table D1 shows, in the private communication treatments, that the partners communicated over 95% of the time. (In the main text, we pool the data from the two private communication treatments. Here we named them as PrivCom and PrivComFri and separately reported the results.) However, when the public channel was available, partners were more likely to exchange messages in the public channel than in their private channel. For example, only two thirds of the partners talked in private channels in PubReadOnly, and the volume of messages was further reduced by one-third in AllChanCom. It looks like the partners were eager to reach out to the loner, presumably to encourage the loner to invest, though they were not necessarily planning to allocate fairly. In AllChanCom, the loner communicated 94% of the time, producing a comparable volume of messages to an average partner. But the loner did not seem to attempt to communicate privately with either of the partners. Message exchanges occurred in 29% of cases in the Private AC channel and 21% of cases in the Private BC channel. In each conversation, about 3.5 lines (or about 43 characters) were exchanged; they were mostly greetings to each other. These statistics are consistent over the course of 8 rounds (see Figure D1).

Figure D1: Evolution of the statistics of conversations



Notes: This figure shows the evolution of "Any Message," "Number of Lines," and "Total Characters" in different communication channels over 8 rounds. The volume and frequency of communication remain roughly consistent over time.

We next study the content of the conversations in each channel. To do that, we employed a different pair of research assistants (who were not aware of our research questions) for each treatment. Their task was to assign the conversation in each group of each channel for each round to one or more semantic domains. For the two private communication treatments, we classify the conversation as "Fair" (the partners planned to allocate proportionally to each other's relative investment), "Less than fair" (the partners planned to allocate less than proportionally, but not nothing to the loner), "Nothing" (the partners planned to allocate nothing to the loner regardless of her investment), "Other" (the partners planned to allocate according to other strategies), and "Concern for C" (the partners showed pity for the loner

Table D1: Descriptive statistics of conversations

		PrivCom	PrivComFri	PubReadOnly	AllChanCom
Private AB	Any Messages	98%	95%	67%	60%
	Lines of Messages	12.1	21.5	8.5	6.1
	Total Characters	239.8	296.0	162.9	105.8
Public (AB)	Any Message			88%	92%
	Lines of Messages			7.3	8.4
	Total Characters			152.5	136.9
Public (C)	Any Message				94%
	Lines of Messages				4.6
	Total Characters				71.1

Notes: 1) The statistics are summarized for conversations that occurred per group per round. 2)"Any Messages" refers to the fraction of groups where at least one message was sent in that channel. Among these groups, "Lines of Messages" refers to the average number of messages by designated person types in that channel and "Total characters" refers to the total volume of letters, spaces and punctuations. 3) "Public(AB)" means the messages sent by the partners in the public channel, and "Public(C)" means the messages sent by the loner in the public channel. "Private AC" and "Private BC" are included for analysis as communication only occasionally occurred in these channels (see **??**).

or they laughed at the loner's misfortune). We also asked research assistants to classify the conversation as "Same strategy" when the partners planned to use the same strategy as last round and as "Else" for all other contents. In our data analysis, if the coder ticks "Same strategy", we impute the categories of the current round from the categories chosen by the coder for the previous round. We classify a conversation to a semantic domain if at least one of the research assistants assigns it to that domain. We also conducted the same analysis by classifying a conservation to a domain if and only if both research assistants assign it to the same domain. The analysis produces qualitatively similar results. Appendix C includes the instructions for the content analysis. For the two public communication treatments, we further classify the conversation in the private and public channels as "High contribution" (the partners suggested a high contribution (> 5) from the loner). Moreover, for AllChanCom, we additionally label the loner's messages as "Fair" (the loner asked for a fair allocation from the partners) and "High contribution" (the loner suggested a high contribution (> 5) from the partners). Table D2 reports the frequency of each semantic domain by channel and by treatment.

Table D2: Fraction of conversations belonging to each semantic domain

Channel	Content	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Private AB	Allocate fair amount to C	11%	11%	11%	3%
	Allocate less than fair to C	14%	23%	12%	5%
	Allocate nothing to C	53%	54%	22%	9%
	Allocate other fraction to C	25%	14%	17%	5%
	Concern for C	66%	75%	29%	15%
	Suggest high investment			44%	13%
Public (AB)	Allocate fair amount to C			63%	75%
	Allocate less than fair to C			8%	0%
	Allocate nothing to C			3%	0%
	Allocate other fraction to C			34%	7%
	Concern for C			27%	5%
	Suggest high investment			75%	83%
Public (C)	Ask for fair allocation				66%
	Suggest high investment				69%

Notes: 1) The statistics are summarized for conversations per group per round. 2) "Public (AB)" refers to messages sent by the partners in the public channel, and "Public (C)" means the messages sent by the loner in the public channel.

More than half the time, conversations in the private communication treatments were about allocating unfairly toward the loner. The frequency of these conversations decreased in the public communication treatments. In public channels, not surprisingly, partners talked about different things; they often encouraged the loner to invest more and promised fair allocations. For example, the partners suggested fair allocations 63% of the time in public conversations in PubReadOnly, and the frequency increased to 75% in AllChanCom.

Although the public channel encouraged cooperation, it also created an opportunity for the partners to deceive the loner. For example, while the partners conspired about unfair allocations toward the loner in their private channel, they might suggest high investment and promise fair allocations in the public channel. In this way, they deliberately tricked the loner and exploited the spoils. We indeed found some partners attempted to do just that. Among all cases where the partners both suggested fair allocation and advocated high investment in the public channel, they suggested unfair allocations toward the loner in their private channel 18.7% of the time in PubReadOnly, though this decreased to 10.1% in

AllChanCom. These partners' actual allocations were indeed unfair. To see whether their plans were correlated with their allocation decisions at the individual level, we estimate the same regression as in Table 2 only for the subsample where the partners suggested high investment in the public channel and unfair allocation in the private channel. The results show that $\beta_1 = 0.141$ in PubReadOnly and 0.373 in AllChanCom, both of which were not significantly different from zero (though the number of observations is low). Thus, the partners' allocations were much less fair than in the full sample.

Result 6. *In private communication treatments, 95% of the time, the partners exchanged messages. Most of the time, private communications included discussions about allocating unfairly toward the loner. When public channels were present, the partners were more likely to communicate in public channels than private channels. They often talked about fair allocations in the public channel. Sometimes the partners conspired about unfair allocation toward the loner in private channels but suggested high investment and promised fair allocation in public channels.*

D2 Conversation Contents and the loner's Investment

Recall that loners' investment increased when public communication channels were present. We next estimate a random effects regression to investigate whether the loner's investment decisions were correlated with communication contents. The dependent variable is the loner's investment, and the independent variables include different semantic domains of the messages exchanged in the public channel classified separately for the partners (AB) and the loner (C). We also include the volume of the partners' private conversations, i.e. the number of hashtags (same as total characters, as in Table D1) the loner saw in the partners' private channel to understand the effect exclusionary communication had on the loner's investment.

Table D3 reports the estimates. We first look at the effect of hashtags (from the partners) on the loner's investment. In PrivCom, the loner's investment decreased marginally for each hashtag she saw. Since the average length of each conversation was about 240 characters,

Table D3: loner's investment and messages

Dependent variable:	loner's investment			
Treatment:	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Number of hashtags	-0.004*	-0.000	-0.005***	-0.006
from PrivateAB	(0.002)	(0.001)	(0.001)	(0.006)
Public (AB): fair allocation			0.912*	0.236
			(0.525)	(1.245)
Public (AB): less than fair			-1.503	0.000
			(1.429)	(.)
Public (AB): nothing to C			1.004	0.000
			(1.432)	(.)
Public (AB): concern for C			0.488	-0.876
			(0.468)	(0.564)
Public (AB): high investment			1.168***	1.151
			(0.258)	(0.995)
Public (C): fair allocation				0.441*
				(0.232)
Public (C): high investment				2.203***
				(0.610)
Constant	4.535***	2.533***	5.034***	5.277***
	(0.431)	(0.475)	(0.607)	(0.437)
Clusters	4	5	4	4
Observations	256	320	226	256

Notes: 1) This table uses random effect models to estimate the determinants of the loner's investment. 2) The coefficients of "Public (AB): less than fair" and "Public (AB): nothing to C" cannot be estimated in AllChanCom because there is no conversation in that channel that can be categorized as such. 3) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

the loner lowered their investment by about 1 unit after seeing conversations they could not interpret. The effect of seeing hashtags was also significant in PubReadOnly: the average length of around 160 characters decreased the loner's investment by around 0.8 units. However, in PrivComFri and AllChanCom, seeing hashtags did not appear to matter to the loner's investment. One explanation is that in PrivComFri, the loner's investment was already very low even when the partners did not talk behind her back, thus leaving little room for her investment to go even lower. In AllChanCom where the loner could talk in the public channel, her investment was probably more likely to be affected by the conversation in the public channel (though we should note that the absolute size of the imprecisely estimated effect of seeing hashtags in AllChanCom is no smaller than in either PrivCom or PubReadOnly).

For the effects of semantic domains in the public channel, in PubReadOnly, the loner's investment significantly increased by around 2 units when the partners suggested both fair allocation and high investment. In AllChanCom, the loner's investment was positively correlated with her own suggestion of fair allocation and high investment. The partners' suggestions of fair allocation and high investment had positive but not statistically significant effects. (The effects of the partners' messages were largely picked up by the loner's messages, suggesting that the content of their conversations was highly correlated. If we exclude the loner's semantic domains, the partners' suggestions of fair allocation and high investment were jointly significant and increased the loner's investment by 3.3 units.) All other domains appeared to have no significant impact on the loner's investment.

Result 7. *The number of hashtags caused by the partners' exclusive conversations had negative effects on the loner's investment, especially in* PubReadOnly. *The partners' suggestion of fair allocation and high investment in public channels led to higher investment from the loner in* PubReadOnly. *In* AllChanCom, *the loner's own suggestion of fair allocation and high investment in public channels was correlated with her higher investment.*

D3 Conversation Contents and the Partners' Allocations

Last, we look at whether these semantic domains were correlated with the partners' actual allocation decisions. We augment the regression in Table 2 by adding dummy variables of whether the partners communicated in corresponding channels and the semantic domains about allocation ("Fair," "Less than fair," and "Nothing to C"). We also include "Concern for C," as it is likely to correlate with the partners' intention to be fair. In AllChanCom, the loner's semantic domain of "Fair allocation" is included (as the loner's "High contribution" domain was highly correlated with the "Fair allocation" domain, we do not include the former in the regression). We further interact the partner's relative investment with different semantic domains to see the marginal effect of each domain on β_1, i.e. the weight on the proportional share in allocation decisions.

Table D4 reports the results. Unsurprisingly, the partners' messages in their private channels were consistent with their allocation decisions across all treatments: when fair allocation was suggested in private, their allocation decisions were indeed much fairer as indicated by the significant decrease in the fixed share to the other partner and the increase in the proportional share (the only exception is in PubReadOnly where it went in the right direction but was not statistically significant); when unfair allocation (zero allocation) to the loner was suggested, the partners were much less fair. The results also suggest that the fact of partners' exchanging messages in private led to fairer allocations in the private communication treatments. An explanation of this is that the partners who sent no messages in a round (which occurred less than 5% of the time) might have reached an agreement in the previous round for unfair allocations. (Note that the intercept and β_1 estimate of the regression show that in the baseline cases where no messages were sent in private, the partners allocated almost everything to each other regardless of the loner's investment.) When the partners could also communicate publicly, their exchanging messages in private led to less fair allocations. Nevertheless, when the partners expressed concern for the loner in private, they were more likely to allocate proportionally, especially in the private communication treatments. We interpret this as sentimental expressions contributing to fairer allocation decisions.

In PubReadOnly, the partners' speaking in the public channel led to fairer allocations: the fixed share to the other partner decreased and they more often allocated according to the other partner's relative investment. However, suggesting fair allocation in public channels was not significantly correlated with their actual allocations. An explanation for this is that speaking in the public channel was highly correlated with suggesting fair allocations. Nevertheless, when the partners suggested unfair allocations (zero allocation) in public channels,

Table D4: The effect of semantic domains on the relative share allocated to the partner

Dependent variable:	Share allocated to the partner			
Treatment:	PrivCom	PrivComFri	PubReadOnly	AllChanCom
β_1: Partner's relative investment	-0.159	0.019	0.211***	0.843***
	(0.514)	(0.032)	(0.047)	(0.063)
A&B in Private AB Channel				
A&B speak in Private Channel	-0.491	-0.366***	0.040	0.176**
	(0.459)	(0.015)	(0.112)	(0.074)
Allocate fairly to C	-0.295***	-0.541***	-0.202***	-0.221***
	(0.086)	(0.107)	(0.076)	(0.030)
Allocate unfairly to C	0.368***	0.330***	0.323***	0.272***
	(0.131)	(0.036)	(0.054)	(0.104)
Concerns for C	-0.042***	-0.132**	-0.069	-0.100
	(0.006)	(0.065)	(0.109)	(0.160)
Relative Inv. × A&B speak privately	0.705	0.361***	-0.017	-0.167**
	(0.619)	(0.019)	(0.156)	(0.083)
Relative Inv. × Allocate fairly to C	0.236*	0.548***	0.206**	0.279***
	(0.130)	(0.107)	(0.093)	(0.047)
Relative Inv. × Allocate unfairly to C	-0.398***	-0.333***	-0.377***	-0.268*
	(0.143)	(0.030)	(0.087)	(0.155)
Relative Inv. × Concern for C	0.061*	0.146**	0.080	0.092
	(0.036)	(0.067)	(0.135)	(0.202)
A&B in Public Channel				
A&B speak in Public channel			-0.511***	-0.040
			(0.051)	(0.141)
Allocate fairly to C			0.167	-0.037
			(0.134)	(0.111)
Allocate unfairly to C			0.368***	0.000
			(0.087)	(.)
Concern for C			-0.077	-0.016
			(0.051)	(0.057)
Relative Inv. × A&B speak publicly			0.543***	0.096
			(0.039)	(0.199)
Relative Inv. × Allocate fairly to C			-0.150	0.049
			(0.150)	(0.179)
Relative Inv. × Allocate unfairly to C			-0.396***	0.000
			(0.152)	(.)
Relative Inv. × Concern for C			0.073	0.027
			(0.068)	(0.043)
C in Public Channel				
C speaks in Public channel				0.093
				(0.134)
Suggest fair allocation				-0.030
				(0.048)
Relative Inv. × C speak publicly				-0.130
				(0.156)
Relative Inv. × Allocate fairly				0.060
				(0.047)
Constant	0.935**	0.972***	0.715***	0.111
	(0.383)	(0.031)	(0.037)	(0.071)
Clusters	4	5	4	4
Observations	512	640	452	512

Notes: 1) This table uses random effects models to estimate the effects of semantic domains in each communication channel on the relative share allocated to the partner. 2) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

they were less likely to allocate proportionally.

In AllChanCom, messages in public channels did not correlate with the partners' allocation decisions. Requests from loners for fair allocations also did not appear to matter to the partners' allocation decisions. It is worth noting that the intercept and β_1 estimate of the regression show that in the baseline cases where no messages were sent in the public channel, the partners allocated almost proportionally to the other team member's relative investment. These results seem to suggest that fair allocations might be considered as a norm when every group member could participate in conversations.

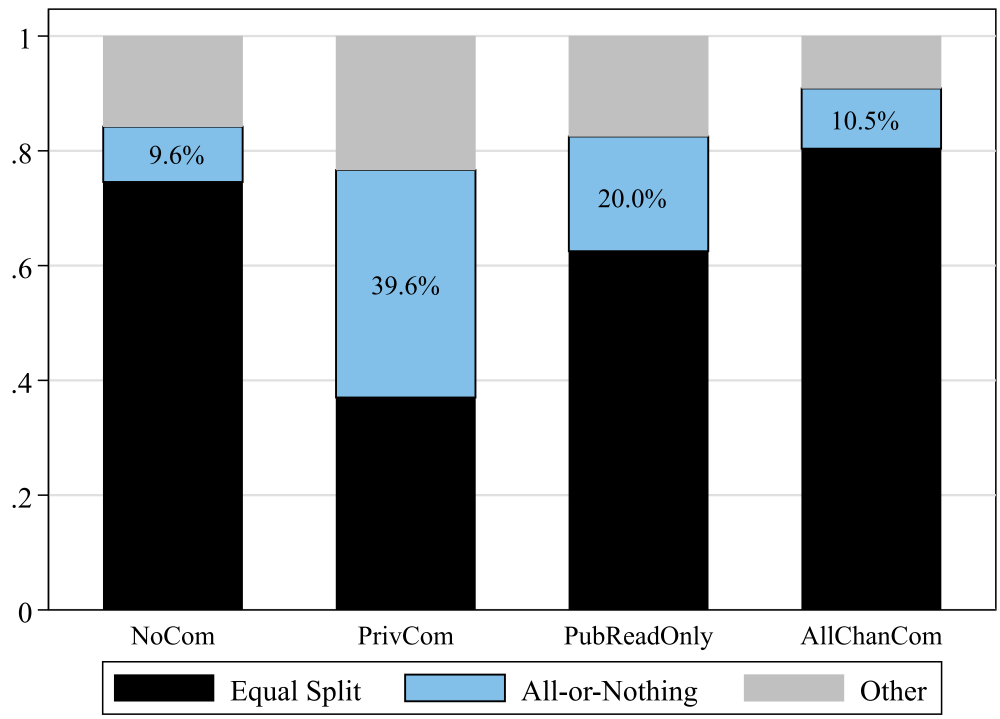
Result 8. *The partners' private conversations were largely consistent with their actual allocation decisions. In* PubReadOnly*, speaking in the public channel made the partners allocate more proportionally. In* AllChanCom*, fair allocation might already be considered a norm, as the messages in the public channel did not appear to matter to the partners' allocation decisions.*

Online Appendix E. The loner's Allocation

In this appendix, we briefly examine how the loner allocated between the partners. Since in our experiments there is little reason for the loner to be biased against one of the anonymous partners, the most natural allocation is proportional to their relative investment. In the case where the partners invested equally (which often occurred), the loner was expected to allocate equally between them. (One third of the pie is always a multiple of 0.2, so participants can easily perform the division by 2.) However, the loner might not allocate fairly out of anger or disappointment if she had been treated unfairly in previous rounds. Thus, unfair allocations may serve as a vehicle of the loner's revenge or punishment toward a random member of the partners, though at the same time rewarding the other partner (recall in the experimental design that the loner cannot identify an individual partner). Or it may serve a "strategic" purpose for possibly only the benefit of other loners: by causing unequal returns to the partners, it may disturb the partners' trusting relationship which is at least partly based on mutual benefits. Figure E1 shows the loner's allocation when the partners invested an *equal* amount. The allocation falls into three categories: equal split, all-or-nothing (i.e. one partner received everything and the other received nothing), and in-between allocations. We found that in many cases the loner did not allocate equally. In particular, a substantial number of allocations was all-or-nothing. Interestingly, it appears that at the treatment level, the fairer the partners' allocation, the less likely the loner would do the all-or-nothing allocation. The all-or-nothing allocation happened strikingly 40% of the time in the private communication treatments. In the public communication treatments where the partners' allocations were fairer than in the private communication treatments, the all-or-nothing allocation happened about 10%∼20% of the time.

At the individual level, however, we did not find that the likelihood of the all-or-nothing allocation was correlated with the loner's experience of the partners' allocations in previous rounds (See Table E1 for random effects regressions on the likelihood of the all-or-nothing allocation). Thus, this seems to suggest that the loner did so *not* directly because of their bad experience in previous rounds, but probably as a strategic move to "punish" one of the partners or create distrust between the partners even though they would not meet each other again. Table E2 additionally shows the number of times the loner made the all-or-nothing allocation in each treatment. It shows that some loners often made the all-or-nothing allocation. For example, in PrivCom, there were 15 persons (out of 72) who did so at least six times.

Figure E1: Loners' allocations to the partners who invested equally



Notes: This figure shows loners' allocation decisions toward the partners who invested equally. All-or-nothing is to allocate all to one of the partners and nothing to the other. Below are the number of observations for each treatment: 114 out of 256 (44.5%) in NoCom, 527 out of 576 (91.5%) in PrivCom, 200 out of 226 (88.5%) in PubReadOnly, and 219 out of 256 (85.5%) in AllChanCom

Nevertheless, the all-or-nothing allocation did not appear to matter to the partners' investment as we did not observe a significant difference in their investment across treatments. Table E3 reports random effects regressions on the one-round change in the partners' investment for the subsample where the two partners invested an equal amount. We find that the partners' investment changes were not significantly correlated with whether they received zero or everything from the loner in previous rounds (with receiving something in between as the reference category).

Result 9. *The loner frequently allocated all-or-nothing to one of the partners rather than equal shares between the partners who invested equally. At the treatment level, the fairer the partners' allocations (in an increasing amount from private communication treatments to public communication treatments), the less likely the loner would make the all-or-nothing allocation.*

Table E1: How partners' previous allocations affect loners' propensity to do all-or-nothing allocations

Dependent variable:	1 if the loner adopted all-or-nothing next round			
Treatment:	NoCom	PrivCom	PubReadOnly	AllChanCom
Get less than proportional	0.010	-0.050	0.024	0.009
from the partners	(0.039)	(0.048)	(0.023)	(0.052)
Get more than proportional	0.093	-0.064	-0.053	0.116
from the partners	(0.086)	(0.125)	(0.194)	(0.165)
Constant	0.069	0.442***	0.205**	0.096*
	(0.045)	(0.035)	(0.082)	(0.051)
Observations	91	399	152	175

Notes: 1) This table shows the determinants of loners' adoption of "all-or-nothing" strategy in the subsequent round. The base category is where the loner receives a proportional amount from the partners. 2) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.

Table E2: Distribution of loners' all-or-nothing allocations

Number of All-or-Nothing allocations	Treatment			
	NoCom	PrivCom	PubReadOnly	AllChanCom
0	17	10	12	17
1	9	11	4	5
2	1	8	4	5
3	3	12	5	4
4	0	11	2	0
5	1	5	2	0
6	1	8	1	0
7	0	4	0	1
8	0	3	0	0
Mean number of A-or-N	0.97	3.2	1.7	1.1
Number of loners	32	72	30	32

Notes: This table shows the distribution of loners' all-or-nothing allocations by treatment.

Table E3: How loners' all-or-nothing allocations affect partners' investments

Dependent variable:	One round change in one of the partner's investment			
Treatment:	NoCom	PrivCom	PubReadOnly	AllChanCom
Get all from	-0.273	0.087	0.167	-1.256
the loner	(0.373)	(0.105)	(0.166)	(1.094)
Get nothing from	-0.626	-0.068	-0.181	-1.413
the loner	(1.056)	(0.098)	(0.297)	(1.125)
Constant	-0.079	0.033	-0.151	0.098
	(0.239)	(0.071)	(0.146)	(0.149)
Observations	194	916	346	376

Notes: 1) This table shows whether a partner receives all-or-nothing from the loner affects her one round change in investment. 2) The regressions only include cases where both partners made the same investment. 3) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at the session level.