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Communication structure and coalition-proofness – Experimental evidence

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ABSTRACT

The paper analyzes the role of the structure of communication—i.e. who is talking with whom—in a coordination game. We run an experiment in a three-player game with Pareto ranked equilibria, where a pair of players has a profitable joint deviation from the Pareto-superior equilibrium. We show that specific communication structures lead to different 'coalition-proof' equilibria in this game. Results match the theoretical predictions. Subjects communicate and play the Pareto-superior equilibrium when communication is public. When pairs of players exchange messages privately, subjects play the Pareto-inferior equilibrium. Even in these latter cases, however, players' beliefs and choices tend to react to messages, despite the fact that these are not credible.

1. Introduction

This paper investigates in a laboratory experiment the relation between the structure of pre-play communication—i.e., who is talking with whom—and coalition-proofness. A Nash equilibrium is coalition-proof if it is immune to self-enforcing coalitional deviations. If communication is needed to organize a deviation, the structure of communication determines the possibility of different groups of players to coordinate and which equilibrium is coalition-proof. The game under study (the coalitional prisoner's dilemma, see Fig. 1) has two Pareto-ranked pure strategy Nash equilibria, and each pair of players has a profitable joint deviation from the Pareto-superior equilibrium (*PSE*). We study how the structure of communication influences the choice of messages, the beliefs and the choice of the players in this game, finally determining the possibility to achieve the efficient equilibrium.

Communication may allow players to coordinate on a Nash equilibrium. Furthermore, if the game features Pareto-ranked Nash equilibria, the common perception is that communication helps achieving the Pareto-superior one. Experiments in 2 by 2 stag hunt games have shown that communication indeed leads to higher rate of coordination on the efficient equilibrium (e.g. Charness, 2000; Cooper et al., 1992). However, if communication can allow all players to coordinate, this may also

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0014-2921/

	X	Y
X	8,8,8	0,0,0
Y	0,0,0	16,16,0

X

	X	Y
X	0,0,0	0,16,16
Y	16,0,16	4,4,4

Y

Fig. 1. The coalitional prisoner's dilemma.

hold for smaller coalitions organizing a deviation. This consideration is at the heart of the coalition-proof Nash equilibrium (Bernheim et al., 1987).[1] The game we study is similar to the example used to motivate that concept. In that example, Bernheim et al. (1987, p. 4) argue that if players have "unlimited opportunities to communicate", the *PSE* is an implausible outcome even if players agreed on playing it, because two players could agree on a self-enforcing and improving deviation from it. The coalition-proof Nash equilibrium sets out to analyze games where every group of players may communicate.

Milgrom and Roberts (1996) recognize that players may not always have unlimited opportunities to communicate with everyone, and propose a coalition-proof equilibrium notion that is sensitive to the "coalition communication structure", which specifies coalitions that are allowed to communicate. A coalition-proof Nash equilibrium under a communication structure is a strategy profile that is immune to deviations that are self-enforcing and improving under that communication structure.[2] In this paper, we design a laboratory experiment that tests the mechanics of coalition-proofness – i.e., that coalitions and subcoalitions use communication to organize joint deviations – under different communication structures.

Our experimental design manipulates the structure of pre-play communication across treatments. Communication takes the form of structured messages, by which players reveal their intended action.[3] In a baseline treatment, players do not communicate (*NoCom*). Each of the other treatments implements one of the possible symmetric communication structures. These are: (i) *Public*: each player sends a public message to both of the other group members; (ii) *Private*: each player sends a private message to each of the other group members; (iii) *Both*: each player sends both the private and the public messages to the other group members. In all treatments we elicit beliefs to check if and when does communication affect them.

The coalition-proof Nash equilibrium under communication structure *Public* is the *PSE* since pairs of players cannot deviate from it. The coalition-proof Nash equilibrium under communication structure *Both*is the Pareto-inferior equilibrium (*PIE*). The *PSE* is not coalition-proof under that structure as it is not immune to the joint deviation by two players. This also implies that the deviation by three players from the *PIE* to the *PSE* is not self-enforcing. The same holds in *Private*. Thus, the theory predicts that the *PSE* will be played only under *Public*, and that the *PIE* will be played in *Private* and *Both*.

To reach the *PSE* in *Public*, players must first agree to play it in the communication phase. In *Private* and *Both*, an agreement to play the *PSE* is not self-enforcing, and as such should not be believed. Indeed, a player should recognize that the other players could coordinate privately to deviate from the *PSE* even if others reveal their intention to play according to it. Thus, the messages observed in the communication phase affect beliefs in *Public*, but not in *Private*and *Both*.

We find that the impact of the communication structure on play is in line with the theoretical predictions. Absent communication, miscoordination is initially high, and play quickly converges to the *PIE*. Coordination on pure strategy Nash equilibria is higher in the first rounds with communication. In *Public*, the *PSE* is played by more than half of the groups, steadily across rounds. A vast majority of the players announce their intention to play the action corresponding to the *PSE*, and play accordingly only when others do so as well. When private communication is allowed, the *PIE* ends up being played by most groups in the last rounds. Lying is prevalent: players try to convince one of their partners to play the *PSE*, while agreeing on a deviation with the other. This strategy is frequently successful because some subjects trust messages that are not credible, especially in earlier rounds. As a result, and contrary to our hypothesis, the outcome of communication affects beliefs also in *Private* and *Both*, where messages should be considered uninformative.

In two-player games, the only possible variation to the structure of communication distinguishes one-sided and two-sided communication. Cooper et al. (1992); 1989) find one-sided communication is more effective in the battle of the sexes, where some symmetry-breaking device is needed, while two-sided is more effective in the stag hunt.[4,5] Relatively few papers have studied the role of pre-play communication in games with more than two-players. Blume and Ortmann (2007)

[1] A number of papers have explicitly modeled pre-play communication in games of complete information, focusing on 2-player games (see Farrell, 1988; 1995; Rabin, 1994; Farrell and Rabin, 1996). A review of this literature can be found in Crawford (1998).

[2] As discussed in more details in Section 2 and Appendix A, we depart from Milgrom and Roberts (1996) in two aspects. First, their solution concept is a version of coalition-proof correlated equilibrium. Moreno and Wooders (1996) and Ray (1996) also propose notions of coalition-proof correlated equilibrium. While we acknowledge that, in general, communication may lead to correlated play, our design is not suited to address correlation. Second, our communication structures are special cases of their "coalition communication structures".

[3] We focus on the communication of intentions of play. A different, though related, literature addresses communication about the state of the world in sender–receiver games with incomplete information (see Crawford and Sobel, 1982; Blume et al., 1993). Within this literature, a number of studies have investigated information revelation under different communication structures. Farrell and Gibbons (1989) compared private and public communication in sender–receiver games with multiple audiences. Battaglini and Makarov (2014) provided an experimental test of the model.

[4] Related to this result, it has been pointed out that, in situations where subjects face strategic risk, mutual communication of intentions may have a reassuring effect (see Charness and Dufwenberg, 2006; 2011; Brandts et al., 2015).

[5] Andersson and Wengström (2012) instead, allow for pre-play and intra-game communication, and show how this can work, through renegotiation, against efficient coordination in dynamic settings.