Communication in Games

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Abstract

In this chapter, we examine the various effects that pre-play cheap-talk communication has in different types of games. We focus specifically on key game characteristics such as the number of players, the structure of preferences, the sequence of moves, and the manner in which communication is introduced. Our analysis offers guidance on when the introduction of communication is likely to alter the outcomes achieved by players across these different games.

1 Prelude

Communication is an integral part of living. We often talk and discuss things before taking actions that have consequences. Economists have long appreciated this point, leading to an exponential growth of papers in the last few decades studying the effects of communication both theoretically and experimentally.[1] The experimental literature documents that communication can have vastly different effects across various strategic situations. It may increase pro-social behavior and efficiency in social dilemma situations, facilitate coordination in games with multiple equilibria, reduce strategic uncertainty inherent in human interactions, enable the sharing of private information to achieve mutually beneficial outcomes, or even, at times, exhibit no discernible impact on behavior. One overarching message that emerges from this body of literature is that communication may serve diverse roles depending on the type of game under consideration.

We take this message as a starting point and look at communication in games from the perspective of designing an experiment. While some experimenters allow players to

[1] For the theoretical literature on cheap-talk communication see Aumann (1990); Farrell (1987, 1988); Rabin (1990, 1994); Myerson (1989); Crawford (2003); Ellingsen and Ostling (2010) and references discussed there. In general, the introduction of communication (weakly) expands the set of equilibrium outcomes in a game. This is because players can use communication to coordinate strategies, potentially leading to new equilibria that would not exist in the absence of communication. Beyond these new equilibrium outcomes, there are always babbling equilibria, in which cheap-talk messages are ignored by the players, and the game proceeds as if there were no communication.

communicate before or during gameplay, others do not. At times, communication appears to facilitate players in achieving preferable outcomes; in other instances, its impact may be negligible or even vary in terms of who benefits from communication. Why does this variability occur? What factors determine the effect of communication and how does this relate to the structure of the game?

We attempt to summarize the diverse effects of communication as a function of game characteristics, such as the number of players, the structure of preferences, the sequence of moves, the information available, and the resulting equilibrium set. This exercise could be useful in guiding the experimental design decisions as a reference point for mechanisms that communication triggers in different games. We evaluate the effect of communication by comparing outcomes and behavior in otherwise identical treatments with and without communication. We explore both the extensive margin, which establishes whether the introduction of communication alters outcomes relative to scenarios without communication, and the intensive margin, which examines the magnitude of these changes.

Designing an experiment involving communication requires making numerous choices. What forms of communication should be allowed? Options include face-to-face interaction, video or audio chats, computer-mediated exchanges, communication in the form of past interactions, advice-sharing, and more. Who is allowed to communicate, when should they do so, and how often? Should all types of messages be permitted, or should communication be restricted to a pre-specified set of messages? These decisions are critical, as they affect both the complexity of data analysis and the behavior of participants.

The literature has only recently begun to systematize the effects of these design choices on observed outcomes. A recent chapter by Brandts et al. (2019) discusses several central implementation issues, including the structure of communication, its content, and the coding of verbal messages. We contribute to this literature by documenting how different communication structures affect behavior in games and how these effects depend on game features. As will become apparent from this chapter, we know quite a lot about the effects of communication in simple complete information games, but much less about more complex dynamic games and games with incomplete information. Much more work is needed to understand the roles communication plays in these environments.

The scope of this chapter. We focus on pre-play *communication in games*, in which communication is not an explicit part of the game setup or players' strategies.[2] We study

[2]There exists a different class of games called *communication games*, in which players send each other messages, i.e., communicating. The classical communication games include the sender-receiver game (Crawford and Sobel, 1982), the persuasion games (Kamenica and Gentzkow, 2011), and the disclosure games (Grossman, 1981; Milgrom, 1981). Crawford (1998) provides a survey of the early findings in this literature, but there have been more developments in the past two decades. This is a fascinating class of games to study, but it requires a whole new chapter in order to do so.

cheap-talk communication, which is costless to transmit, non-binding, and does not limit the strategic choices of players or affect their payoffs.[3] In some games we consider in this chapter, introducing cheap-talk communication does not alter the set of equilibria of the game, while in others it expands the set of outcomes that can be supported as an equilibrium. We will be precise about such cases as we review the literature.

Most papers we discuss here study the impact of written communication as opposed to video, audio, or face-to-face communication. Written communication can be implemented either as free-form messages (written in prose) or restricted to a pre-specified set of messages (players' actions or intentions). Both structures have their advantages and disadvantages. The unrestricted protocols are natural and rich, but analyzing such data is not trivial. On the contrary, analyzing restricted communication is much easier, but such protocols constrain participants in terms of what they can express. As we will see, in some games restrictive communication will be sufficient for establishing socially efficient outcomes; in others, richer forms of communication are required to do so. Finally, we look at games played by individuals rather than by teams of players.[4]

2 Simultaneous-Move Games with Multiple Equilibria

Games with multiple equilibria suggest a natural role for communication. Communication can serve as a platform for equilibrium selection. Through talking, players can reduce strategic uncertainty about each other's actions and coordinate on which equilibrium they should play. In this section, we ask whether communication is successful in achieving this goal. We distinguish between the games in which equilibria are Pareto ranked and those in which no such ranking exists. The latter class is sometimes called the mixed-motive games (Ellingsen and Ostling, 2010).

2.1 Games with Pareto-ranked Equilibria

The two most commonly studied games in this category are the two-player Stag Hunt game and the multiplayer Minimum Effort or Weak Link game. The Stag Hunt game, illustrated in panel (A) of Figure 1, is a simultaneous-move game that highlights the tension between social cooperation and risk. In this game, two hunters face a choice: cooperate to hunt a stag (a large animal) or act independently to hunt a hare (a smaller animal). The game has two Nash equilibria. The first is the Pareto efficient equilibrium, where both players cooperate to hunt the stag. The second is a less efficient equilibrium, where both players choose to hunt hares. While hunting the stag offers a higher payoff, it carries a greater

[3] See Martinelli and Palfrey (2020) for the recent survey of the effects of pre-play activities in collective decision games, including among others information acquisition and costly messages.

[4] For the effects of communication in games played by teams see Kagel (2018) and Kim and Palfrey (2023).

risk—if one hunter goes for the stag but the other does not, the first hunter receives nothing. By contrast, hunting the hare is a safe option, yielding a moderate payoff regardless of the other hunter's decision.

The Minimum Effort or Weak Link game (Van Huyck et al., 1990), illustrated in panel (B) of Figure 1, is a multiplayer extension of the Stag Hunt game. Like the Stag Hunt game, it features multiple equilibria, which can be Pareto ranked according to the total surplus generated, i.e., efficiency. Regardless of the number of players, the main challenge in achieving the efficient equilibrium in both games lies in the risk involved in doing so: the most efficient equilibrium tends to be the riskiest if one has doubts about other players' actions.

Figure 1: Stag Hunt and Minimum Effort Games

	Player B	
Player A	Left	Right
Top	800, 800	800, 0
Bottom	0, 800	1000,1000

(A): Stag Hunt Game (Cooper et al., 1992)

	Other Players' Minimum Effort				
Effort of Player i	0	10	20	30	40
0	200	200	200	200	200
10	150	210	210	210	210
20	100	160	220	220	220
30	50	110	170	230	230
40	0	60	120	180	240

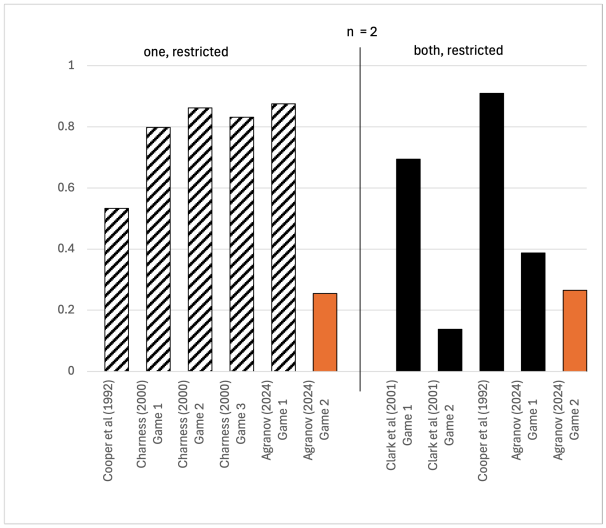
(B): Minimum Effort Game (Van Huyck et al., 1990)

Figure 2 summarizes how communication affects efficiency depending on game elements. We assess the effectiveness of communication by comparing the percentage increase in playing the efficient equilibrium at the group level or the efficiency of selected strategies at the individual level in the communication treatment relative to the no communication treatment. Below, we discuss these elements in detail.[5]

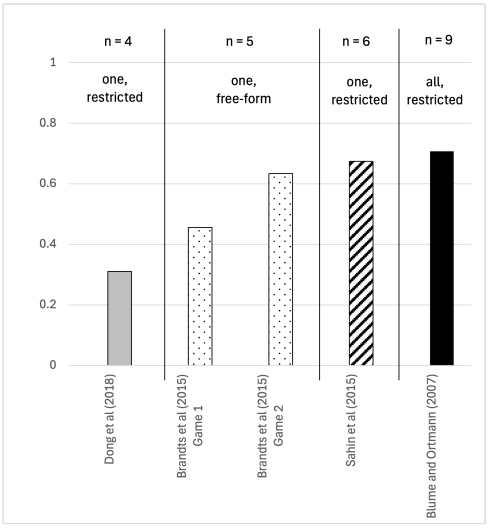
Communication structure. Several studies have investigated the impact of pre-play communication in Stag Hunt games, all of which employed a limited set of messages corresponding to strategies in the game. These messages are interpreted as signals of a player's intended action. The studies vary in terms of whether one or both players are allowed to send such messages and in the level of risk associated with playing the efficient strategy

[5]Whether we focus on efficient outcomes or on the efficiency of individual strategies depends on the data provided in the corresponding studies. For instance, in the Stag Hunt games, most papers report the frequency of efficient outcomes across treatments, except for Duffy and Feltovich (2002), which is why we look at the percentage increase in playing efficient equilibrium. In contrast, for the Minimum Effort game, most studies report the average effort levels chosen by players in each treatment. This is why we report the percentage increase in the efficiency of individual strategies in this case.

FIGURE 2: Efficacy of communication in reaching efficiency in coordination games with Pareto-ranked equilibria



(A): Stag Hunt Game
% increase in efficient outcomes



(B): Minimum Effort Game
% increase in efficiency of strategies

Notes: The left panel reports the percentage increase in the frequency of playing efficient outcome due to the introduction of communication in the Stag Hunt games. The right panel reports the percentage increase in the efficiency of individual strategies players choose due to the introduction of communication in the Minimum Effort games. The number n at the top of the graphs indicate the number of players in each game. Each parameterization of the game is indicated by a separate bar. All games except for Game 2 in Agranov (2024) have symmetric payoffs across all participating players. Game 2 in Agranov (2024) features asymmetric payoffs depicted in Figure 3. The communication structure is indicated on the top of each graph; it specifies who can speak (one or both players in the Stag Hunt game, one or all players in the Minimum Effort game), and whether communication is restricted to intended action or it is a free-form.

captured by the variation in payoffs. In some treatments, such as those by Cooper et al. (1992), Charness (2000), Duffy and Feltovich (2002), and Agranov (2024) communication is one-way, where a randomly selected player sends a message before the game begins. In other treatments, Cooper et al. (1992), Clark et al. (2001), and Agranov (2024) use two-way communication, allowing both players to send messages.[6]

[6]Burton et al. (2005) survey this literature and conclude that most players announce their intention to play the payoff-dominant action and indeed follow through on these announcements. The authors discuss experimental findings in light of theoretical arguments regarding the usefulness of cheap-talk communication in games with multiple equilibria (Aumann, 1990; Farrell, 1987, 1988; Rabin, 1994). See also Jimenez-Jimenez and Cosano (2021) who study the two-person game with richer action space. In this game, two players choose numbers between 0 and 100. When two players make the same choice, each one receives a payoff equal to the chosen number. Any outcome in which two players choose the same number constitutes an equilibrium, and, as in the Minimum Effort game, these equilibria are Pareto ranked. The efficient equilibrium features both players choosing the highest possible action available. The authors document a significant increase in

Focusing on results from the Stag Hunt games that feature symmetric payoffs similar to those described in panel (A) of Figure 1, we observe that one-way restricted communication is highly effective in shifting outcomes toward the efficient equilibrium. While two-way communication can also be effective, it tends to be less consistent and shows greater variability across studies.

There are fewer studies comparing different communication technologies in Minimum Effort games, as most papers focus on a single structure. Some studies use free-form chats (Brandts et al., 2015), while others limit messages to align with the action space (Blume and Ortmann, 2007; Sahin et al., 2015; Dong et al., 2018). In some cases, signaling is done by a pre-selected player (Sahin et al., 2015; Brandts et al., 2015; Dong et al., 2018), whereas in others, all players have a means of communication (Blume and Ortmann, 2007). When only one player is allowed to communicate, their identity is either randomly determined, elected by the group, or assigned based on an unrelated task prior to the game, such as trivia questions.[7] The panel (B) of Figure 2 shows the increase in the efficiency of players' chosen strategies due to the introduction of communication at the individual level. There is currently insufficient evidence to determine whether some communication technologies are more effective than others.

The number of players. The effectiveness of communication in achieving efficient outcomes may vary depending on the number of players involved. A comparison between the left and right panels of Figure 2 suggests that, on average, communication is more effective in two-player games than in multi-player ones. However, when focusing on multi-player games, there seems to be a trend where larger groups find it easier to coordinate on efficient strategies. It is important to note that these comparisons are made across different studies, as we are not aware of any research that explicitly tests the interaction between the number of players and the effectiveness of communication.

Preferences' alignment. All studies discussed above focused on games with multiple Pareto-ranked equilibria which feature symmetric payoffs across players. Is that an important feature that determines the effectiveness of communication? Can communication shift outcomes towards more efficient ones when players derive asymmetric benefits from doing so? Agranov (2024) examines these questions and conducts treatments with and without communication for the two versions of the Stag Hunt game: one with symmetric payoffs (Game 1) and one with asymmetric payoffs (Game 2). The payoffs of these two games are summarized in Figure 3.

coordination on choosing the same number when one player can send another a suggested action.

[7] See also Brandts and Cooper (2007), where one player, designated as the manager, chooses the bonus parameter for their firm (a team of four workers) in addition to sending a text message to the team. This study is excluded from Figure 2 because the bonus choice alters the workers' payoffs.

FIGURE 3: Symmetric and Asymmetric Stag Hunt Games (Agranov, 2024)

	Player B	
Player A	Left	Right
Top	7, 7	6, 0
Bottom	0, 6	9, 9

(A): Game 1: Symmetric payoffs

	Player B	
Player A	Left	Right
Top	7, 7	6, 0
Bottom	0, 6	7, 11

(B): Game 2: Asymmetric payoffs

The effectiveness of communication in the two versions of the Stag Hunt is presented in Figure 2 with orange bars depicting the asymmetric payoffs game. A consistent pattern emerges when comparing the orange bars with the others. The effectiveness of communication in Stag Hunt games appears to depend on the alignment of players' preferences. Communication is highly effective when players benefit equally from achieving the Pareto-dominant equilibrium, as seen in all Stag Hunt games with symmetric payoffs. However, when only one player stands to gain from coordinating on the efficient outcome, as in Game 2, the impact of communication is significantly limited.

Insight 1: Communication enhances coordination on efficient equilibrium in games in which multiple equilibria can be Pareto ranked. The effectiveness of communication depends on the number of players, the communication structure, and the preferences alignment between players. In two-player games, coordination is notably high even with highly restrictive communication. Coordination tends to become more challenging in larger groups and when communication tools impose more restrictions. Preferences' alignment is an important determinant of the effectiveness of communication: when both players stand to benefit from coordinating on an efficient outcome, communication is highly effective; otherwise, the effect of communication is quite limited. Further experiments are warranted to validate the interaction effect between group size and the richness of communication, particularly in larger groups.

2.2 Games with No Natural Ranking of Equilibria

In some games, there is no natural ranking of equilibria. Instead, there are multiple equilibria with the same total surplus, but unequal, payoffs to the players. This complicates the play: both players prefer to coordinate on any equilibrium rather than to miscoordinate, but players may disagree about the ranking of equilibria. This is the case in the Battle of the Sexes and the Chicken games presented in Figure 4 and in the Volunteers' Dilemma discussed below.

FIGURE 4: Payoff matrices for games with multiple equilibria with no natural ranking

	Player B	
Player A	Left	Right
Top	0, 0	600, 200
Bottom	200, 600	0, 0

(A): Battle of the Sexes (Cooper et al., 1989)

	Player B	
Player A	Left	Right
Top	70, 70	50, 80
Bottom	80, 50	40, 40

(B): Chicken game (Duffy and Feltovich, 2002)

	Player B	
Player A	Pink	Blue
Pink	10, 10	0, 0
Blue	0, 0	10, 10

(C): Pure Coordination (Wang and Houser, 2019)

Communication structure. There are only a handful of studies on the effects of communication in such games and the results are mixed. Cooper et al. (1989) study the Battle-of-the-Sexes game (panel (A) in Figure 4) and compare three communication structures: no communication, the one-way communication with a randomly selected player being able to send a non-binding message indicating his action to another player, and the two-way communication, in which both players send their intentions before playing the game. Without communication, players coordinate on one of the two pure strategy equilibria in 48% of cases. The addition of communication helps, but the effect depends on who can speak. When both players can speak, the coordination rates increase to 55%, while with one-way communication, the coordination rates are as high as 95%. Duffy and Feltovich (2002) study one-way communication by a randomly selected player in the Chicken game (panel (B) in Figure 4) and find that one-way communication has a rather small effect both on coordinating on which equilibrium to play and on reaching the efficient outcome, which is not an equilibrium. Players coordinate on playing one of the equilibria 48% of the time without communication compared to 53% in the treatment with one-way communication implemented as in Cooper et al. (1989). Wang and Houser (2019) study the two-person pure coordination game (panel (C) in Figure 4), which features no disagreement on equilibria ranking between players. They find that free-form messages improve coordination rates because these messages include both signaled intentions and attitudes, which players take into account when making their decisions. Two-dimensional restricted communication was as good as free-form in coordinating players' actions, but one-dimensional communication was not as effective.

Incomplete information. Hu et al. (2020) introduces private information about the relative benefits of coordination on different equilibria in the Battle of the Sexes game, and study the effects of restricted and unrestricted communication on play. In both structures, subjects tend to exaggerate their private information, but talking helps coordination on which equilibrium to play.[8] The free-form communication performs much better than

[8] When two players send different messages, the modal behavior is to coordinate on the preferred action of the player who sends the higher message.

the restrictive one, raising the coordination rates to 85% and almost doubling the players' payoffs.

The number of players. The Volunteer's Dilemma game (Diekmann, 1985) is the multiplayer version of the Battle of the Sexes game. A group of people needs one volunteer to perform a task; the task is costly, which is why everyone prefers that someone else do it. However, all players agree that the worst outcome occurs when no one performs the task. This game has many pure strategy equilibria, each featuring another player performing the costly task, and resulting in unequal payoffs to players. Feldhous and Stauf (2016) study whether allowing one player to send a message indicating whether or not they intend to volunteer affects coordination in groups with three members in total. The findings show that one-way communication is effective at ensuring that at least one group member volunteers and marginally raises average payoffs across all members. Senders predominantly say they do not intend to volunteer, which prompts one of the remaining group members to volunteer. As a result, the efficiency gains are solely appropriated by the sender.

Insight 2: Communication has limited success in improving coordination rates in complete information games with multiple equilibria, which cannot be Pareto ranked and feature asymmetric payoffs.[9] However, the existing papers predominantly focused on restricted communication with the message space being confined to the action space. It is unclear whether free-form communication could substantially alter these results and mitigate the payoff asymmetry presented in complete information mixed-motive games. In coordination games with private information, unrestricted communication is quite effective at raising coordination rates.

3 Games with Unique Equilibrium

3.1 Social Dilemmas

The social dilemma settings are defined by two properties (Dawes, 1980): (a) individuals receive higher payoffs if they defect rather than cooperate, regardless of what others do, and (b) everyone is better off when everybody cooperates. Three classical social dilemma games have been studied in the literature. The Prisoner's Dilemma game (PD) is a two-player binary actions game, in which the equilibrium is not the socially optimal outcome (see Figure 5). The Public Good game (PG) typically features more than two players, who choose the proportion of the private endowment they wish to contribute to a public project. The tokens contributed to the public project are multiplied by a factor greater than one but less than the number of players. Each player enjoys the benefits of

[9] The exception is one-way communication in the Battle of the Sexes game studied by Cooper et al. (1989).

FIGURE 5: Payoffs in the Prisoner's Dilemma

	Player B	
Player A	Cooperate	Defect
Cooperate	90, 90	10, 120
Defect	120, 10	70, 70

Prisoner's Dilemma game
(Charness, 2000)

the public project, regardless of their investment in it, in addition to the tokens they do not contribute. The unique equilibrium of the game is to free-ride and contribute nothing, while the socially optimal behavior prescribes allocating all tokens to it. In the Common Pool Resources game (CPR), one player's consumption of resource units removes these units from the common pool. When the resource units are highly valued and all players have open access to the pool, players face strong incentives to appropriate more and more, leading to overuse and depletion of the resource. This individually optimal behavior is at odds with socially optimal behavior, according to which there exists a socially optimal level of appropriation that maximizes the joint surplus. The main difference between the PG and the CPR games is that the efficient outcome in the former entails all group members contributing their entire endowment to the public good, while the efficient outcome is sustained at the interior extraction level in the latter game.

There is a relatively strong consensus in the literature that communication in experimental social dilemmas increases the frequency with which players choose joint payoff-maximizing strategies, despite the conflict between individual incentives and cooperative strategies. For overviews, see Sally (1995); Ledyard (1995); Chaudhuri (2011); Balliet (2010); Ostrom (2006); Bicchieri and Lev-On (2007). Why? What are the main forces driving this positive effect of communication on cooperation? There are several. First, communication enables parties to establish an informal agreement by which actions should be taken. That is, communication reduces strategic uncertainty about what other players would do and facilitates the development of mutual beliefs about the behavior of others. Second, communication has been shown to focus players' attention on pro-social norms which shape mutual beliefs and drive the results toward more efficient outcomes.

Communication structure. The structure of communication affects how effective communication is at promoting socially optimal behaviors. Face-to-face or voice communication is extremely effective and is capable of sustaining the highest cooperation levels

(see Jensen et al. (2008) for the PD games, Isaac and Walker (1988); Bochet et al. (2006); Frohlich and Oppenheimer (1998) for the PG games and Ostrom and Waker (1991); Ostrom et al. (1992) for the CPR games).[10] Brosig et al. (2001) clarify this pattern and establish that audio communication without face-to-face interaction performs significantly worse in the PG games than face-to-face communication implemented via video conference or via face-to-face interaction; the latter two mediums are equally effective. Among written communication protocols, free-form communication between all group members seems to be the most effective one, but not as effective and more fragile compared with face-to-face communication (see Bicchieri and Lev-On (2007) for the evidence in the PG games and Rocco and Warglien (1995) for the CPR games). Restricting communication by allowing players to communicate only their intended actions strongly diminishes beneficial properties of communication and leads to either small or no effect at all compared with no communication condition (see Charness (2000) and Duffy and Feltovich (2002) for such evidence in the PD games, and Bochet and Putterman (2009); Wilson and Sell (1997); Bochet et al. (2006) for the evidence in the PG games). Similar effects are observed in threshold public good games with uncertainty about contribution costs among group members. Palfrey et al. (2017) explore the effect of communication structures in such a setting and find that communication increases efficiency only if group members can communicate freely via unrestricted chat but not if they are limited to indicating their contributing intentions or their cost threshold via pre-specified message. We are not aware of studies that look at the effect of numerical written communication in the CPR games. Finally, restricting communication to a one-way channel from either an elected or randomly determined leader suggesting contribution levels to other group members increases contribution levels initially but these effects are only short-lived and not sustainable (Levy et al., 2011).

The number of players. The size of the group facing the social dilemma may affect the impact of communication on cooperation rates. If the main benefit of communication lies in reducing strategic uncertainty and promoting coordination on a socially beneficial outcome, then one would expect the effect of communication to become weaker as the group grows larger. This expectation, however, is not born out. Pavitt and Broomell (2016) study

[10] Frohlich and Oppenheimer (1998) report stable patterns of high contribution across multiple rounds of play with face-to-face communication and also stable but lower contribution levels with email communication. Bochet et al. (2006) show that with both face-to-face and written free-form communication, the average contributions decline over time, but the decline is very mild and could be driven by the end-of-experiment effect. Isaac and Walker (1988) found that face-to-face communication not only enhances cooperation in the round immediately following the interaction, but its positive effects also persist through subsequent iterations, even in the absence of further communication. A comparison of contribution levels in the first rounds across different communication structures reflects similar patterns to those observed when averaged across all rounds.

the CPR games with different group sizes and find that, in the presence of face-to-face communication, the group size does not affect the efficacy of communication. Balliet (2010) conducts a meta-analysis of communication and cooperation in all three social dilemmas games (the PD, the PG, and the CPR games) and finds that communication has stronger effects on cooperation in larger rather than in smaller groups, the opposite from our intuition above. It is still not clear what the root of this result is, and more research is needed to pin down the interaction between the group size and the communication in the social dilemma settings.

Preferences' alignment. Most of the studies discussed above consider symmetric social dilemma environments, in which all players start with the same endowments and benefit equally when cooperative outcome is implemented. The question is whether or not this is an important feature of the environment. Absent communication, heterogeneity in endowments, and differential benefits from the public good provision or common resource have been identified as possible impediments to cooperation (Ostrom, 1990; Cherry et al., 2005; Hacket, 1992; Margreiteri et al., 2005).[11] Heterogeneity brings to light distributional conflict among players, since some benefit more than the others from public good (common resource). Can communication overcome such a problem? There is not enough evidence to draw any conclusions yet about this point. For the public good games, Isaac and Walker (1988) run treatments with symmetric and asymmetric endowments and find that communication is less effective in groups with asymmetric endowments. However, the participants in these experiments were not told what the endowments of other group members were. This confounds the effects of asymmetric endowments with those of incomplete information.[12] Chan et al. (1999) look at the effects of face-to-face communication as they vary the degrees of heterogeneity between players: the heterogeneity may be in endowments, in benefits from the public good, or in both. They find that communication significantly increases contributions when group members differ in one dimension, but the effect vanishes when members differ on both dimensions. For the CPR game, the only study that we are aware of is Hackett et al. (1994), who study the game with two types of appropriators: some have large initial endowments, and others have small ones. Hackett et al. (1994) find that face-to-face communication was powerful enough to overcome this distributional conflict and in seven out of eight experiments, the rent extractions were approximately socially optimal. More research is needed to confirm these results and evaluate their robustness.

[11] Margreiteri et al. (2005) study homogeneous and heterogeneous groups in the CPR setting and find that homogeneous groups reach more efficient outcomes when groups can vote on the allocation scheme but not otherwise.

[12] Isaac and Walker (1988) report that discussions during communication periods in the symmetric games support the view that subjects acted "as if" endowments were equal.

Insight 3: Communication promotes cooperation and increases efficiency in social dilemma settings. The richness of communication protocol directly translates into the effectiveness of communication with face-to-face communication being the most effective over all mediums and free-form messages being the most effective among written communication. More research is needed to explore the interaction between the efficacy of communication and the group size, as well as the heterogeneity among group members.

3.2 Trust Games

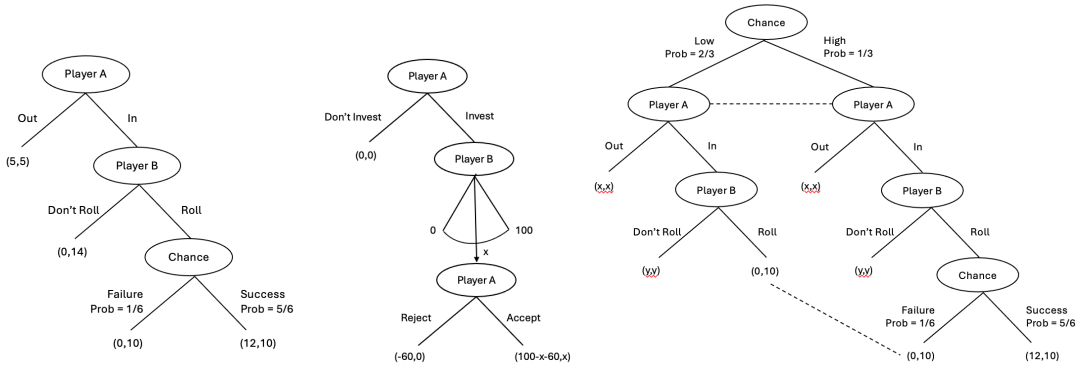
This class of games represents settings in which players act sequentially and have opportunities to form partnerships. Partnerships are beneficial for both players, but are risky for the first mover since the second mover may appropriate all of the proceeds of the partnership. Similar to Social Dilemma settings, the unique Subgame Perfect Equilibrium in this class of games is inefficient, while there exists a different outcome, which maximizes the joint surplus but is not an equilibrium. Communication between players has a natural role in such games as it may serve as a platform for establishing trust between players, curbing the opportunistic behavior of the second mover, and facilitating the play of the efficient non-equilibrium outcome.

In the original version of the Trust Game (Berg et al., 1995) player A can send some or none of their endowment to player B, who receives triple the amount sent. B can then return some or none of what they received to A.[13] Theoretically, B should never return any money to A, which is why A would send nothing to B in the first place. This subgame perfect equilibrium is inefficient, as money triples when it exchanges hands. Several studies have examined the impact of communication in this basic game, generally finding that pre-play communication fosters trust and improves efficiency (panel (A) in Figure 7). These studies differ in the way communication was introduced: Lev-On et al. (2010) allows for free-form communication between both players, Servatka et al. (2011) permits free-form communication only from player B to player A, while Ben-Ner and Putterman (2009) and Ben-Ner et al. (2011) conducts several treatments, some with two-way free-form communication and others with two-way restricted communication.

Three additional variants of the Trust Game have been studied to explore the effects of communication. Charness and Dufwenberg (2006, 2010) examine a hidden-action game, depicted in panel (A) of Figure 6, where a chance move conceals player B's action from player A. As a result, A may receive a low payoff whether B chooses Roll or not, removing perfect observability. Charness and Dufwenberg (2006) investigate two versions of this hidden-action game: Game 1 with payoffs as depicted in panel (A) of Figure 6 and Game 2, which modifies players' payoffs from (5,5) to (7,7) when player A chooses Out.

[13] The game was originally called the Investment Game when it was introduced by Berg et al. (1995), but quickly changed its name to the Trust Game in the follow-up literature.

FIGURE 6: Trust Games



(A): Hidden-action game (B): Hold-up problem (C): Hidden-information game

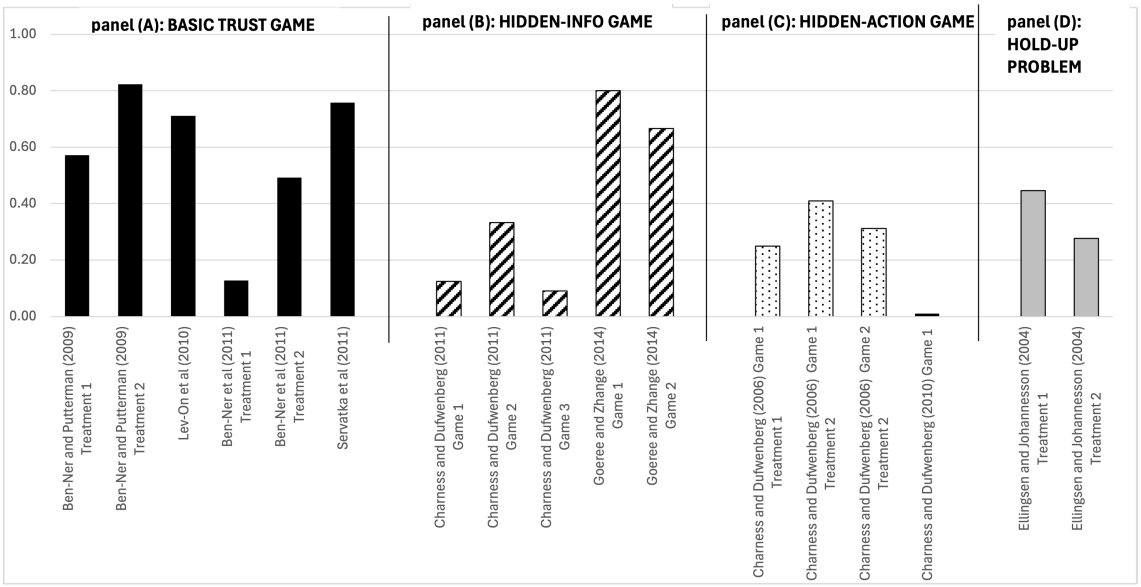
Notes: Panel (A) depicts the extensive form of the hidden-action game studied in Charness and Dufwenberg (2006, 2010). Panel (B) depicts the hold-up problem studied in Ellingsen and Johannesson (2004). Panel (C) depicts the hidden-information game studied in Charness and Dufwenberg (2011).

The addition of the chance move in the hidden-action game does not alter the theoretical prediction according to which the first movers should opt out knowing that the second mover will choose Don't Roll. In the experiment, the authors vary which player can send a free-form message: in Treatment 1, it's player A; in Treatment 2, it's player B. Charness and Dufwenberg (2010) focuses on Game 1 and allows player B to send a predetermined message to A, stating, "I promise to choose Roll." The panel (C) in Figure 7 shows that while free-form messages are somewhat effective at persuading player A to choose In, the predetermined message has no such effect.

Ellingsen and Johannesson (2004) look at the related hold-up problem depicted in panel (B) of Figure 6. The hold-up problem has an additional stage, in which the first player either approves or rejects the allocation proposed by the second mover. The addition of the approval stage in the hold-up problem does not change the predicted outcome: the first-mover is expected to refrain from investing. The different treatments in the paper investigate whether the effectiveness of communication depends on which of the two players can speak and what kinds of messages are allowed. In Treatment 1, player A could send a free-form message to player B, while in Treatment 2, the sender was player B. Both the identity of the sender and the content of messages affected trust and the tendency of the first player to invest (panel (4) in Figure 7).

Charness and Dufwenberg (2011) and Goeree and Zhang (2014) study the hidden-information game in which player B can be either a low type or a high type (panel (C) in Figure 6). Both types can complete an easy project denoted by action Don't Roll or a hard project denoted by action Roll. Player A does not observe B's type and, thus, cannot

Figure 7: Effectiveness of communication in Trust Games



Notes: We report the percentage increase in the frequency of the first-mover choosing an efficient action in the communication treatment relative to the no communication treatment. In the basic trust game, this is the proportion of endowment that player A transfers to player B. In the hidden action and hidden information games, this is the likelihood that player A chooses In. In the hold-up problem, this is the likelihood that player A invests.

condition their action on it. The parameters (x, y) are varied in Charness and Dufwenberg (2011) from $(5, 5)$ in Game 1 to $(5, 7)$ in Game 2 to $(7, 7)$ in Game 3. In Goeree and Zhang (2014) both games correspond to the parameterization $(5, 7)$. In all versions of the game, the efficient outcome cannot be achieved due to adverse selection problem.[14] The theoretical prediction is that both types of player B choose Roll and player A choose Out. Both Charness and Dufwenberg (2011) and Goeree and Zhang (2014) allow player B to communicate freely with player A and find that this increases the frequency of efficient outcomes. The magnitude of the effect is different across these two papers. In Charness and Dufwenberg (2011) the effect is the largest when $(x, y) = (5, 7)$, i.e. when player B strictly benefits from playing the efficient outcome.

Insight 4: Communication may enhance efficiency in sequential trust games, but the degree to which it does so hinges on both the message technology and the specifics of the game. Free-form communication by both players proves highly effective in the basic trust game. However, restrictions imposed on natural communication, either by limiting the message space or by dictating who can speak, in general, diminish the beneficial impact

[14] The socially optimal outcome is for player A to hire a low type for an easy project and a high type for a hard project. This outcome can be achieved in the complete information game.

of communication.[15] The alternative versions of the trust game have only been examined with one-way communication; these versions have demonstrated responsiveness to free-form messages. However, an open question remains as to whether the two-way communication between players through natural language can lead to efficiency levels comparable to those achieved in the basic trust game.

3.3 Oligopoly Market Games

Communication has been explored in market-sharing games, in which collusion is possible. Players who attempt to collude in pursuit of higher profits might use cheap-talk to coordinate their actions and reduce strategic uncertainty about others' actions. The two classical games considered in the literature are markets with price competition, a la Bertrand games, and markets with quantity competition, a la Cournot games. In both settings, communication has been shown to move the markets' outcomes towards collusive ones, even though these are typically not equilibria outcomes.

Communication structure. The extent to which communication helps depends on the communication format implemented in the market interactions. Restricted communication protocols such as unilateral announcements of future prices have small and typically temporary effects (Holt and Davis, 1990, 1995; Andersson and Wengstrom, 2007; Harrington et al., 2016). On the contrary, face-to-face or free-form written communication between all participants leads to diminished competition, higher prices, and higher profits for all colluding firms (see Friedman (1967); Isaac et al. (1984); Fonseca and Normann (2012); Harrington et al. (2016) for the evidence in the Bertrand games and Daughety and Forsythe (1987); Waichman et al. (2014); Gomez-Martinez et al. (2016); Freitag et al. (2019) for the evidence in the Cournot games). Further, Lee and Hoffman (2021) show that the effect of cheap talk on price collusion in the Bertrand game depends on the frequency of communication: recurrent communication is required to sustain collusion as prices tend to decrease in rounds in which communication is forbidden.

Several papers have explored the effects of free-form communication in more intricate market structures. Mollers et al. (2017) study the vertical markets with two downstream firms and vary who can speak with whom. The two-way private communication between the upstream and each downstream firm reduces the aggregate quantity to the halfway point between no communication Cournot level and joint profit-maximizing monopolistic level, while the three-way unrestricted communication closes the remaining gap and results in essentially complete monopolization of the market. Normann et al. (2015) augment the Cournot game with the pre-play stage in which firms simultaneously decide

[15] The exception is high efficiency observed by Servatka et al. (2011) in the basic trust game with free-form communication from the second mover to the first mover.

whether they wish to join the buyer group. If enough firms join, then the in-group firms procure the product at a lower marginal cost compared with the out-group firms. Firms use free-form communication to establish quantitative agreements on outputs and such agreements are very effective at supporting collusion. This contrasts with non-quantitative collusive statements, which do not reduce competition in markets.

The number of players. Only two studies systematically varied the number of firms that attempt to collude in markets and studied the ability of larger groups to sustain collusion using cheap talk. Waichman et al. (2014) compare duopolies and triopolies in Cournot-type markets and find that a higher number of players makes collusion harder. Fonseca and Normann (2012) study the effectiveness of communication in achieving collusive outcomes in Bertrand-type markets with two, four, six, and eight players and find that the gains from communication do not monotonically decline in the number of firms but instead are inverse U-shaped with the medium-sized industries gaining the most from talking.[16]

Asymmetries between players. Most of the studies discussed above used symmetric environments with identical firms.[17] Very few studies explored the effect of asymmetries between market participants in these settings. Harrington et al. (2016) consider a variant of the Bertrand price game with sellers that may have different cost functions. In each period, a seller chooses a price and a maximum quantity to be sold. A seller sells the minimum of its demand and the maximal quantity it selects. The authors vary whether the sellers have symmetric or asymmetric costs and the number of sellers in the market. Price announcements raise prices only in duopolies with symmetric sellers, but do not lead to higher collusion in markets with more than two sellers or with asymmetric sellers. On the contrary, free-form communication is quite effective at inducing collusive outcomes regardless of the number of sellers and heterogeneity in sellers' costs. Fischer and Normann (2018) study how asymmetric Cournot duopolies collude in experiments and vary whether the role of the efficient firm is earned in a contest or assigned randomly. Their findings suggest that communication tends to benefit the inefficient firm, which is why efficient firms are less likely to engage in communication when such communication is optional. In addition, when roles are earned and firms can talk to each other, they often collude by producing equal amounts, which is at odds with the theory of asymmetric Cournot games.

[16] This finding is driven by the fact that even without communication, markets with two firms manage to collude frequently, while such collusion is practically absent in markets with more than two players. This coupled with the monotonic decrease in the overall frequency of collusive outcomes under communication protocols produces the inverse U-shaped gains from communication.

[17] The exception is Daughety and Forsythe (1987) who allow for asymmetries between firms' cost functions, but participants did not know the cost function of their opponent, and, as a result, the beliefs about the opponent's costs are not controlled.

Guth et al. (2018) study intra-play communication in a capacity- then price-setting game with capacity installation costs, which are sunk and firms being able to collude in prices. The authors find that asymmetries in capacity make coordinating on the same price more difficult and reduce the truthfulness of price messages, overall making communication less effective.

Incomplete Information. Cason and Mason (1999) study the duopoly Cournot game with uncertain demand. Both players receive a partially informative signal about demand in the current round and choose whether to share this signal before playing the symmetric duopoly game with homogeneous goods and linear demand. The results show that players often share their private information; however, the effect on the output choices in the Cournot game is limited. As a result, information sharing does not increase collusion.

Procurement of Goods via Auctions. Only a few papers explored cheap-talk communication in auction settings. Isaac and Walker (1985) consider the first-price independent private value auctions with four bidders with and without face-to-face communication. With communication, bid-rigging cartels are often but not always sustained: all players bid zero and the highest value wins. The rotation scheme is implemented since players play repeatedly with each other.

The next two papers focus on the one-shot auctions. Noussair and Seres (2017) consider two-person second-price sealed-bid auctions in which bidders' valuations have both private and common value components. Bidders choose whether to form a cartel or compete with each other. Bidders who choose to form a cartel can communicate with each other using a free-form chat option and make side payments using a knockout auction. A large fraction of bidders join cartels and efficiency is significantly reduced as a result of it. Agranov and Yariv (2018) study the effects of free-form communication in both first- and second-price independent private value auctions. In some treatments, bidders can talk to each other after observing their private values and before the bidding stage, while in others, they can also transfer money to one another after seeing the auction's results. Communication by itself has a limited effect on prices in both auction formats. However, coupled with transfers, communication is extremely effective: over 70% of both first- and second-price auctions culminate in the object being sold at zero price.

Finally, we note that except for the last two papers on communication in auctions, most papers discussed in this section implement the repeated version of the market-sharing game, in which players are allocated to groups at the beginning of the experiment and play several rounds in this fixed matching (Freitag et al., 2019; Fonseca and Normann, 2012; Normann et al., 2015; Guth et al., 2018; Harrington et al., 2016; Lee and Hoffman, 2021; Fischer and Normann, 2018; Cason and Mason, 1999). This fixed matching allows

players to fine-tune their beliefs about actions of their group members, which is essential for successful collusion. At the same time, this design choice might lead to additional repeated game effects, which are not present in the one-shot market games.

Insight 5: Free-form communication is effective at reducing competition and establishing successful collusive outcomes in market-sharing games with symmetric firms. In games with incomplete information, communication coupled with side transfers reduces prices and increases collusion; however, without transfers, communication has only limited effects. A larger number of market firms and asymmetries between the firms seem to reduce the effectiveness of communication. More studies are required to validate these results and establish their robustness.

4 Bargaining games

Bargaining games with complete information at first glance feature no clear role for communication. In these games, a group of people with two or more members is charged with dividing available resources between members, subject to the rules of bargaining. These rules specify who makes allocation proposals, how these proposals reach the voting stage, and how many votes are required to pass the proposal. Theoretically, the continuation values of all players are pre-determined by the primitives of the game, so there should be nothing to talk about except for mitigating strategic uncertainty about others' behavior and perhaps resolving distributional conflicts that may lead to inefficient delays in reaching agreements in some bargaining games.[18]

Two-person bargaining games. We start our review with the simplest Dictator game, in which one player makes a binding allocation of a fixed budget, and all allocations are equally efficient. Several papers showed that allowing receivers to send messages increases the generosity of proposers. Andreoni and Rao (2011) establish that anytime the receiver can speak, the resulting allocations are more egalitarian. Mohlin and Johannesson (2008) show that this is true even if these messages are composed by participants in a different experiment. Xiao and Houser (2007) and Ellingsen and Johannesson (2008) demonstrate the effect persists even if receivers send a message to the proposer after the allocations are implemented. This result is known in the literature as the "power of asking." It suggests that communication decreases the social distance between bargainers with conflicting interests and may promote more altruistic behavior.

[18] In this section, we focus on bargaining games in which the budget is fixed and the set of possible allocations is unrestricted, leaving the decision of how to divide the budget in the hands of the bargainers. These bargaining games differ from coalition negotiation games, in which the value appropriated by any subset of players is explicitly specified by the experimenter and the sum of these values differs between coalitions. We refer the reader to Charness (2012) who discusses the effects of communication in such games.

The Ultimatum game adds a strategic component to this setting by requiring the recipient to accept or reject the proposed allocation and, as a result, the layer of strategic uncertainty. Starting with Roth (1995) the literature documented the beneficial effects of communication in the Ultimatum game. Roth (1995) and Zultan (2012) compare three versions of the Ultimatum game: one without communication, one with face-to-face unrestricted communication, and one with face-to-face communication, in which players are not allowed to discuss the bargaining game per se but can engage in social conversation with each other. Both types of communication decrease the disagreement rates and result in a more equal distribution of resources between the two players. Both papers also find that the likelihood of equal splits is higher in the unrestricted communication treatment than in the restricted communication treatment, with this difference being much larger in Roth (1995) than in the Zultan (2012) paper.[19] The more restricted versions of communication are less effective at promoting egalitarian outcomes and, in fact, often work to the contrary. Rankin (2003) finds that responders' payoffs were lower in the Ultimatum games in which they could request money before proposals were made. Andersson et al. (2010) show that proposers' payoffs are higher in Ultimatum games in which they can send messages to the responders before they make their decisions.

Multilateral bargaining. What happens when the bargaining group becomes larger? Does communication play a similar role and lead to more egalitarian outcomes? The answer is no. Agranov and Tergiman (2014) and Baranski and Kagel (2015) compare bargaining outcomes in committees that use Baron-Ferejohn bargaining protocol with majority voting rule and vary whether committee members can communicate via free-form text messages. Contrary to the two-person bargaining games discussed above, the introduction of communication moves outcomes further away from egalitarian ones and closer to those predicted by stationary subgame perfect equilibrium. In particular, the vast majority of passed allocations feature minimum winning coalitions, in which only half of the committee receives positive shares, and proposers appropriate a significantly higher share of resources as compared to no communication treatment. The mechanism that drives these results resembles the auction for a place in the coalition, which occurs between non-proposers. Recognizing that a simple majority is enough to pass a proposal, non-proposers compete with each other for a place in the coalition by announcing their reservation prices. The proposer exploits this competition by inviting the cheapest members into the coali-

[19] See also Brosig et al. (2004) who study the effects of communication in the two-stage sequential bargaining game with pre-specified distribution of resources among bargainers. In this game, the unique subgame-perfect equilibrium prescribes allocation which is not socially optimal and entails different payoffs to two bargainers. When players can talk using a video conference tool, many pairs reach a socially optimal outcome, despite its being non equilibrium. The email communication, which preserves anonymity between bargainers, moves results in the same direction but is less effective than face-to-face communication.

tion and appropriates the remaining resources. The communication patterns show that most communication is private and contains conversations about the reservation values of non-proposers. In addition, committees that were allowed to communicate reduced the frequencies of delays which are not common but do happen at times without communication.

The competition between non-proposers is a fundamental feature of bargaining in groups with more than two players as long as the voting rule does not require unanimous support to pass proposals. When unanimous support is mandated by the institutional rules, Agranov and Tergiman (2019) show that the introduction of communication leads to more egalitarian allocations, similar to the Ultimatum game. In this case, most communication is public and contains conversations predominantly about fairness, equality, and social concerns. These conversations affect proposers' behavior since each committee member has a de facto veto power.

Incomplete Information. There is little research on the effects of communication in bargaining games with incomplete information. One of the few papers that study this is Brandts et al. (2016) who demonstrate that free-form communication affects the types of contracts that bargainers choose when faced with uncertainty about the seller's cost. The game features two bargainers: the buyer who can choose a contract type (flexible or rigid) and a price and the seller who can choose whether to accept or reject the offered contract. If the seller rejects the contract, both parties receive the outside option payments. If the seller accepts the contract, the seller delivers a good to the buyer. The seller's cost is realized after the contract stage. If parties agree on a flexible contract, then the buyer can adjust the initial price after observing the cost of the seller. However, if the rigid contract is chosen, the initial price cannot be adjusted. The authors show that relative to the no communication treatment flexible contracts become a more popular choice in the treatment with free-form communication. These flexible contracts deliver higher efficiency and higher earnings for both players. The success of flexible contracts in settings with communication stems from the ability of bargainers to make informal agreements and promises, which effectively remove the ambiguity of flexible contracts.

Insight 6: Communication mitigates strategic uncertainty in bargaining games with complete information and reduces inefficiencies that come from delaying agreements. Whether the introduction of communication leads to more or less egalitarian outcomes depends on the committee size, the voting rule used by the committee, and the communication structure. The initial studies of bargaining with incomplete information suggest the additional benefits of free-form communication in such settings. More work is needed to understand how sensitive these results are to the communication protocol and details of the bargaining situation at hand.

5 Collective Decisions and Voting Games

Voting games combine features of team competition and free-riding within teams. The standard voting game, known in the literature as the participation game (Palfrey and Rosenthal, 1983), consists of two groups of voters with commonly known group sizes. The two groups compete against each other. Each voter decides whether to vote or abstain without knowing the choices made by other voters. Voting is costly and, as a result, the free-riding problem arises within groups. Palfrey and Rosenthal (1983) consider the winner-take-all election system with plurality rule and show that, theoretically, this game features either one or two quasi-symmetric Nash equilibria, in which all members of the same team participate with the same probability.[20] The introduction of communication may introduce correlation in voting decisions and, as a result, expand the set of equilibria and predicted turnout rates that can be sustained in these settings. Given this, it is natural to ask how communication among voters affects turnout.

In the remainder of this section, we provide a partial overview of the experimental literature on the effects of communication in voting games focusing on the differences between game structures and communication protocols. We refer the reader to the excellent survey by Martinelli and Palfrey (2020) which partially overlaps with our overview but in addition considers a larger set of pre-election activities including costly communication and information acquisition activities.

Two-Candidate Elections with Complete Information. Schram and Sonnemans (1996) investigate a participation game with two equally-sized groups with and without communication. The authors vary whether the election winner is determined by the winner-take-all rule or proportionally, effectively mimicking a proportional representation scheme. The communication is implemented as a five-minute face-to-face communication between group members after they have played 20 rounds without communication. The results show that communication increased turnout in both systems but the effect is stronger in the winner-take-all system. Palfrey and Pogorelskiy (2017) focus on the winner-take-all scheme, but vary the relative sizes of the two groups in addition to variation in voting costs and the communication structure. In one treatment, there was no communication. In another, the communication was restricted to group members only, i.e., group communication. In the third treatment, the communication was broadcast to the entire society, i.e., public communication. In the treatments with communication, participants could send any free-form message via a chat box located on the screen. The main result of the experiment is that both types of communication benefit the majority group by increasing

[20] This game also has asymmetric equilibria, but most of the studies abstract away from these equilibria due to the complexity of coordinating their implementation.

their turnout rates and corresponding winning probability. Similarly to Schram and Sonnemans (1996), Palfrey and Pogorelskiy (2017) find that party communication increases turnout, but the effects of public communication are more nuanced and depend on the voting costs.

Two-Candidate Elections with Incomplete Information. A few papers explored the effects of communication in voting games with uncertainty about the distribution of preferences among voters. In this setting, a group of voters collectively chooses one of two alternatives. The returns to each alternative depend on the realization of the underlying state. Voters receive private signals about that realization and choose whether to vote for one of the alternatives or abstain (if abstention is allowed). Guarnaschelli et al. (2000) and Goeree and Yariv (2011) consider the game with costless participation and different communication structures. Guarnaschelli et al. (2000) study majority and unanimity voting rules and allow for restricted communication in the form of a straw poll vote preceding the actual vote. They find that voters tend to disclose their private information in the polls but do so less than predicted by the theory. The overall effect of such restrictive communication on election outcomes was not very large, with the notable exception of the majority rule, in which pre-election polls increase strategic voting.[21] Goeree and Yariv (2011) study a similar game with unrestricted free-form communication among voters. In treatments with communication, voters could send any message to any subset of voters in their group. The authors vary the distribution of preferences among subjects (some featuring common interests, while others allowing for heterogeneity in preferences) and the voting rule used by the group to make decisions (majority, super-majority, and unanimity). The introduction of communication significantly improves efficiency and reduces the difference in outcomes that emerge under different voting rules. The latter effect is strongest when voters have common preferences.

Agranov et al. (2018) study the variant of this game, in which voting is costly and voters can abstain from participating. Voters know their preferences but are unsure of how many others share their preferences. The most relevant to our survey is a comparison between the treatment without communication and the one with non-binding pre-election polls, in which aggregate statistics about voters' intentions were communicated to all group members. Pre-election polls increase majority participation and decrease minority participation rates. These voting patterns have an important effect on the overall

[21] See also Pogorelskiy and Shum (2019) who introduce media bias in voters' private signals and study how voters share this news depending on the social network that ties them together. The authors study two network structures: the polarized network, in which supporters of the same candidate have social connections with each other but not with the supporters of the other candidate, and the complete network, in which all voters are connected. The results show that voters share news which favors their preferred candidate and do not account for such biased information dissemination when they vote.

welfare: polls do not have detrimental welfare effects since the winning probability of the majority-preferred candidate is higher than theoretically predicted.[22]

Finally, Grosser and Schram (2010) and Klor and Winter (2007) consider experimental polls that reveal the precise distribution of preferences in the electorate, which transforms the game into the Palfrey and Rosenthal (1983) participation game.[23] They find that polls, by and large, increase turnout and have welfare effects that depend on how equally divided support is. When there are unequal levels of support, polls have non-negative welfare effects. However, in closely divided electorates, polls have detrimental effects on welfare.

Multi-Candidate Elections. Several papers explored the effects of communication in multi-candidate elections. Forsythe et al. (1993, 1996) consider the elections between three candidates in a society in which voters' preferences among these three candidates are known. The setup is such that a majority of voters, which is less than two-thirds of the whole electorate, is split in their preferences between two similar candidates, while a minority favors the third candidate. If all voters vote sincerely, the third candidate who is the Condorcet loser wins the election. However, if the majority of voters coordinate on supporting one of their candidates, then the win of the Condorcet loser can be avoided (Duvergenian equilibria). The experiments show that non-binding pre-election polls help majority voters to coordinate actions on one of the majority-favored candidates. This strategic behavior by the majority voters reduces the frequency with which the Condorcet loser wins, which is the most common outcome without polls. See also Rietz (1993) for similar results.

Kittel et al. (2014) consider a variant of the multi-candidate setting, in which voting is costly and communication between voters is structured differently. In some treatments, voters cannot communicate at all, while in others they can send free-form chat messages either to other voters who share their preferences (party communication) or to the entire electorate (public communication). The authors find that without communication, the game is very complex and the majority tends to abstain. When communication is allowed, overall turnout increases, majority voters vote strategically, and the probability of the Condorcet loser winning drops significantly. There are few differences in the outcomes between the two communication conditions.[24]

[22] The theoretical results of detrimental welfare effects of polls are obtained for the perfect polls condition, in which voters observe whether they are part of the expected majority or minority given the realization of the state.

[23] See also Grosser and Schram (2006) who study the game similar to Schram and Sonnemans (1996) but introduce a type of local communication, in which some voters act as first-movers and can vote early or late, while the remaining voters observe the vote count of first-movers before they make their voting decisions. This sequentially in voting decisions serves as a form of restrictive communication between voters.

[24] See also Bouton et al. (2017) who introduce uncertainty about the size of the groups that constitute the majority. There is no communication between voters per se in this setting, but the authors compare the treatment in which voters are informed of the realized support for each majority candidate with the treatment

Insight 7: In two-candidate voting games that feature abstention, restricted communication in the form of pre-election polls generally increases turnout. In voting games, in which communication does not affect overall turnout, it changes the composition of participating voters: majority voters participate more and minority participate less when elections are preceded by polls, which ultimately benefits majority voters. In settings with uncertainty, communication tends to be truthful and highly predictive of group outcomes. The free-form communication increases efficiency and reduces the differences in outcomes that emerge under different voting rules; however, the effects of restricted communication in a similar setting are limited. In multi-candidate elections, communication increases the ability of voters to vote strategically and reduces the winning chances of the Condorcet loser.

6 Other Games

In this section, we briefly review a few other games, in which cheap-talk communication plays an important role. These papers uncover additional channels through which communication affects actions and outcomes. However, given that there are only a few such studies per game, it is hard to draw more general conclusions at this point.

Games played on networks. Charness et al. (2023) study the effects of restricted and unrestricted communication in the extended symmetric Stag Hunt game played on two networks, which differ in the degree of clustering among neighbors. The extended Stag Hunt game has three actions: one that leads to a low payoff safe equilibrium, one that leads to a higher payoff but risky equilibrium, and one that leads to a non-equilibrium outcome with the highest total surplus. The messages that contain bare intentions are not effective at reaching socially efficient outcomes, while unrestricted communication is very effective (over 90% of outcomes maximize total surplus) with the success of such communication being higher in the network with lower clustering.

Collective Resistance Game. This three-player game between the leader and two subordinates models how exploitative leaders can attempt to maintain power in a society with different interest groups (Weingast, 1997). The game features three equilibria with some degree of transgression and one socially efficient non-equilibrium outcome, in which the leader refrains from transgressing the subordinates.[25] This game has an intricate and in-

in which they are not. The former case can be viewed as the election with a poll. The introduction of the poll increases the frequency of strategic voting and Duvergenian equilibria tend to emerge. Without the poll, most voting is sincere.

[25]Specifically, the leader chooses whether to transgress against both subordinates, just one of them, or refrain from transgressing. The subordinates play a simultaneous move game after the leader makes his

teresting structure as it captures the elements of social dilemma situation coupled with endogenously arising asymmetry between subordinates.

The work by Cason and Mui explored the effects of different communication structures in this game. Cason and Mui (2007) show that the frequency of coordinated resistance increases and the likelihood of transgression by the leader decreases when subordinates can communicate with each other. This happens in the treatment, in which communication occurs after subordinates observe the leader's move, and also in the treatment, in which communication is private and happens before the leader makes their choice. The latter structure is the most effective at preventing the leader from transgressing against both subordinates. In this paper, communication is restricted to indicate intended actions only. Cason and Mui (2014) and Cason and Mui (2015) explore free-form unrestricted communication in the same game and find that unrestricted communication facilitates coordinated resistance much more than restricted protocols and repeated interaction between players. The authors document the difference in how the two subordinates communicate depending on the target of transgression.

Repeated games. A few papers have explored the effects of communication in repeated environments. These environments may feature a large set of equilibria, in which communication can be used as a platform for mutual coordination and equilibrium selection. In the absence of such communication, the coordination seems miraculous and unrealistic. Arechar et al. (2017) implement restricted communication limited to the intended actions in the infinitely repeated prisoner's dilemma. The results suggest that communication increases cooperation when returns to cooperation are high, but not when such returns are relatively low. Kagel (2018) studies unrestricted free-form communication in the finitely repeated prisoners' dilemma game, in which theory predicts no cooperation between players with common knowledge of rationality using a backward induction argument. Contrary to that prediction, communication leads to 100% cooperation in the first stage of a game compared to 50% cooperation in the absence of communication. It is not clear whether the differential effects of communication observed in these two papers are due to differences in game structure (finite versus infinite horizon, payoff matrix of the stage game) or communication structure (restricted versus unrestricted).

choice, and can either challenge the leader or acquiesce. If the subordinates do not challenge, a divide-and-conquer strategy delivers high rewards for the leader at the expense of the targeted subordinate. The beneficiary of the transgression earns a higher payoff by acquiescing than by challenging, regardless of what action the targeted subordinate takes. However, if both the beneficiary and the targeted subordinate challenge then the former incurs a small cost and they achieve the coordinated resistance outcome with payoffs equal to what they would get if the leader did not transgress. The socially optimal but non-equilibrium outcome emerges when the leader chooses not to transgress against both subordinates.

Multi-stage games. Cooper and Kuhn (2014) analyze communication in a two-stage game of conditional cooperation, in which a cooperation stage is followed by a coordination game. In this game, the credible threat to play a Pareto inferior Nash equilibrium in the second stage can theoretically support cooperation in the first one. The authors vary the type of communication available to players ranging from restricted structures (pre-play intentions with or without punishment followed by failure to reach cooperation in the first stage) to unrestricted free-form messages before each stage of the game. The results show that rich communication structures are required to sustain collusion. This supports the view that communication acts as a coordinating device via credible pre-play threats to punish deviations in the first stage. Such credible threats are not observed in the treatments with restricted communication. The possibility of renegotiation between stages further facilitates collusion.

Andersson and Wengstrom (2011) study a different two-stage game and show the harmful effect of renegotiation. The first stage is the prisoner's dilemma game, while the second stage is a coordination game with two Pareto-ranked equilibria. The authors run two treatments: one with pre-play communication, which occurs before the first stage, and another with both pre-play and intra-play communication, which occurs in between stages. The communication is restricted to intended actions in each stage with the ability to condition one's intention on the opponent's play in the first stage. Pre-play communication positively affects cooperation but only when renegotiations are banned. The results suggest that the possibility of renegotiation may impede the credibility of initial communication and undermine the credibility of cooperative strategies.

7 Incorporating communication in an experiment

In concluding this chapter, we examine the trade-offs involved in incorporating communication into the design of new experiments. The field remains divided on this issue, and the perspective presented here reflects the author's subjective view rather than a professional consensus.

It is rare for people interacting with each other to be completely deprived of the opportunity to communicate, either before or during the interaction. It is therefore tempting to think that any experiment should include some form of communication.

In fact, there are several advantages to doing so. First, since communication is often an integral part of the environment, including it in experimental design enhances the external validity of the results. Whether communication is essential to the setting under investigation depends on the experimenter's judgment. For example, studying bargaining behavior and outcomes in standing and permanent committees likely requires communication, whereas its role may be less significant in ad hoc or temporary committees designed

to accomplish a specific task within a set timeframe.

Second, incorporating communication can be particularly valuable because it provides insight into why individuals behave the way they do. Rich communication protocols, such as free-form messaging, offer a wealth of information that can help researchers identify the factors driving participants' behavior and understand how final outcomes are reached. Communication transcripts may allow researchers to assess whether theoretical predictions hold for the right reasons. Since each theoretical prediction includes an underlying mechanism that pins down why participants should behave in a certain way, communication analysis can either validate this mechanism or uncover unaccounted forces that are significant in the experimental environment and are missed in theory.

Third, in games with multiple equilibria, communication serves as a natural coordination device. It is easy to implement and it provides the theory with its best chance to explain observed behavior. If players are unable to coordinate on an equilibrium even when given access to such coordination tools, one would reasonably doubt their ability to do so in the absence of these tools.

Finally, in complex games, participants might use communication to explain the game's mechanics to each other. Whether this feature is beneficial or detrimental depends on what transpires during these conversations. In any case, analyzing communication protocols can offer valuable insights into how subjects perceive and interpret the game, which is an interesting question in its own right.

However, introducing communication into experiments comes with costs. First, analyzing communication transcripts is not a trivial task (see Brandts et al. (2019)'s survey for the discussion of up-to-date methods of analyzing free-form communication and the challenges in it). Beyond the technical issues, the primary cost, in my view, is the loss of experimental control. A major advantage of laboratory experiments is the ability to precisely control the environment in which participants interact. The experiment defines all elements of the game: the players involved, the sequence of moves (decision nodes), the available actions at each node, the information each player has, and how decisions translate into payoffs. Moreover, most experiments induce players' preferences, further refining control. This control is crucial because the aim is to create a simplified but realistic economic environment where we can observe decision-making with real economic consequences. While experimental settings are often complex, the goal is to offer a clean test of core theories of human behavior. To do so, we typically reduce economically interesting settings to their essential components, preserving the key trade-offs while stripping away extraneous factors. Introducing communication between players, however, can introduce a host of uncontrolled factors, such as differences in communication styles, persuasiveness, or participants' psychological states. These external influences, which are not part of the theoretical framework and beyond the experimenter's control, can confound the

results and obscure the core mechanisms the experiment aims to test.

The second drawback of introducing communication is that, theoretically, it tends to expand the set of equilibria that can be sustained in the game. This weakens the theory's predictive power and, in some cases, can lead to folk theorem-like outcomes, where the theory becomes difficult to dispute. Even if not all observed outcomes align with equilibrium play, broadening the equilibrium set complicates the game.

Third, as we've seen in many of the games discussed in this chapter, communication tends to reduce strategic uncertainty present in all games. While this can be beneficial in some games, it can be detrimental in others. For example, in environments where strategic uncertainty is a key feature—such as games played by large groups, or one-shot games with strangers—introducing communication may undermine the purpose of the experiment by altering the setting being studied.

To summarize, incorporating communication into a new experiment has both advantages and disadvantages. If the research question focuses on the effects of communication within a particular setting, the solution is straightforward: both treatments, with and without communication, should be conducted for comparison. The challenge arises when the goal is to study a game that does not feature communication between players as modeled theoretically. In this case, weighing the pros and cons becomes more complex and depends heavily on the specifics of the research question and the inferences one wants to draw from the experimental results. As we continue to learn more about the effects of communication in different strategic environments, these decisions should become clearer, and a consensus will hopefully emerge. For now, this decision is still part of the art of designing an experiment.

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