Communication Among Voters Benefits the Majority Party*

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Abstract

How does communication among voters affect turnout? In a laboratory experiment, subjects, divided into two competing parties, choose between costly voting and abstaining. Pre-play communication treatments, relative to the *No Communication* control, are *Public Communication* (subjects exchange public messages through computers) and *Party Communication* (messages are public within one's own party). Communication benefits the majority party by increasing its turnout margin, hence its winning probability. Party communication increases turnout; public communication decreases total turnout with a low voting cost. With communication, there is no support for Nash equilibrium and limited consistency with correlated equilibrium.

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How does pre-play communication among economic agents affect collective decisions? Prominent game-theoretic models for situations such as voting, contributing to a public good, multi-lateral bargaining, auctions, and entry games, to name a few, typically discard the availability of pre-play communication among the players. They do so, in part, because of an increased complexity of the equilibrium analysis under communication, and, in part, because original equilibria are

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maintained due to the non-binding nature of pre-play communication. Many experimental studies show, however, that pre-play communication can have significant effects on outcomes in many different settings.[1]

In this paper, we attempt to explore the general principles behind pre-play communication in a laboratory experiment on voter turnout, an application that combines features of free-riding and team competition. The game is very simple: two groups of voters of commonly known different sizes (think political parties) compete against each other in a winner-take-all election under plurality rule. Voters simultaneously decide on a binary decision: vote or abstain. Voting is costly, with a commonly known cost of voting that is the same for all voters.

In the turnout game without communication, each player decides whether or not to vote independently of others. The game-theoretic analysis of this case (Palfrey and Rosenthal, 1983) shows that, generally, there will be either one or two quasi-symmetric Nash equilibria, in which all members of the same party mix with the same probability of voting. There are also asymmetric equilibria, which we do not consider here, as they are logically implausible without a device to break symmetries.[2]

With communication, the formal structure of the turnout game changes dramatically, as individual turnout decisions can now be correlated. Allowing for correlation greatly expands the set of equilibria. In fact, the game with unrestricted communication admits an infinite number of equilibria, with expected total turnout ranging between nearly zero and twice the size of the minority party for all positive voting costs, such that abstention is not a dominant strategy (Pogorelskiy, 2017).

We study the effects of unmediated pre-play communication on turnout. Before making their decisions, subjects engage in free-form communication by broadcasting computer chat messages to subsets of players. We consider two cases: *public communication*, where players can exchange public messages visible to all participants; and *party communication*, where players can exchange messages that are public only within their own party (majority or minority). These communication protocols have broad analogs to communication that occurs in real elections. For example, car

[1]See, e.g., Cooper *et al.* (1992), Agranov and Tergiman (2014), Agranov and Yariv (2015), Palfrey and Rosenthal (1991), and Palfrey *et al.* (2015).

[2]See Alós-Ferrer and Kuzmics (2013) and Kuzmics and Rogers (2010).

bumper stickers can be interpreted as public messages, while Facebook status updates, visible only to one's own group of friends or social connections, are examples of group-based public messages.[3]

A refinement of correlated equilibrium, *subcorrelated equilibrium* is used to characterise the equilibria with party communication (Pogorelskiy, 2015). While our experiment (and the model) does not have any explicit centralized mobilisation efforts per se, one can view the kind of decentralised communication studied here as corresponding to neighbourhood information exchanges (Großer and Schram, 2006), conversations and interactions with family and friends, or communication via social media.[4]

In addition to the communication treatment, the experiment varies two other crucial parameters of the model: the voting cost ("low" cost vs. "high" cost) and the relative party sizes (large vs. small minority). This leads to a $3 \times 2 \times 2$ design with a total of 12 different treatments. A novel feature of this study is the sensitivity of turnout to changes in these parameters under our restrictions on communication, which allows us to identify interaction effects between communication mode and key parameters of the theoretical model.

The main finding of the experiment is that communication affects turnout for the majority and minority parties in much different ways. Specifically, *communication benefits the majority party*, as it increases the expected turnout margin relative to no communication, and, hence, increases the expected margin of victory for the majority and the probability of the majority winning. The finding is unambiguous, robust, and quite strong. We observe it in all treatments, for both communication protocols, both low and high voting costs, and both large and small majorities. Furthermore, in almost all cases, the effects are statistically significant and large in magnitude. This result is not only strong, but also surprising (at least to us), in the sense that it is not predicted by any theoretical model of which we are aware, including our correlated and subcorrelated equilibrium models.[5]

[3]Bond *et al.* (2012) studied effects of a very influential group-based message in a turnout setting featuring the "I Voted" button on top of Facebook users' newsfeed.

[4]Field experimental studies, which usually isolate a particular communication mechanism, have shown significant but mixed evidence (Gerber and Green, 2000; Gerber *et al.*, 2011), which is perhaps not surprising, given the variety of different ways in which people communicate. Effectiveness of political communication depends on complex interactions of different communication mechanisms, political actors, and institutional structures (Druckman, 2014).

[5]The theoretical model of Denter and Sisak (2015) shows that, under certain conditions, perfect polls (a restricted form of communication) can create momentum in favour of the front-running candidate. The underlying mechanism, however, is totally different, as in their model, two candidates strategically choose investments in their political

The experiment also generates three other findings that complement this main finding.

First, the communication design of the experiment allows us to test the *consistency of experimental data under communication with correlated equilibrium.* Although correlated equilibria have been largely ignored in the experimental study of pre-play communication, they are particularly well-suited for the analysis of such games.[6] This is especially the case with our design, as it includes both public and party communication mechanisms, which require somewhat different variations on the correlated equilibrium concept. We design several new tests to check for the consistency with correlated equilibrium and find that voting cost plays an important role here: with low cost and group communication, we cannot reject the hypothesis that the data are generated by a correlated equilibrium, while with high cost, this is no longer the case for either communication treatment. On the other hand, in almost all communication treatments, we reject the hypothesis that voters' individual decisions are independent, implying *no support for Nash equilibrium under communication.*

Second, we identify an interaction effect between the structure of communication and the cost of voting. *Party communication increases total turnout. With a low voting cost, public communication decreases total turnout. With a high voting cost, public communication does not significantly affect total turnout.* Thus, we identify a *cost/communication interaction effect*, whereby cost considerations appear to be an important factor in participation decisions under communication, which ties in with some existing empirical results (Brady and McNulty, 2011; Hodler and Stutzer, 2015). Surprisingly, public communication, at an election stage where voters' preferences have already been formed, can be detrimental to getting out the vote.

Third, we find that *turnout rates are affected by the voting cost and election competitiveness.* Theoretically, turnout in each party is higher when costs are lower. We observe this cost effect in all treatments, except with public communication. We also observe positive effects of ex ante election competitiveness on turnout (as measured by the relative party sizes), holding the other treatment dimensions constant.[7]

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campaigns, trying to influence the decisive voter's probabilistic choice.

[6] A notable exception is Moreno and Wooders (1998). See also Cason and Sharma (2007), and Duffy and Feltovich (2010) for studies of abstract games with recommended play.

[7] The cost and competition effects have support from other experiments (Levine and Palfrey, 2007; Herrera *et al.*, 2014; Kartal, 2015).

The remainder of the paper is organised as follows. In Section 1, we provide a brief literature review. Section 2 lays out the theoretical model of voter turnout, including formal definitions of correlated and subcorrelated equilibrium as it applies the the voter turnout game. In Section 3, we describe the details of our experimental design. Section 4 presents our findings at the electorate level and party level. Section 5 concludes. Additional estimation details are in Appendix A. Experimental instructions are in Appendix B. Experimental data and programs are available online.

1 Related Literature

Several studies have investigated the effects of restrictive communication mechanisms – such as neighbourhood information exchange and polls – on voter turnout. Großer and Schram (2006) consider the effects of communication in the form of neighbourhood information exchange. In their model, every two voters form a neighbourhood, with one being an early voter (sender) and one a late voter (receiver). They find that information exchange increases turnout, although these results seem to be sensitive to the analysed sender-receiver protocol. Großer and Schram (2010), and Agranov *et al.* (2017) study the effects of polls on turnout and welfare in the lab.[8] In particular, Agranov *et al.* (2017) show that polls do not have negative welfare effects.

More relevant to the current paper, the authors also find evidence for voting with the winner, where a voter is more likely to turn out if she thinks that her preferred candidate is more likely to win. While this ties in nicely with our main finding that communication benefits the majority party by increasing its expected margin of victory, the environment, the communication mechanism, and the results of the two papers differ in important ways. Concerning the difference in environments, Agranov et al.'s explores information revelation in a game with uncertainty about the distribution of preferences. Voters have incomplete information and private signals about the number of voters favouring each candidate. Prior to polling, voters do not even know whether or not they are in the majority party, and polls serve as an information aggregation device to reveal simultaneously to all voters the relative sizes of the two candidates' support in the electorate. By contrast, this study focuses on an environment where the number of voters favouring each candidate is common

[8] Morton *et al.* (2015), in a natural experiment, estimate that exit polls decrease turnout and increase bandwagon voting. Theoretic models of polls include McKelvey and Ordeshook (1985) and Denter and Sisak (2015).

knowledge among all the voters from the very start of the game, so communication can only serve as a coordination device to allow for correlation in the turnout decisions of the voters; no actual information is transmitted. Concerning the difference in mechanism, the communication technology in Agranov et al. is very limited, being only a poll, where each voter sends a vote message to the experimenter, and then only the aggregate vote count in the poll is reported back to all voters. By contrast, our subjects use a free-form computerised chat with public (i.e., multi-way) messages that do not provide any new information about the environment, and only serve as a coordination device. In our group-communication treatment voters from different parties communicate through separate chats, so communication is partially private. The results are also different. They find that information transmission with polls *increases* majority participation rates but *decreases* minority turnout rates. The effects move turnout rates in opposite directions, mobilising both a positive (for the majority) and a negative (for the minority) bandwagon, triggered by the revelation of the true distribution of voter preferences. While we observe this effect in some of our treatments, we find that in other treatments, communication affects participation rates in both parties in the *same direction*, with the effect on majority party turnout being relatively stronger (when both parties' turnout rates increase), and relatively weaker (when both parties' turnout rates decrease).

In theory, pre-play communication can replicate the effects of both polls and neighbourhood information exchanges. Schram and Sonnemans (1996b) study Schram and van Winden's (1991) social pressure turnout model in the lab and find that communication increases turnout. There are two groups, each with opinion leaders who produce social pressure on others to turn out. One of the basic predictions of that model is that communication increases turnout. In their experiment, for five minutes, there was oral communication among the members of the same group, after which five more rounds of the game without further communication were played. This is different from having pre-play communication in each round, as in our paper.

Another related paper is Kittel *et al.* (2014). They study three-party elections with costly voting, varying voter preference types (swing voters, who have strict rankings over three parties, vs. partisans, who strictly prefer one party but are indifferent between the two less preferred ones); party labels; and pre-play communication protocol (public across groups vs. public within groups, as in our experiment). Kittel et al. find that communication increases both turnout and the amount of strategic voting. The effects of the communication protocol on turnout depend on voter preferences and are nuanced. In particular, swing voters and partisans show different turnout rates: swing voters assigned to their second choice are more likely to turn out in the "all-chat" than in the "party-chat," while swings assigned to their first choice, as well as partisans, show no difference. While we use similar communication treatments, our results are not directly comparable since three-party elections introduce a completely different motive for voting, and introduce additional strategic considerations.[9]

2 The Model

In this section, we provide some theoretical background for the pivotal-voter model of Palfrey and Rosenthal (1983) on which our experiment builds. There is a set of voters N with $|N| = n$, divided into two parties, N_A and N_B, with a number of supporters $n_A > n_B = n - n_A > 0$. Voters in each party decide between voting for their respective party (action 1) or abstaining (action 0). Each player i's action space is $S_i = \{0, 1\}$. The set of joint voting profiles is $S = S_1 \times \cdots \times S_n$, i.e., $S = \{(s_i)_{i \in N} | s_i \in \{0, 1\}\}$; and the set of all probability distributions over S is $\Delta(S)$. Player i's utility at an action profile (s_i, s_{-i}) is denoted $\mathcal{U}_i(s_i, s_{-i})$; and her expected utility from s_i given belief about others' actions σ_{-i} is $U_i(s_i, \sigma_{-i}) \equiv \mathbb{E}_{\sigma_{-i}} \mathcal{U}_i(s_i, \cdot)$. The election is decided by a simple plurality rule, with ties broken randomly. Voting is costly, with $c \in (0, 1/2)$ being the common voting cost. Each player i's utility is normalised to 1 if the voter's preferred party wins, 1/2 if there is a tie, and 0 otherwise, minus the voting cost, if i decides to vote. The game has complete information, and the only uncertainty from a player's point of view comes from not knowing what, exactly, everybody else is going to choose. Each voter would ideally prefer her party to win the election without her actually voting, so the game combines a free-rider problem with a collective action problem in each party. Rational voters trade off the expected benefits from voting against

[9] Several strands of the literature are less related to our paper. One studies the effects of deliberation on jury voting, where abstention is not allowed (Guarnaschelli *et al.*, 2000; Goeree and Yariv, 2011). Another studies the performance of the rational turnout models in the lab but without communication among voters (Schram and Sonnemans, 1996a; Levine and Palfrey, 2007; Duffy and Tavits, 2008; Herrera *et al.*, 2014; Kartal, 2015). There are also studies of communication within and between teams in team contests in which members choose individual effort levels that determine the joint team output. See, in particular, Sutter and Strassmair (2009), who find that within-team communication increases average effort levels. Balliet (2010) surveys studies of communication in social dilemmas with a focus on the prisoner's dilemma.

the cost, so the probability of their vote changing the election outcome is the key factor. In an equilibrium, this so-called *pivot probability* is determined endogenously.

In a *quasi-symmetric* Nash equilibrium (NE), each player i who prefers party $N_j, j \in \{A, B\}$, mixes between voting for j and abstaining with the same probability $q = q_j$ conditional on the party, and given these strategies, each player must be indifferent between the two actions: $U_i(0, q_{-i}) = U_i(1, q_{-i})$. The equilibrium voting probabilities are determined from the following two equations:

$$2c = \Pr(i \in N_A \text{ is pivotal}) \tag{1}$$

$$2c = \Pr(i \in N_B \text{ is pivotal}) \tag{2}$$

Expressing the pivotal probability via equilibrium voting probabilities q_A and q_B, we obtain

$$\begin{aligned} 2c = &\sum_{a=0}^{n_B} \binom{n_A - 1}{a} \binom{n_B}{a} q_A^a (1 - q_A)^{n_A - 1 - a} q_B^a (1 - q_B)^{n_B - a} \\ &+ \sum_{a=0}^{n_B - 1} \binom{n_A - 1}{a} \binom{n_B}{a+1} q_A^a (1 - q_A)^{n_A - 1 - a} q_B^{a+1} (1 - q_B)^{n_B - a - 1} \end{aligned} \tag{3}$$

$$\begin{aligned} 2c = &\sum_{b=0}^{n_B - 1} \binom{n_A}{b} \binom{n_B - 1}{b} q_A^b (1 - q_A)^{n_A - b} q_B^b (1 - q_B)^{n_B - 1 - b} \\ &+ \sum_{b=0}^{n_B - 1} \binom{n_A}{b+1} \binom{n_B - 1}{b} q_A^{b+1} (1 - q_A)^{n_A - b - 1} q_B^b (1 - q_B)^{n_B - 1 - b} \end{aligned} \tag{4}$$

In both equations, the first sum on the right hand side is the equilibrium probability of a single vote to make a tie, the second is the equilibrium probability of a single vote to break the tie in favour of the preferred party. Probabilities of a tie and near tie (i.e., a tie ± one vote) provide a measure of the expected closeness of the election, as well as the probability of the minority party winning (the *upset rate*), which affects a measure of social welfare. The equilibrium logic leads from the primitives of the model (party sizes and voting cost) to predictions about these probabilities and about the turnout rates in each party and in the whole electorate.[10] The equilibrium probability

[10] There are other, asymmetric Nash equilibria in this class of games – see Palfrey and Rosenthal (1983) – but our experimental design makes them infeasible to sustain.

of a joint voting profile with a total votes for N_A and b total votes for N_B is

$$\nu(a,b) \equiv \binom{n_A}{a}\binom{n_B}{b} q_A^a (1-q_A)^{n_A-a} q_B^b (1-q_B)^{n_B-b} \tag{5}$$

A *correlated equilibrium* (CE), developed in Aumann (1974, 1987), is a probability distribution over joint action profiles such that at every profile, each player's choice is a best response under the posterior distribution conditional on that choice. Formally, a correlated equilibrium is $\mu \in \Delta(S)$ such that for all $i \in N, s_i, s_i' \in S_i$

$$\sum_{s_{-i}\in S_{-i}} \mu(s_i, s_{-i}) \left(\mathcal{U}_i(s_i, s_{-i}) - \mathcal{U}_i(s_i', s_{-i})\right) \geq 0 \tag{6}$$

In a CE of the turnout game, unlike Nash equilibrium, there are two best response conditions for each player: conditional on deciding to vote, and conditional on deciding to abstain. Every CE, μ, is defined by the following $2n$ inequalities (in addition to the standard probability constraints) for each $i \in N$:

$$\Pr(i \text{ is pivotal} \mid i \text{ abstains}; \mu) \leq 2c$$
$$\Pr(i \text{ is pivotal} \mid i \text{ votes}; \mu) \geq 2c$$

The main difference between NE and CE is that in the latter, players' strategies can be correlated, while in a Nash equilibrium, all players decide whether to vote or abstain independently. Thus, every Nash equilibrium is also a correlated equilibrium, but (in a formal sense) almost all correlated equilibria of the turnout game are not Nash equilibria. Using the formula for conditional probability, each pair of CE inequalities can be simplified:

$$\frac{\frac{1}{2}-c}{c}\Pr(i \text{ is pivotal \& abstains}|\mu) \leq \Pr(i \text{ is non-pivotal \& abstains}|\mu) \tag{7}$$
$$\frac{\frac{1}{2}-c}{c}\Pr(i \text{ is pivotal \& votes}|\mu) \geq \Pr(i \text{ is non-pivotal \& votes}|\mu) \tag{8}$$

To check consistency with a correlated equilibrium, we need frequency estimates of the joint turnout profiles from the data. The number of such profiles in a n-person electorate is 2^n, making it infeasible to estimate frequencies with our data. To circumvent this problem, we reduce the number of joint profiles to a manageable size by combining all the profiles that have the same number of votes from each party and differ only by the identity of those voting and abstaining. This reduction implicitly assumes that such profiles are equally likely. For example, we assume that the following profiles have equal probability: a profile with all of the minority voting and with voters 1, 2, and 3 of the majority voting; and a profile with all of the minority voting and with voters 4, 5, and 6 of the majority voting. To state this assumption formally, let $\mu(z_i, a, b)$ denote the probability of any joint profile where player i plays strategy z_i, and, among the other $n-1$ players, a players turn out in group N_A and b players turn out in group N_B (where "groups" correspond to the majority and minority party, respectively, in the context of our experiment).

ASSUMPTION 1. *(Group-symmetric distributions). We consider only distributions over joint voting profiles that satisfy the following restrictions:*

$$\forall i \in N_A, \forall a \in \{1, \ldots, n_A - 1\}, \forall b \in \{0, \ldots, n_B\} : \qquad \mu(0_i, a, b) = \mu(1_i, a-1, b)$$

$$\forall k \in N_B, \forall b \in \{1, \ldots, n_B - 1\}, \forall a \in \{0, \ldots, n_A\} : \qquad \mu(0_k, a, b) = \mu(1_k, a, b-1)$$

Applying Assumption 1, we now have a total of $(n_A + 1)(n_B + 1)$ different profiles for which frequencies can be estimated from the data. We can now simply write $\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}$ for the probability of a joint profile with a votes from party N_A and b votes from party N_B (cf. Nash-induced joint probability $\nu(a, b)$ in (5).) For a group-symmetric correlated equilibrium, conditions (7)–(8) can be simplified (Pogorelskiy, 2017) and written as a system of four inequalities: two for a player in N_A, and two for a player in N_B, with respect to $(n_A+1)(n_B+1)$ unknowns, $\mu_{a,b}$:

$$\frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B}\binom{n_A-1}{a}\binom{n_B}{a}\mu_{a,a}+\sum_{a=0}^{n_B-1}\binom{n_A-1}{a}\binom{n_B}{a+1}\mu_{a,a+1}\right)\leq$$
$$\sum_{a=1}^{n_A-1}\sum_{b=0}^{\min\{a-1,n_B\}}\binom{n_A-1}{a}\binom{n_B}{b}\mu_{a,b}+\sum_{a=0}^{n_B-2}\sum_{b=a+2}^{n_B}\binom{n_A-1}{a}\binom{n_B}{b}\mu_{a,b} \tag{9}$$

$$\frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B}\binom{n_A-1}{a}\binom{n_B}{a}\mu_{a+1,a}+\sum_{a=1}^{n_B}\binom{n_A-1}{a-1}\binom{n_B}{a}\mu_{a,a}\right)\geq$$
$$\sum_{a=2}^{n_A}\sum_{b=0}^{\min\{a-2,n_B\}}\binom{n_A-1}{a-1}\binom{n_B}{b}\mu_{a,b}+\sum_{a=1}^{n_B-1}\sum_{b=a+1}^{n_B}\binom{n_A-1}{a-1}\binom{n_B}{b}\mu_{a,b} \tag{10}$$

and

$$\frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B-1}\binom{n_A}{a}\binom{n_B-1}{a}\mu_{a,a}+\sum_{a=0}^{n_B-1}\binom{n_A}{a+1}\binom{n_B-1}{a}\mu_{a+1,a}\right)\leq$$
$$\sum_{a=2}^{n_A}\sum_{b=0}^{\min\{a-2,n_B-1\}}\binom{n_A}{a}\binom{n_B-1}{b}\mu_{a,b}+\sum_{a=0}^{n_B-2}\sum_{b=a+1}^{n_B-1}\binom{n_A}{a}\binom{n_B-1}{b}\mu_{a,b} \tag{11}$$

$$\frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B-1}\binom{n_A}{a}\binom{n_B-1}{a}\mu_{a,a+1}+\sum_{a=1}^{n_B}\binom{n_A}{a}\binom{n_B-1}{a-1}\mu_{a,a}\right)\geq$$
$$\sum_{a=2}^{n_A}\sum_{b=1}^{\min\{a-1,n_B\}}\binom{n_A}{a}\binom{n_B-1}{b-1}\mu_{a,b}+\sum_{a=0}^{n_B-2}\sum_{b=a+2}^{n_B}\binom{n_A}{a}\binom{n_B-1}{b-1}\mu_{a,b} \tag{12}$$

Pogorelskiy (2017), in an analysis of correlated equilibria in turnout games, characterises the bounds of the set of CE in these games. In particular, CE can have total expected turnout of up to twice the size of the minority party when the *minority is large* (i.e., the minority's size is at least 50% that of the majority), and up to the majority size in the remaining, small minority, case. Such turnout rates are generally higher than in a quasi-symmetric Nash equilibrium. CE presume unrestricted communication among all players.

A *Subcorrelated equilibrium*(SCE), proposed in Pogorelskiy (2015), is a correlated equilibrium with additional restrictions on the structure of admissible correlations. Formally, a SCE is defined relative to a partition of the set of players into K disjoint groups, $\Pi = \{N_1, ..., N_k, ..., N_K\}$, and is given by a joint distribution on strategy profiles $\mu \in \Delta(S)$ that satisfies the incentive constraints given by (6), such that μ is generated by K independent probability distributions, each over its respective group sub-profiles. That is, the joint distribution, μ is decomposable as a product of K distributions: there exist $(\gamma_1, ..., \gamma_K)$ with $\gamma_k \in \Delta(S^k)$ such that

$$\mu(s) = \prod_{k=1}^{K} \gamma_k(s|N_k), \tag{13}$$

for all $s \in S$, where $s|N_k := ((s_i)_{i \in N_k})$ is group N_k's action sub-profile in profile s.

Thus subcorrelated equilibrium nests both Nash equilibrium and correlated equilibrium as extreme special cases: In the definition of subcorrelated equilibrium, $K = 1$; and in a Nash equilibrium, $K = N$. Note that every subcorrelated equilibrium is also a correlated equilibrium, just as every Nash equilibrium is a correlated equilibrium, and finer partitions (weakly) reduce the set of subcorrelated equilibria by imposing additional decomposability constraints. For the turnout game, we consider the subcorrelated equilibria defined by the two groups ($K = 2$) corresponding to the majority and minority parties. Thus, in this setting SCE requires that the joint distribution over all-electorate voting profiles is a CE that is also a product of the two mixed party turnout distributions, one for each party. Thus, in a subcorrelated equilibrium, votes can be correlated within, but not across the two parties, implicitly capturing a restriction that any communication between voters takes place within parties.

The effect of this constraint depends on the size of the minority (Pogorelskiy, 2017). With a sufficiently large minority, one can limit communication in this way (i.e., to remain unrestricted only within each party) and still get twice the size of the minority as the theoretical upper bound on the expected total turnout. In contrast, the decomposability restriction of independence across parties is binding in the small minority case and implies an upper bound with lower turnout than in CE.

3 Experimental Design

3.1 Experimental Treatments and Theoretical Predictions

In the experiment, we vary the sizes of the parties, n_A and n_B, the common voting cost c, and the communication protocol. The last factor is especially important, because communication allows voters' actions to be correlated, which can, in theory, lead to higher turnout than predicted by the standard Nash equilibria.

The above considerations led us to implement the following $2 \times 2 \times 3$ design: large minority ($n_A = 6$, $n_B = 4$) vs. small minority ($n_A = 7$, $n_B = 3$); high cost ($c = 0.3$) vs. low cost ($c = 0.1$); and three communication treatments. With respect to communication, the three treatments were: *No Communication* (NC); *Public Communication* (PC), where players communicate prior to playing the turnout game by exchanging public messages visible to all participants; and *Group-restricted public communication* (GC), where players can exchange messages that are visible only to other members of their own group/party.

Table 1 summarises equilibria with maximal expected turnout. The table shows the maximum expected turnout rates for quasi-symmetric Nash,[11] correlated and subcorrelated equilibria, for the four treatments in the party-size/voting-cost domain, as well as relevant related equilibrium probabilities. We denote by T_A (T_B) the expected equilibrium turnout rate in party A (B); T is the expected total turnout rate; Tie is the probability of a tie, $Pivot$ is probability of a pivotal event (defined as *tie*± one vote); $Upset$ is the probability of the minority party winning (upset rate); and $Margin$ is the expected margin of victory for party A. It is defined as

$$\text{Margin} = \frac{n_A T_A - n_B T_B}{n_A T_A + n_B T_B}. \tag{14}$$

Note that $Pivot$ and Tie are total probabilities of the respective joint vote profiles rather than individual-specific probabilities of a single vote making or breaking a tie. E.g., for the case of

[11] Given the anonymous random matching and the symmetric structure of the game for each party, we limit attention to Nash equilibria in which all members of the party mix with the same probability. This is standard in the analysis of data from turnout experiments: e.g., Schram and Sonnemans (1996a); Agranov *et al.* (2017). Other kinds of highly asymmetric Nash equilibria are discussed in Palfrey and Rosenthal (1983).

$n_A = 7$ and $c = 0.1$, these probabilities in the turnout-maximising SCE are slightly lower than in a quasi-symmetric NE (cf. respective rows in Table 1). Despite this, the expected total turnout rate is higher in the SCE. The reason is that in the SCE, individual turnout probabilities are correlated within each party, so each individual faces potentially different (weaker) incentive constraints than in NE.

Table 1: *Theoretical Values for Equilibria with Maximal Total Expected Turnout*

					Nash Quasi-Symmetric				
n_A	n_B	c	T_A	T_B	T	Tie	Pivot	Upset	Margin
6	4	0.1	0.625	0.375	0.525	0.089	0.298	0.083	0.428
–	–	0.3	0.161	0.253	0.198	0.322	0.781	0.518	−0.023
7	3	0.1	0.521	0.479	0.508	0.098	0.319	0.009	0.435
–	–	0.3	0.147	0.380	0.217	0.310	0.773	0.545	−0.052
					Subcorrelated Equilibria				
n_A	n_B	c	T_A	T_B	T	Tie	Pivot	Upset	Margin
6	4	0.1	0.667	1.000	0.800	0.200	0.636	0.365	0.000
–	–	0.3	0.667	1.000	0.800	0.600	0.790	0.421	0.000
7	3	0.1	0.725	0.482	0.652	0.096	0.278	0.048	0.556
–	–	0.3	0.544	0.799	0.620	0.479	0.691	0.240	0.227
					Correlated Equilibria				
n_A	n_B	c	T_A	T_B	T	Tie	Pivot	Upset	Margin
6	4	0.1	0.667	1.000	0.800	0.200	0.636	0.365	0.000
–	–	0.3	0.667	1.000	0.800	0.600	0.790	0.421	0.000
7	3	0.1	0.831	0.296	0.670	0.059	0.335	0.030	0.735
–	–	0.3	0.591	0.716	0.628	0.429	0.764	0.215	0.317

Notes: There are other correlated equilibria with smaller total turnout, and a low-turnout quasi-symmetric Nash equilibrium that is not listed here.

Table 1 shows several patterns of the theoretical equilibrium properties across treatments. We emphasise those regarding the total turnout[12] in the following proposition.

PROPOSITION 1. *In equilibria that maximise expected turnout under our parameters, the total turnout rate is 1) weakly increasing with correlation in voters' actions (from a Nash to a Subcorrelated to a Correlated equilibrium); 2) increasing in ex ante election competitiveness, except under high voting cost in the quasi-symmetric Nash equilibrium; and 3) weakly decreasing in the voting cost.*

[12] One should note that different solution concepts in Table 1 make equilibrium predictions at different levels: quasi-symmetric NE pins down individual turnout probabilities, conditional on their party, SCE pins down party-specific turnout rates (individual turnout probabilities within a party may be correlated), and CE pins down the total turnout rate (individual turnout probabilities both within and across parties may be correlated. For $n_A = 6$, both SCE and CE achieve the same maximal expected total turnout, so party-restricted correlation in SCE has no bite). Furthermore, there may be multiple equilibria with the same expected turnout. Therefore, we use total turnout rates to make aggregate predictions that are comparable. To check consistency of the data with theory, we use frequency distributions over joint vote profiles rather than a single summary statistic.

3.2 Procedures

We ran a total of ten sessions with a high common cost ($c = 0.3$) and another ten sessions with a low common cost ($c = 0.1$), with the main focus on the effects of communication. For each cost, there were two sessions of no communication (NC) and four sessions each of the two communication treatments: group communication (GC), and public communication (PC). We used a within-subjects design for the relative size treatment in each session, and we recruited 20 subjects per session to mitigate the effects of shared histories in the presence of communication. The same communication mode (NC, GC, or PC) was used throughout the entire session. No subject participated in more than one session. For communication treatments, we limited the duration of chat to 110 seconds.[13]

Each session consisted of 20 "matches", divided into two parts with 10 matches (which we'll interchangeably refer to as rounds) in each part. In each match, players in the majority and the minority group were asked to decide whether to abstain or to vote for their party's candidate, knowing the common voting cost. To avoid possible experimenter demand effects, no voting context was mentioned.[14] Majority and minority parties were called "type A" and "type B," respectively. Subjects chose between two abstract options, X and Y, which corresponded to voting and abstention, respectively. The voting cost was implemented as an opportunity cost (i.e., choosing option Y would result in a bonus payoff equal to c). An example of the user interface is shown in Figure A.1 in Appendix A. Sample instructions, which were read aloud by the experimenter, are in Appendix B.

Subjects were randomly assigned to parties and electorates according to the following algorithm. At the beginning of part 1, all subjects were randomly assigned one of the two possible types, which split the session participants into majority and minority pools. For example, if part 1 had relative party sizes of $(7, 3)$ and there were 20 subjects in the session, 14 of these subjects were randomly selected to be in the majority pool, and the remaining 6 subjects were assigned to the minority pool. Next, in the first match of part 1, two ten-voter electorates were created by randomly assigning 7 subjects from the majority pool and 3 subjects from the minority pool to form one of these

[13]When analysing chat logs, it was clear that this amount of time was more than enough for meaningful communication.

[14]Levine and Palfrey (2007) conducted experiments with both neutral and "election" contexts and found no significant difference in behaviour.

electorates, with the remaining subjects forming the second electorate. This electorate assignment step was carried out at the beginning of each of the ten matches of part 1 and was independent across matches. Thus, for the ten matches of part 1, the assignment of subjects to the party *pools* remained unchanged, but the assignment to one of the two ten-voter electorates was randomly shuffled after every match. See Figure 1. At the beginning of part two, the subjects were informed that relative party sizes were different. (In this example, the relative party sizes in part two would be $(6,4)$.) Subjects were then randomly re-allocated into the two party pools in the following way. All subjects from the former minority pool were assigned to the new majority party pool, with the remaining members of the new majority party pool assigned randomly from the previous majority pool. A former minority subject's new assignment to a party pool was fixed throughout the 10 matches in part 2; a former majority subject's new assignment to a party pool was determined randomly at the beginning of each match.

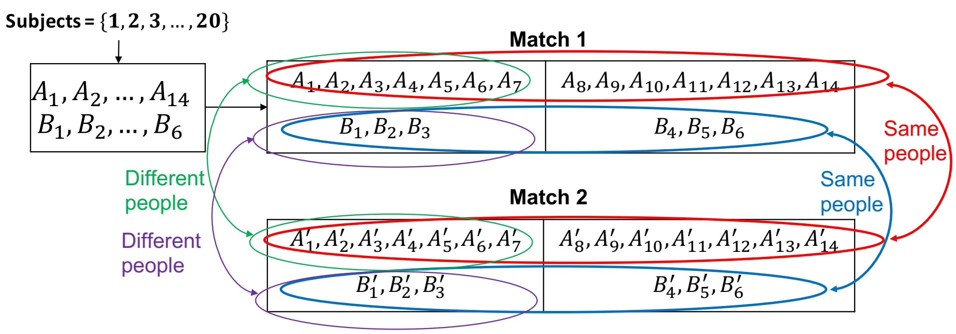

Figure 1: *Assignment to parties and electorates in Part 1 (example for (7,3) size treatment): 20 subjects are first randomly assigned into a majority pool of 14 and minority pool of 6 members; each subsequent match each pool is randomly split into two 10-person electorates comprising 7 members from A and 3 members from B.*

We chose this scheme to mitigate the inherent inequality of payoffs across subjects since, in either size treatment, the majority was more likely to win.[15] Subjects' IDs within their party were randomly re-assigned every round. In communication treatments, each message contained information about the sender's ID and party, so public messages from different subjects could be clearly distinguished.

[15] We encountered a minor software issue once when switching to part 2 in two sessions ((7,3)(6,4), high cost, and either PC or GC). The resulting session protocol violation was that not all of the minority voters in part 1 might have been switched to the majority in part 2. There were no other violations, and we do not view this as an issue for the analysis.

We did not inform subjects about the number of matches in each part. Instructions for part 2 were delivered after part 1 concluded. Two rounds from each part were randomly selected and the subjects paid, so the payoff of each subject was the sum of payoffs in four rounds plus the show-up fee of $7. Overall, the 20-session, $2 \times 2 \times 3$ design used 400 subjects, which generated a dataset with a total of 800 elections. The average payoff per subject was $28.99. Sessions with communication lasted approximately 1.5 hours, and sessions without communication took a bit less than one hour.[16]

Table 2 summarises our design and experimental parameters.

Table 2: *Session Summary*

Communication	Session	Cost $c = 0.1$		Session	Cost $c = 0.3$	
		First 10 rounds	Last 10 rounds		First 10 rounds	Last 10 rounds
Group Chat	1	(6,4)	(7,3)	2	(6,4)	(7,3)
	3	(7,3)	(6,4)	4	(7,3)	(6,4)
	5	(6,4)	(7,3)	6	(6,4)	(7,3)
	7	(7,3)	(6,4)	8	(7,3)	(6,4)
Public Chat	9	(6,4)	(7,3)	10	(6,4)	(7,3)
	11	(7,3)	(6,4)	12	(7,3)	(6,4)
	13	(6,4)	(7,3)	14	(6,4)	(7,3)
	15	(7,3)	(6,4)	16	(7,3)	(6,4)
No Chat	17	(6,4)	(7,3)	18	(6,4)	(7,3)
	19	(7,3)	(6,4)	20	(7,3)	(6,4)

Notes: Each row represents two sessions. Table cells contain the sizes of (Majority, Minority) for each treatment. For each communication regime and voting cost, each session combined two size treatments and had 20 rounds total, with two independent electorates in each round.

4 Results

For each treatment, Figure 2 presents the averages of turnout rates in each party and the total turnout rate.[17] The corresponding numerical values are reported in Table A.1 in Appendix A. With our $2 \times 2 \times 3$ design and 20 sessions, the total number of elections was 40 in each NC treatment and 80 in each GC and PC treatment. To account for possible correlation across rounds and across ten-person groups (as group composition changed after every round), we treated each group over ten rounds as a panel, and computed panel-corrected standard errors with a correction for first-order

[16] All sessions were conducted at the UC-Irvine Experimental Social Science Laboratory (ESSL). The computer software was developed using the Multistage framework (http://multistage.ssel.caltech.edu).

[17] For expositional clarity, for many of our results, we report additional supporting figures and estimation details (e.g., standard errors and p-values) in Appendix A.

autocorrelation within each panel.[18] Figure 2 shows a number of differences across treatments, which we discuss and test below.

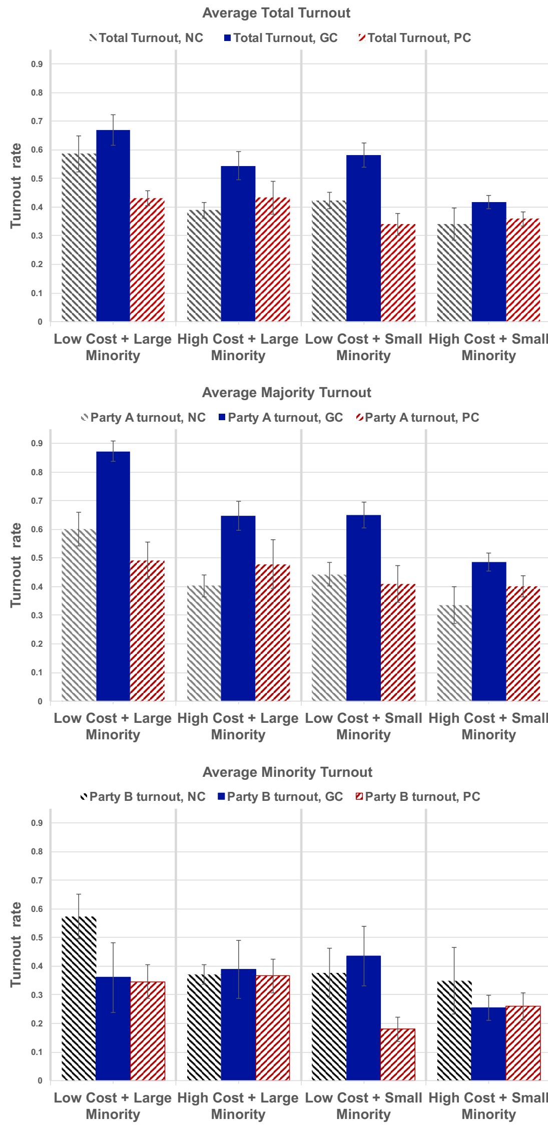

Figure 2: *Average Turnout Rates.*

A quick comparison with the theoretic predictions for max-turnout equilibria in Table 1 shows that Nash equilibrium is not very consistent with the behaviour observed in our experiment: average total turnouts rates in the data are much higher (with one exception) than in the maximal turnout Nash equilibria predictions of Table 1, already in the NC treatment, and even more so in the

[18]We also ran the standard two-sample t-test for comparison of means across treatments, which assumes independent observations in each sample, and found very similar results. Clustering by subject also produced similar outcomes. The findings we report in Figure 2 and Table A.1 are more conservative.

GC treatment. Similar to the stylised facts from real-world elections and many past experimental findings, voters in the lab tend to over-vote compared to the Nash equilibrium.

In contrast, a casual inspection of the turnout rates suggests that the data might be consistent with correlated and subcorrelated equilibrium predictions, although to establish this more rigorously requires a deeper analysis, which we present below in Section 4.5.

Total turnout rates in Figure 2 are somewhat lower than the max-turnout correlated and subcorrelated equilibrium predictions in Table 1, but they seem to satisfy the constraint of the turnout upper bound. Thus, it might be possible to associate correlated and subcorrelated equilibria with expected turnout that would match the data. In order to check this, we develop and apply a formal direct test for consistency with correlated and subcorrelated equilibria in Section 4.5.2.

Figures A.2 – A.3 in Appendix A provide a more-detailed presentation of voting patterns in the majority and minority parties. There, we also estimate individual voting probabilities for each subject, and group them by treatment and session to assess between-session variability (see Figures A.4 and A.5 in Appendix A).

The remainder of this section is organised as follows. In Sections 4.1–4.3, we statistically test the treatment effects of changes in communication protocol, voting cost, and relative party sizes. These behavioural effects are tested for using group-level decisions and do not rely on specific assumptions about equilibrium behaviour. In Section 4.4 we check robustness of test results to multiple hypothesis and learning using regression analyses. In Section 4.5, we look at voting profile frequencies and check whether these patterns are consistent with equilibrium behaviour. In Section 4.6, we focus on communication treatments and report the analysis of the chat logs.

4.1 Effects of Communication on Turnout

We start our analysis by looking at the main effect of interest: how communication affects turnout.

RESULT 1. ***(Total Turnout)*** *Group communication increases total turnout. Public communication decreases turnout under low cost, and has no effect under high cost.*

Support. To test for the effect of communication on total (and party) turnout, we compared the average turnout rates under two different communication modes, while keeping party sizes and voting cost fixed.[19]

Table 3: *Effects of Communication on Turnout and Victory Margin*

Group Communication minus No Communication							
n_A	n_B	c	$\Delta\hat{T}_A$	$\Delta\hat{T}_B$	$\Delta\hat{T}$	$\Delta\hat{T}_A - \Delta\hat{T}_B$	ΔMargin
6	4	0.1	0.274***	−0.214***	0.083**	0.490***	0.447***
–	–	0.3	0.244***	0.018	0.154***	0.227***	0.264***
7	3	0.1	0.208***	0.060	0.160***	0.150**	0.118
–	–	0.3	0.150***	−0.094	0.076**	0.244***	0.331***
Public Communication minus No Communication							
n_A	n_B	c	$\Delta\hat{T}_A$	$\Delta\hat{T}_B$	$\Delta\hat{T}$	$\Delta\hat{T}_A - \Delta\hat{T}_B$	ΔMargin
6	4	0.1	−0.108**	−0.229***	−0.155***	0.121*	0.124*
–	–	0.3	0.076	−0.004	0.044	0.085*	0.172***
7	3	0.1	−0.034	−0.196***	−0.082***	0.162**	0.143
–	–	0.3	0.066*	−0.091	0.018	0.153**	0.257**

Significance codes: *** < 0.01, ** < 0.05, * < 0.1

From Table 3, we see that, for each treatment, GC increases total turnout, compared to NC. By contrast, the effect of PC is quite mixed. With high cost, PC has no significant effect on total turnout. On the other hand, PC decreases turnout significantly with low cost for both size treatments. ■

RESULT 2. ***(Party Turnout)*** *Communication affects party turnout differently for the majority and minority parties: in all cases, communication increases (decreases) turnout more (less) for the majority party than for the minority party. Thus, communication always increases the expected margin of victory for the majority party. With group communication, it uniformly increases majority turnout and has either no effect or a negative effect on minority turnout. With public communication and low cost, it decreases turnout by minority, with a smaller in magnitude, or no effect on majority; with high cost, there are no significant effects.*

Support. Looking at the party turnout rates in Table 3, we see that GC increases majority turnout for each treatment, compared with NC. PC increases majority party turnout for large majority size and high cost, but decreases majority turnout under low cost (the decrease is not significant for the large majority treatment).

The effect of communication on minority turnout is less pronounced. GC decreases minority turnout, compared to NC for the large minority and low cost. PC decreases minority turnout,

[19]We report two-sided p-values in Table A.3 in Appendix A.

compared to NC for low cost, decreases for high cost are not significant.

The next-to-last column of Table 3 shows the difference between the marginal effect of communication on majority turnout compared to its effect on minority turnout. *In all cases,* $\Delta\hat{T}_A - \Delta\hat{T}_B$ *is positive and statistically significant.* Because $n_A > n_B$, this implies immediately that communication increases the expected margin of victory for the majority party.[20] The increase is significant in all treatments except for the low cost, small minority. See the last column of Table 3. ■

Next, we look at the effects of communication on several electoral characteristics: probability of ties, pivotal events, and upsets.

RESULT 3. ***(Pivotal Events and Upsets)*** *Communication nearly uniformly decreases probabilities of ties and pivotal events, and significantly so for pivotal events under group communication (all except for low cost and small minority), as well as one case of public communication with high cost and large minority. Communication nearly uniformly decreases the probabilities of upsets, with significant effects in half of the group communication treatments.*

Support. We report the corresponding results in Table 4.

Table 4: *Effects of Communication on Electoral Characteristics*

Group Communication minus No Communication					
n_A	n_B	c	ΔTie	ΔPivot	ΔUpset
6	4	0.1	-0.256^{***}	-0.312^{***}	-0.231^{***}
–	–	0.3	-0.133	-0.214^{***}	-0.045
7	3	0.1	-0.082	-0.079	-0.064
–	–	0.3	-0.139	-0.199^{***}	-0.127^{**}
Public Communication minus No Communication					
n_A	n_B	c	ΔTie	ΔPivot	ΔUpset
6	4	0.1	-0.072	0.022	-0.047
–	–	0.3	-0.080	-0.126^{*}	0.065
7	3	0.1	-0.004	-0.012	-0.033
–	–	0.3	-0.077	-0.083	-0.094

Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$

From Table 4, we find that communication nearly always decreases probabilities of ties, pivotal events, and upsets. Out of 24 comparisons, 22 have a negative sign. The effect is generally stronger for GC, and in all 12 GC vs. NC comparisons, the effect is negative. However, these differences are significant in less than half the cases. The reason that these differences are generally negative follows almost directly from the earlier observation that communication (either GC or PC) always

[20]The expected margin of victory is defined in (14).

increases majority turnout by more than it increases minority turnout, leading to wider margins of victory for the majority and fewer close elections. ■

4.2 Effects of Changing the Voting Cost

Intuitively, increasing the voting cost should lead to a lower expected turnout. However, the equilibrium effect is ambiguous for a few reasons. First, even without communication, there are symmetric equilibria in which turnout is increasing in the cost;[21] and communication expands the set of equilibria relative to Nash, allowing for a wider range of expected turnout relative to the no-communication equilibrium. Second, communication allows voters to coordinate their actions, so it is possible that with communication, they might coordinate on a higher turnout equilibrium with high voting costs than with low voting costs.

RESULT 4. ***(Cost Effect)*** *Increasing the voting cost reduces the total turnout for each size and communication treatment, except public. In two out of these four treatments, these effects are driven by uniform changes in both parties' turnout rates; in the remaining two, they are driven by changes in one party's turnout only. Increasing the voting cost nearly uniformly increases the probability of pivotal events, with significant effects under group communication and large minority, and under no communication and small minority.*

Support. We first look at the effect of increasing the voting cost on turnout (Table 5), and then report the effects on the electoral characteristics (Table 6).

Table 5: *Effects of Cost on Turnout*

		High Cost minus Low Cost			
n_A	n_B	Communication mode	$\Delta\hat{T}_A$	$\Delta\hat{T}_B$	$\Delta\hat{T}$
6	4	NC	-0.196^{***}	-0.204^{***}	-0.197^{***}
–	–	GC	-0.226^{***}	0.028	-0.127^{***}
–	–	PC	-0.012	0.020	0.001
7	3	NC	-0.107^{***}	-0.027	-0.081^{**}
–	–	GC	-0.165^{***}	-0.181^{***}	-0.165^{***}
–	–	PC	-0.007	0.078^{**}	0.019

Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$

[21] This may sound counter-intuitive. However, as Palfrey and Rosenthal (1983, p.42) note, for voters to be indifferent between voting and abstaining in a mixed Nash equilibrium, voting cost must equal their (endogenous) pivotal probability. In the high turnout symmetric equilibrium (with equal-sized parties), as the cost increases, so does their pivotal probability and, correspondingly, total turnout. See also Nöldeke and Peña (2016).

From Table 5, we see that reducing the voting cost increases total turnout for each size and communication treatment, except for PC. Breaking down the total turnout by parties, we see that these changes usually produce similar effects on party turnouts, except for GC with large minority, and NC with small minority, where the majority is affected more, and PC with small minority, where the minority is affected more.

Table 6 presents the corresponding effects of the cost change on the electoral characteristics considered earlier: the probability of ties, pivotal events, and upsets.

Table 6: *Effects of Cost on Electoral Characteristics*

High Cost minus Low Cost					
n_A	n_B	Comm. mode	ΔTie	ΔPivotal	ΔUpset
6	4	NC	−0.067	0.127	−0.055
–	–	GC	0.056	0.225***	0.132
–	–	PC	−0.075	−0.022	0.057
7	3	NC	0.126	0.200**	0.108
–	–	GC	0.068	0.080	0.044
–	–	PC	0.053	0.129	0.047

Significance codes: *** < 0.01, ** < 0.05, * < 0.1

From Table 6, we see that reducing the voting cost does not significantly affect the probability of ties. Reducing the cost decreases the probability of pivotal events under GC with large minority and under NC with small minority. The probability of upsets is nearly uniformly increasing in the cost (except for NC and large minority), but the changes are not significant. ■

4.3 Effects of Changing the Relative Party Sizes

We now turn to the effects of changing the party sizes while keeping the electorate size fixed. Intuitively, when the minority party is closer to 50%, a competition effect should lead to higher turnout in both parties. That is, the competition effect hypothesis is that turnout in each party is decreasing in $n_A - n_B$. Thus, increasing the minority party size from 3 to 4 at the expense of the majority party should increase turnout in each party. However, theoretically, this is not always the case with the highest turnout equilibrium: a more competitive election, ex ante, does not necessarily lead to higher equilibrium overall turnout. Furthermore, the effect of election competitiveness can be different for the majority and minority parties. Table 1 shows that in the high turnout, quasi-symmetric Nash equilibrium, the majority party turnout is higher in more-competitive elections, but minority turnout is actually depressed, and the theoretical effect of competitiveness on overall turnout can go either way; for our experimental parameters, the effect of competitiveness on overall turnout is positive if cost is low, but negative if cost is high. In both correlated and subcorrelated highest turnout equilibria, the effect of competitiveness on overall turnout and on minority turnout is positive, as intuitively expected. However, for the majority party, there is an interaction between cost and competitiveness. With high cost, the effect of competitiveness on T_A is positive, as expected, but with low cost, it goes the other way.

In contrast to the rather ambiguous theoretical implications about the competition effect, the data from the experiment speak quite clearly. In nearly all comparisons, there is a significant competition effect.

RESULT 5. ***(Competition Effect)*** *Increasing competitiveness increases total turnout, majority party turnout, and minority party turnout.*

Support. The effects on turnout are reported in Table 7. The competition effect on total turnout is positive and significant in all cases but one in which it is not significant. The competition effect on majority party turnout is positive in all cases and significant in five out of six cases. The competition effect on minority party turnout is positive and significant in four out of six cases and is insignificant in the remaining two. Overall, the effects are not particularly consistent with the high-turnout equilibrium effects of competitiveness in Table 1, as the theoretical sign of the competition effect depends on the cost of voting, and can go in different directions for different parties. With a high voting cost, six out of nine differences are significant and have the same sign as the theoretical effect in Table 1. The remaining three differences are not significant. However, with a low voting cost, half of the differences are significant with the opposite sign.

Table 7: *Effects of Changing the Relative Party Size on Turnout*

Minority Size 4 minus Minority Size 3				
c	Comm. mode	$\Delta\hat{T}_A$	$\Delta\hat{T}_B$	$\Delta\hat{T}$
0.1	NC	0.156^{***}	0.198^{***}	0.165^{***}
–	GC	0.222^{***}	-0.076	0.088^{**}
–	PC	0.082^{*}	0.165^{***}	0.092^{***}
0.3	NC	0.067^{*}	0.021	0.049
–	GC	0.161^{***}	0.134^{**}	0.126^{***}
–	PC	0.076	0.108^{***}	0.074^{**}

Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$

While we observe strong competition effects on turnout, there are few significant effects on the probability of ties, pivotal events, and upsets.[22] ■

4.4 Robustness of Treatment Effects

In this section, we discuss two potential concerns about the aggregate treatment effects reported in Sections 4.1–4.3. First, pairwise comparisons may suffer from multiple hypothesis testing problems and require type I error correction. Second, aggregate results may mask subject learning over time.

In order to partially alleviate both of these concerns, we ran several regression analyses for each party and total turnout, as well as the margin of majority victory. Table 8 reports the results for Logit (columns 1–3) and Tobit (column 4) specifications. The dependent variable is the binary decision to vote (except for column 4, in which it is the normalised margin).[23] The regressors are treatment dummies and their interactions.[24] The standard errors are clustered at the group-round level. To account for potential learning over time, we included an early round dummy variable taking value of 1 for rounds 1–5 and value of 0 for rounds 6–10 of each treatment.

The regression analysis results are consistent across treatments. First, we found no evidence of learning: none of the early rounds dummies was significant on their own or as part of any interaction terms.[25]

Second, as Table 8 shows, the main results in Sections 4.1–4.3 follow through: Group communication increases total turnout. Public communication decreases total turnout with low cost as the interaction terms Comm × Cost indicate. Increasing voting cost reduces everyone's turnout. Increasing minority size (i.e., competitiveness) increases turnout but the effect is only significant in interactions with cost. Group communication increases the majority victory margin, although there is a negative effect when interacted with size and voting cost.

[22]See Table A.8 in Appendix A.

[23]The regression in column 4 uses a Tobit specification with bounds -1 and 1.

[24]We also carried out regressions with vote shares (i.e., turnout rates) as dependent variables, for Tobit and OLS specifications. The results are qualitatively similar.

[25]To avoid clutter, the regression estimates of the early rounds dummies and their interactions are omitted in Table 8.

Table 8: *Regressing Party and Total Turnout on Treatment Dummies*

		T_A	T_B	T	Margin
Const		-0.475^{**}	-0.457^{***}	-0.468^{***}	0.104
		(0.229)	(0.174)	(0.150)	(0.139)
Comm	GC	1.004^{***}	0.052	0.619^{***}	0.400^{**}
		(0.311)	(0.311)	(0.237)	(0.168)
	PC	0.442	0.000	0.268	0.272
		(0.286)	(0.295)	(0.202)	(0.175)
Size	$n_A = 7$	−0.175	−0.161	−0.172	0.290
		(0.322)	(0.332)	(0.250)	(0.218)
Comm × Size	GC, $n_A = 7$	−0.425	−0.403	−0.300	−0.019
		(0.408)	(0.504)	(0.334)	(0.254)
	PC, $n_A = 7$	−0.287	−0.228	−0.224	−0.052
		(0.400)	(0.486)	(0.320)	(0.266)
Cost	$c = 0.1$	0.916^{***}	0.863^{***}	0.895^{***}	0.102
		(0.327)	(0.312)	(0.216)	(0.175)
Comm × Cost	GC, $c = 0.1$	0.323	-1.188^{**}	−0.458	0.253
		(0.428)	(0.510)	(0.311)	(0.222)
	PC, $c = 0.1$	-0.766^{*}	-1.108^{***}	-0.895^{***}	−0.075
		(0.412)	(0.433)	(0.285)	(0.229)
Size × Cost	$n_A = 7$, $c = 0.1$	−0.553	−0.791	-0.617^{*}	0.078
		(0.423)	(0.499)	(0.320)	(0.267)
Comm × Size × Cost	GC, $n_A = 7$, $c = 0.1$	−0.134	2.286^{***}	0.900^{**}	-0.603^{*}
		(0.537)	(0.757)	(0.427)	(0.328)
	PC, $n_A = 7$, $c = 0.1$	0.341	0.389	0.415	0.092
		(0.535)	(0.680)	(0.416)	(0.339)

Notes. Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$. Standard errors (in parentheses) are clustered at the group-round level $N = 800$. Comm refers to communication mode. Size refers to majority size. In Column 2, the controls are as follows. GC (group communication) and PC (public communication) are relative to NC (no communication). $n_A = 7$ is relative to $n_A = 6$. $c = 0.1$ is relative to $c = 0.3$. All specifications include a dummy for early rounds as well as all its interactions.

4.5 Correlated Equilibrium Analysis and Tests

In this section, we investigate whether adding communication results in a "higher" correlation in voters' choices, and whether the data are consistent with correlated and subcorrelated equilibria. We start by making additional assumptions necessary for the tests and formulating the test hypotheses.

Assumptions and Hypotheses

For the analysis of correlation in the data, we need to apply Assumption 1, which reduces the number of possible profiles to a total of $(n_A+1)(n_B+1)$ different profiles – i.e., 32 and 35 profiles in the small minority $(7,3)$ and large minority $(6,4)$ treatments, respectively, for which frequencies can be estimated from the data. Furthermore, this assumption is also plausible to hold in our data, since player IDs within each party are randomly reassigned every round. In addition to Assumption 1, we need to assume that the joint probability distribution is fixed throughout the game to ensure consistency of the frequency estimates.

ASSUMPTION 2. *(Fixed distribution) The realised voting outcomes are drawn every round from the* same *joint probability distribution (not necessarily an equilibrium one).*

Next, we formalise and test the following three hypotheses:

HYPOTHESIS 1. *(Independent Voting Decisions) Each voter votes independently with the same probability conditional on her party.*

HYPOTHESIS 2. *(Quasi-symmetric Nash) With NC, individual voting probabilities of the majority and minority party members,* q_A^* *and* q_B^**, respectively, are determined by a quasi-symmetric Nash equilibrium.*

HYPOTHESIS 3. *(Correlated and Subcorrelated Equilibria) a) With PC, the vote distribution is consistent with a correlated equilibrium; b) With GC, the distribution is consistent with a subcorrelated equilibrium.*

Hypotheses 1 – 3 inform us about important properties of voting behaviour with and without communication. If Hypothesis 1 holds, voting strategies can be described by two probabilities, q_A and q_B, for voters in the majority and minority party, respectively. Notice that Hypothesis 1 simultaneously requires independence and equal voting probabilities across voters within the same party, so, in principle, it can be rejected due to a violation of either property. But since Assumption 1 implies symmetry among all players in a party, we focus on testing for independence only. Thus, if we find that Hypothesis 1 does not hold, we interpret this as evidence for correlated voting. So, if Hypothesis 1 holds with no communication but is rejected with communication, this implies that communication introduces correlation. Moreover, this would immediately imply that the voting data with communication are not consistent with Nash equilibrium play.

If Hypothesis 2 holds, the two voting probabilities under NC are pinned down by the equilibrium conditions on q_A and q_B in (3) and (4). If Hypothesis 3 holds, then our simple communication protocols can effectively imitate a complex correlating device required for correlated and subcorrelated equilibrium implementation (in some correlated equilibria, private communication via some form of mediated communication would be required). If Hypothesis 3 is rejected, this could be due to voters not playing a group-symmetric correlated/subcorrelated equilibrium (e.g., because of being boundedly rational or having social preferences) or, perhaps, because mediated communication protocols are needed to implement the equilibrium correlating device.

4.5.1 Correlation in voting decisions

In this section, we investigate Hypotheses 1 and 2. The findings are summarised by

RESULT 6. ***(Independence and Correlation)*** *Without communication, voters' turnout decisions are independent. Quasi-symmetric Nash is rejected under the high voting cost but not under the low voting cost and large minority. Introducing communication results in correlated turnout decisions in seven out of eight treatments, with no support for Nash equilibrium play.*

Support. First, we check Hypothesis 1. We employ two different tests to compare the probability distribution of joint voting profiles estimated from the data with the induced distribution under the null: Likelihood Ratio and Epps-Singleton, the latter being a more powerful non-parametric alternative to the Kolmogorov-Smirnov test for comparing discrete distributions (see Appendix A.1 for test details).

Table 9 shows that in all NC treatments, none of these tests rejects Hypothesis 1 (independent voting) at the 0.05 level. Hypothesis 1 is rejected by the Likelihood Ratio test for all communication treatments (except PC under low cost), as well as by the Epps-Singleton test under high voting cost for both PC and GC, and under low cost for PC. Thus, both the Likelihood Ratio and Epps-Singleton tests produce relatively consistent results. Since Epps-Singleton does not take into account the variance in the estimation of $\hat{q}_A$ and $\hat{q}_B$, we are more confident in the Likelihood Ratio test when interpreting our results under communication.

Table 9: *Test for Symmetric Independent Voting: Estimated vs. Induced Distributions*

Communication	n_A	n_B	c	ES test		LR test	
				W_2	p-val	LR	$\chi^2_{0.05}$
NC	6	4	0.1	1.173	0.883	35.780	46.194 (32)
–	–	–	0.3	0.962	0.916	35.631	–
GC	–	–	0.1	5.381	0.250	215.444***	–
–	–	–	0.3	19.339***	0.001	170.422***	–
PC	–	–	0.1	12.715**	0.013	66.029***	–
–	–	–	0.3	11.830**	0.019	112.384***	–
NC	7	3	0.1	4.636	0.327	16.694	42.557 (29)
–	–	–	0.3	3.979	0.409	30.330	–
GC	–	–	0.1	3.981	0.409	168.517***	–
–	–	–	0.3	12.202**	0.016	95.288***	–
PC	–	–	0.1	0.815	0.936	22.522	–
–	–	–	0.3	11.037**	0.026	73.897***	–

Notes: W_2 is the two-sample Epps-Singleton test statistic for discrete data, computed using a modified version of the external Stata routine **escftest**. LR is the likelihood ratio, corresponding $\chi^2_{0.05}$ critical value with $(n_A+1)(n_B+1)-3$ degrees of freedom (either 32 or 29). Significance codes: *** < 0.01, ** < 0.05, * < 0.1

In the NC treatments, we focus on testing Hypothesis 2 for the max turnout quasi-symmetric Nash equilibrium because the summary data statistics indicate very high turnout rates that are inconsistent with the low-turnout, quasi-symmetric Nash equilibrium.[26] The results of the Epps-Singleton test are reported in Table 10. We reject Hypothesis 2 under high cost (and, marginally, under low cost and small minority), but not under low cost and large minority. Thus, in the low-cost NC treatments, the data are roughly consistent with a max-turnout quasi-symmetric Nash equilibrium. For communication treatments, we find that voting decisions are correlated, so there is no consistency with Nash equilibrium.[27]

■

[26] See Table A.1 in Appendix A.

[27] As an extra check, we tested and rejected Nash under all communication treatments.

Table 10: *Test for Max-Turnout Quasi-Symmetric Nash under NC*

n_A	n_B	c	ES test	
			W_2	p-val
6	4	0.1	2.752	0.600
–	–	0.3	48.595***	0.000
7	3	0.1	7.830*	0.098
–	–	0.3	26.193***	0.000

Notes: W_2 is the two-sample Epps-Singleton test statistic for discrete data, computed using a modified version of the external Stata routine **escftest**. The null hypothesis is that the equilibrium distribution and the estimated distribution are the same. Significance codes: *** < 0.01, ** < 0.05, * < 0.1

4.5.2 Consistency with correlated and subcorrelated equilibria

Having estimated the frequencies of all joint voting profiles, we can now test whether the realised vote distribution forms a correlated or a subcorrelated equilibrium.

The technical details of the tests for Hypothesis 3 are in Appendix A.2. The main idea is to compare the estimated probabilities of the joint profiles $\hat{\mu}_{a,b}$ for each pair of vote counts (a, b) with the induced probabilities $\tilde{\mu}_{a,b}$ under the null of the respective Hypothesis. We compare the two distributions by means of a two-sample Epps-Singleton test.

RESULT 7. ***(Correlated Equilibrium)*** *Correlated and subcorrelated equilibria are both rejected for all public communication treatments and most group communication treatments. We do not reject correlated equilibrium under group communication and low cost. We also do not reject sub-correlated equilibrium under group communication, low cost, and small minority.*

Support. Table 11 presents the results of our test for constraint violations for all of our treatments. Inconsistency with equilibrium (indicated by a test rejection) is generally due to the observation of too low a frequency of pivotal events, conditional on voting.[28]

We find, however, that under the low cost and GC, we cannot reject the null of aggregate voting behaviour being consistent with a correlated equilibrium (and marginally reject it for the large minority case). By contrast, we soundly reject the correlated equilibrium hypothesis in the remaining

[28] See Tables A.9 – A.12 in Appendix A. The results from Table 11 should be interpreted with caution, because they are based on a relatively small number of observations, and because there are many possible profiles, so the data are rather sparse.

Table 11: *Test for Consistency with Correlated Equilibrium*

Communication	n_A	n_B	c	IU stat
GC	6	4	0.1	5.487*
–	–	–	0.3	67.698***
PC	–	–	0.1	12.893***
–	–	–	0.3	38.335***
GC	7	3	0.1	1.364
–	–	–	0.3	91.712***
PC	–	–	0.1	15.938***
–	–	–	0.3	44.282***

IU test statistic is defined in (A.8) in Appendix A.2.
Significance codes: *** < 0.01, ** < 0.05, * < 0.1.

treatments.[29]

Table 12 presents the results of our test for a subcorrelated equilibrium in the communication treatments.[30] The estimated group frequencies and equilibrium constraints are in Tables A.11 – A.12 in Appendix A.2.

Table 12: *Test for Consistency with Subcorrelated Equilibrium*

Communication	n_A	n_B	c	IU stat
GC	6	4	0.1	16.429***
–	–	–	0.3	213.204***
PC	–	–	0.1	17.462***
–	–	–	0.3	95.414***
GC	7	3	0.1	4.759
–	–	–	0.3	124.498***
PC	–	–	0.1	30.390***
–	–	–	0.3	64.876***

IU test statistic is defined in (A.8) in Appendix A.2.
Significance codes: *** < 0.01, ** < 0.05, * < 0.1.

We see from Table 12 that the test results for subcorrelated equilibrium are broadly in line with the results for correlated equilibrium, and that GC, low cost, and small minority remains the only consistent treatment. ■

4.6 Analysis of Chat Data in Communication Treatments

In this section, we take a deeper look at the actual communication between subjects. Our main goals here are to try to understand how PC differs from GC and how the number of messages in

[29] Strictly speaking, this is a joint hypothesis of a correlated equilibrium and Assumptions 1–2.

[30] Because the set of subcorrelated equilibria is contained in the set of correlated equilibria, rejection of correlated equilibrium implies rejection of subcorrelated equilibrium (and Nash equilibrium).

different categories is related to turnout.

We recorded the messages that subjects exchanged during each pre-play communication stage and employed an independent research assistant to classify and code the messages according to ten general categories, listed in Table 13.

Table 13: *Message Categories and Observed Aggregate Frequencies*

Code	Description	Examples	GC, %	PC, %
0	Irrelevant	"hello"	30.81	31.30
1	Disagreement	"no!"	1.12	1.56
2	Agreement to a proposed joint strategy	"alright"	7.43	3.71
3	General discussion about rules	"you can only get 135 in type A"	23.22	19.26
4	Informative statement about history	"one A chose Y last time"	7.19	5.16
5	Question to others: what are we going to do?	"so X or Y?"	2.19	1.68
6	Strategy suggestion about others'/own/group decision	"if you're 1-4 pick x"	21.92	34.51
7	Own plan: will choose X	"I'll do X"	3.80	1.38
8	Own plan: will choose Y	"I'll do Y"	2.04	1.21
9	Ambiguous	"not sure"	0.27	0.23
		Total number of messages	13,109	14,015

We begin our analysis by looking at the message frequency distributions pooled across cost and group size treatments.

RESULT 8. ***(Message Types)*** *Public and group communication induce similar message frequencies overall, but public communication treatments have more strategy suggestions and fewer agreement and own plan messages than group communication treatments. About 31% of all messages are irrelevant in both communication treatments.*

Support. We compute message frequencies for each category listed in Table 13 and report them in the last two columns of that table. We observe a large fraction of irrelevant messages (code 0: about 31% of the total of about 4,040 (about 4,400) messages under GC (PC).) Other high-frequency categories of messages include strategy suggestions (code 6: about 22% of the total under GC and about 35% under PC); and discussion about the rules of the game (code 3: about 23% under GC and about 19% under PC.) The next two largest categories are messages expressing agreement (code 2: about 7% under GC and about 4% under PC) and messages informative about the history of play (code 4: about 7% under GC and about 5% under PC). A smaller fraction of messages relate to questions to others and own plans (codes 5, 7, and 8, respectively.) The remaining categories – disagreement and ambiguous messages – comprise, on average, less than

1.7% of the total messages.[31] ■

To assess how the number of messages in different categories affects turnout rates, we estimate a simple linear relationship, regressing for each communication treatment the normalised total turnout[32] on the total number of messages in each code category.

RESULT 9. ***(Message Effects)*** *Irrelevant messages have no effect on the normalised turnout rate, despite their large share. Agreement messages increase normalised turnout (significantly with group communication); and disagreement messages decrease normalised turnout (significantly with public communication). Total turnout increases in the number of messages stating intent to vote and decreases in the number of messages stating intent to abstain. Since intent messages are mostly truthful, this effect is driven largely by voters' own turnout rather than their influence on others.*

Support. Table 14 reports estimates from an ordered probit model regressing the normalised total turnout on the number of messages in each of the categories (with standard errors and p-values reported in Table A.15 in Appendix A.) We also estimate the ordinary least squares model and find very similar results.

Table 14: *Effects of the Number of Messages on Normalised Total Turnout in Communication Treatments*

Communication	Message Category						
	(Irrelev.)	(Disagr.)	(Agr.)	(Hist.)	(Q&S)	(Vote)	(Abst.)
Group	0.008	0.028	0.085***	0.029	0.013***	0.140***	−0.130***
Public	0.003	−0.038***	0.025	−0.002	−0.001	0.333***	−0.276***

Notes. Table cells contain for each message code ordered probit estimates of the effects of the total number of messages per electorate in that category on the normalised total turnout. Significance codes: *** < 0.01, ** < 0.05, * < 0.1. For clarity of presentation we combined messages with codes 0, 3, and 9 into the "Irrelevant" category. We also combined messages with codes 5 and 6 into the "Q&S" category. The remaining message categories are as described in Table 13.

While the intent messages (the last two columns of Table 14) show significant effects, it could well be the case that an increase (decrease) in total turnout is simply due to voters being truthful about their plans. To see whether voters expressing the intent to vote or abstain actually carry out their

[31] See Tables A.13 – A.14 in Appendix A for a breakdown of message frequencies by treatment and round. Those tables suggest that the patterns are not a by-product of pooling across rounds or treatments. One minor exception is that we observe a somewhat increasing proportion of irrelevant messages over rounds, especially under PC.

[32] Normalised total turnout makes data from cost and size treatments suitable for pooling together by taking into account deviations of individual observations from the treatment-specific averages. It is defined for each group-round election i in treatment $j \in$ {High cost, Low cost} $\times$ {Large minority, Small minority} $\times$ {Public, Group} as $t_{ij} = \frac{T_{ij} - \bar{T}_j}{N_j}$, where T_{ij} is the total number of votes; $\bar{T}_j$ is the average number of votes (mean turnout rate); and N_j is the number of group-round observations.

promises, we compute a "truth" rate, defined for each election (group-round observation) as the ratio of truthful messages (i.e., a voter says that she'll vote and does vote, or she says that she'll abstain and does abstain) to the total number of intent messages in that election (i.e., messages with "vote" and "abstain" codes). The average truth rate (pooled across majority and cost treatments) for GC is 0.869 ($se = 0.014$, $p = 0.000$), and for PC, it is 0.812 ($se = 0.022$, $p = 0.000$). Thus, voters stating their intent are mostly truthful.

Estimating the effect of intent messages on others' turnout is far from straightforward: in the same chat, there could be several voters expressing the intent to turn out, or some expressing the intent to turn out and others the intent to abstain, and excluding all those who state any intent would conflate the effects. Our crude estimates (available upon request) show some effect of the intent messages on turnout through influencing the turnout of others, but the bulk of the change is driven by voters' own turnout (or non-turnout in the case of abstention). ■

5 Concluding Remarks

This is the first laboratory study to examine how unrestricted and party-restricted pre-election communication among voters affects turnout, by creating correlation between voter turnout decisions. The experiment investigated how changes in communication structure affect both turnout and electoral outcomes under different conditions of the cost of voting and ex ante election competitiveness.

There are a number of central findings of the experiment. The most important finding is that communication unambiguously benefits the majority party by increasing its expected turnout margin. This finding is robust to all the different treatment variations in the experiment. This result is surprising in the sense that we are not aware of any existing theoretical model that would predict this systematic finding, including the Nash equilibrium model and our related analysis of correlated equilibrium of the turnout game.

Second, we develop and apply a test for the effect of communication on correlation. With no communication, we find strong evidence of independence, but only limited support for symmetric mixed Nash equilibrium. With communication, individual voting decisions are correlated, but again find only limited support for correlated equilibrium, and no support for Nash equilibrium. Overall, the effects of communication on correlation, and hence on outcomes, are significant and comparable in magnitude to the effects of changing the main exogenous parameters of the model, which have traditionally been viewed as key driving variables that influence turnout – i.e., voting cost and the competitiveness of the election.

Third, we observe an interaction effect between the form of communication and the voting cost in terms of how these two factors influence overall turnout in elections. In particular, party-restricted communication increases turnout for both cost levels. Unrestricted public communication decreases turnout with a low voting cost and has no effect on turnout with a high voting cost. This has potentially relevant policy implications, especially since get-out-the-vote campaigns are shifting towards social media – reaching new levels of political communication – and since changes in voting technology and election laws affect the cost of voting.

Fourth, for most treatments, we find evidence for both a cost effect (turnout decreases in the voting cost) and a competition effect (turnout increases in the relative size of the minority).[33]

We wish to underscore the importance of developing rigorous theoretical models to explicitly take communication possibilities into account. Correlated and Subcorrelated equilibria provide a useful framework for this. Testing for these equilibria in our data is the first attempt to identify the general principles behind communication-based coordination in competing groups using the correlated equilibrium approach.

Finally, one wonders how the results from our laboratory-scale elections extend to larger electorates, and how our correlated and subcorrelated equilibrium approach could be applied to model communication with many voters. These two questions are not independent. For example, practical limitations preclude efficient unmediated communication among all the members of large electorate. In typical elections, communication to and between voters is partly coordinated and mediated by

[33] In addition to the turnout-related results, we also looked at the effects on welfare, which, in this model, highlights the tradeoff between the probability the majority party wins, the voting cost, and the expected total turnout. Reducing the voting cost or the relative minority size increases total welfare in all treatments. Communication increases welfare under low voting cost, but decreases it under high voting cost, for partition (7,3). See Table A.1 in Appendix A. More detailed results are available from the authors upon request.

party leaders and activists, and the explosion of diverse social media networks induces unmediated communication to take place within many smaller clusters of users. Our approach is compatible with both of these features. In particular, mediated communication by leaders can make it even easier rather than harder to coordinate voters by inducing correlation in their turnout decision, and the existence of smaller clusters of groups who engage in unmediated communication via social media is consistent with our theoretical approach of modelling group communication using subcorrelated equilibrium, only with a finer partition of the set of voters. In a broader sense, this suggests that our findings about the turnout effects of group communication in the laboratory might have useful insights for the larger aggregate levels.[34] The partial success of this framework, especially the surprising and robust finding about the differential effect of communication on majority and minority parties, invites further study. While beyond the scope of the current paper, a very interesting and challenging extension of this initial study would be to explore the effects of mediated and unmediated communication in much larger laboratory elections.

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[34]In the field, there can also be additional factors at play, such as social pressure (DellaVigna *et al.*, 2017) or ethical voting considerations (Coate and Conlin, 2004; Feddersen and Sandroni, 2006). We do observe some evidence of social pressure in the chat logs, but do not find evidence of ethical voting behaviour.

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Appendix A Additional Details (for online publication)

The figures and tables in this appendix present additional estimation details for results in Section 4.

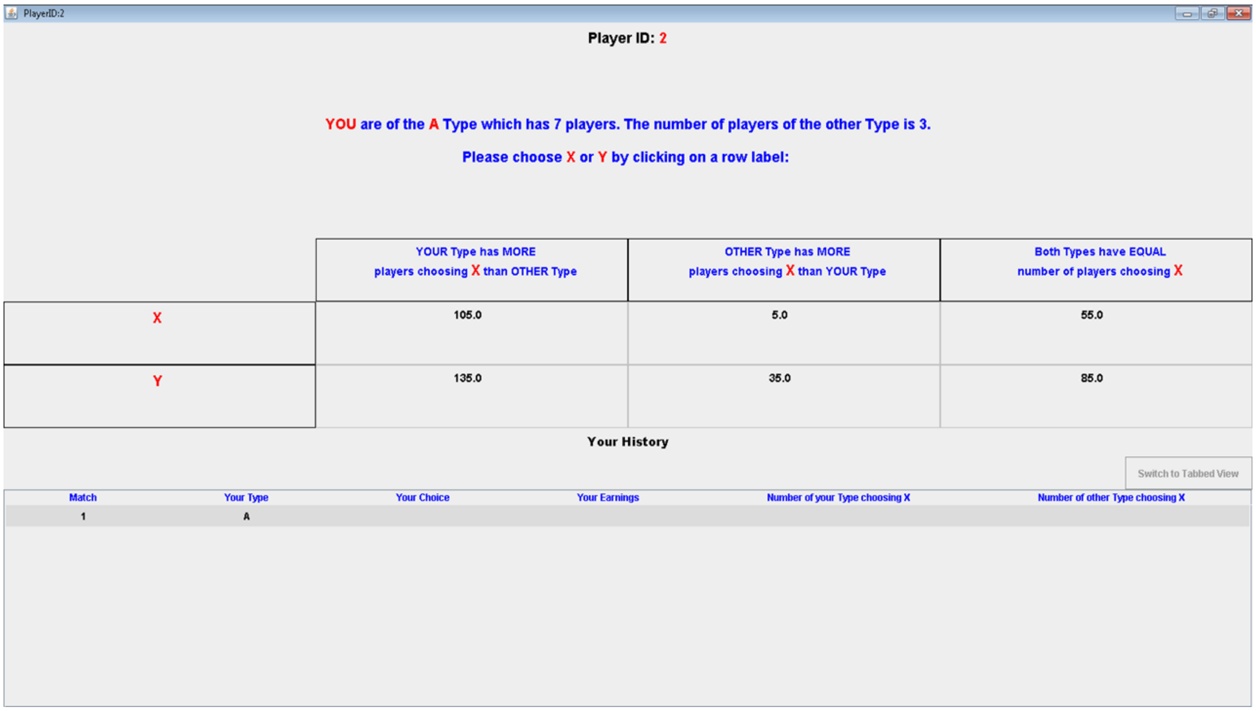


Figure A.1: *User Interface (NC Treatment)*

Table A.1: *Mean Turnout and Group Welfare Rates By Treatment*

NC											
N	n_A	n_B	c	$\hat{T}_A$		$\hat{T}_B$		$\hat{T}$		$\hat{W}$	
40	6	4	0.1	0.600	(0.030)	0.574	(0.040)	0.587	(0.032)	0.489	(0.009)
–	–	–	0.3	0.403	(0.020)	0.371	(0.018)	0.390	(0.014)	0.442	(0.010)
–	7	3	0.1	0.443	(0.021)	0.377	(0.044)	0.423	(0.015)	0.614	(0.026)
–	–	–	0.3	0.336	(0.033)	0.349	(0.059)	0.341	(0.029)	0.509	(0.015)
GC											
N	n_A	n_B	c	$\hat{T}_A$		$\hat{T}_B$		$\hat{T}$		$\hat{W}$	
80	6	4	0.1	0.873	(0.018)	0.361	(0.062)	0.670	(0.027)	0.526	(0.007)
–	–	–	0.3	0.647	(0.026)	0.389	(0.052)	0.544	(0.025)	0.408	(0.013)
–	7	3	0.1	0.651	(0.023)	0.436	(0.053)	0.582	(0.022)	0.620	(0.013)
–	–	–	0.3	0.486	(0.016)	0.255	(0.022)	0.417	(0.012)	0.536	(0.012)
PC											
N	n_A	n_B	c	$\hat{T}_A$		$\hat{T}_B$		$\hat{T}$		$\hat{W}$	
80	6	4	0.1	0.491	(0.033)	0.346	(0.030)	0.432	(0.013)	0.514	(0.006)
–	–	–	0.3	0.479	(0.043)	0.366	(0.030)	0.433	(0.029)	0.417	(0.009)
–	7	3	0.1	0.409	(0.033)	0.180	(0.022)	0.340	(0.020)	0.633	(0.018)
–	–	–	0.3	0.402	(0.019)	0.259	(0.025)	0.359	(0.012)	0.539	(0.014)

Notes: N is the number of group decision observations. Panel-corrected AR(1)-corrected standard errors are in parentheses.

Table A.2: *Mean Frequencies by Treatment*

NC									
N	n_A	n_B	c	Tie		Pivotal		Upset	
40	6	4	0.1	0.272	(0.044)	0.477	(0.086)	0.259	(0.049)
–	–	–	0.3	0.205	(0.068)	0.603	(0.052)	0.204	(0.058)
–	7	3	0.1	0.111	(0.182)	0.300	(0.085)	0.116	(0.084)
–	–	–	0.3	0.237	(0.086)	0.500	(0.035)	0.223	(0.046)
GC									
N	n_A	n_B	c	Tie		Pivotal		Upset	
80	6	4	0.1	0.016	(0.067)	0.165	(0.053)	0.027	(0.062)
–	–	–	0.3	0.072	(0.059)	0.390	(0.046)	0.159	(0.064)
–	7	3	0.1	0.029	(0.046)	0.221	(0.038)	0.052	(0.042)
–	–	–	0.3	0.097	(0.031)	0.301	(0.038)	0.096	(0.034)
PC									
N	n_A	n_B	c	Tie		Pivotal		Upset	
80	6	4	0.1	0.200	(0.051)	0.499	(0.092)	0.212	(0.031)
–	–	–	0.3	0.125	(0.048)	0.477	(0.052)	0.269	(0.035)
–	7	3	0.1	0.107	(0.089)	0.288	(0.065)	0.083	(0.056)
–	–	–	0.3	0.160	(0.042)	0.417	(0.049)	0.130	(0.035)

Notes: N is the number of group decision observations. Panel-corrected AR(1)-corrected standard errors are in parentheses

Table A.3: *Effects of Communication on Turnout*

GC v. NC													
N	n_A	n_B	c	$\Delta\hat{T}_A$		$\Delta\hat{T}_B$		$\Delta\hat{T}$		$\Delta\hat{T}_A - \Delta\hat{T}_B$		ΔMargin	
80 v. 40	6	4	0.1	0.274***	(0.000)	−0.214***	(0.005)	0.083**	(0.050)	0.490***	(0.000)	0.447***	(0.000)
–	–	–	0.3	0.244***	(0.000)	0.018	(0.743)	0.154***	(0.000)	0.227***	(0.001)	0.264***	(0.001)
–	7	3	0.1	0.208***	(0.000)	0.060	(0.390)	0.160***	(0.000)	0.150**	(0.043)	0.118	(0.105)
–	–	–	0.3	0.150***	(0.000)	−0.094	(0.142)	0.076**	(0.020)	0.244***	(0.000)	0.331***	(0.001)
PC v. NC													
N	n_A	n_B	c	$\Delta\hat{T}_A$		$\Delta\hat{T}_B$		$\Delta\hat{T}$		$\Delta\hat{T}_A - \Delta\hat{T}_B$		ΔMargin	
80 v. 40	6	4	0.1	−0.108**	(0.016)	−0.229***	(0.000)	−0.155***	(0.000)	0.121*	(0.078)	0.124*	(0.086)
–	–	–	0.3	0.076	(0.115)	−0.004	(0.899)	0.044	(0.180)	0.085*	(0.077)	0.172***	(0.007)
–	7	3	0.1	−0.034	(0.391)	−0.196***	(0.000)	−0.082***	(0.001)	0.162**	(0.022)	0.143	(0.114)
–	–	–	0.3	0.066*	(0.083)	−0.091	(0.165)	0.018	(0.573)	0.153**	(0.021)	0.257**	(0.011)

Notes: Two-sided p-values in parentheses. Significance codes: *** < 0.01, ** < 0.05, * < 0.1

Table A.4: *Effects of Communication on Electoral Characteristics*

GC v. NC									
N	n_A	n_B	c	ΔTie		ΔPivotal		ΔUpset	
80 v. 40	6	4	0.1	−0.256***	(0.002)	−0.312***	(0.003)	−0.231***	(0.004)
–	–	–	0.3	−0.133	(0.142)	−0.214***	(0.003)	−0.045	(0.602)
–	7	3	0.1	−0.082	(0.665)	−0.079	(0.401)	−0.064	(0.498)
–	–	–	0.3	−0.139	(0.134)	−0.199***	(0.000)	−0.127**	(0.028)
PC v. NC									
N	n_A	n_B	c	ΔTie		ΔPivotal		ΔUpset	
80 v. 40	6	4	0.1	−0.072	(0.289)	0.022	(0.861)	−0.047	(0.423)
–	–	–	0.3	−0.080	(0.340)	−0.126*	(0.088)	0.065	(0.338)
–	7	3	0.1	−0.004	(0.984)	−0.012	(0.910)	−0.033	(0.742)
–	–	–	0.3	−0.077	(0.427)	−0.083	(0.170)	−0.094	(0.107)

Notes: Two-sided p-values in parentheses. Significance codes: *** < 0.01, ** < 0.05, * < 0.1

Table A.5: *Effects of Cost on Turnout*

High Cost v. Low Cost									
N	n_A	n_B	Comm. mode	$\Delta\hat{T}_A$		$\Delta\hat{T}_B$		$\Delta\hat{T}$	
40	6	4	NC	−0.196***	(0.000)	−0.204***	(0.000)	−0.197***	(0.000)
80	–	–	GC	−0.226***	(0.000)	0.028	(0.730)	−0.127***	(0.001)
–	–	–	PC	−0.012	(0.823)	0.020	(0.634)	0.001	(0.971)
40	7	3	NC	−0.107***	(0.008)	−0.027	(0.712)	−0.081**	(0.017)
80	–	–	GC	−0.165***	(0.000)	−0.181***	(0.002)	−0.165***	(0.000)
–	–	–	PC	−0.007	(0.855)	0.078**	(0.021)	0.019	(0.415)

Notes: Two-sided p-values in parentheses. Significance codes: *** < 0.01, ** < 0.05, * < 0.1.

Table A.6: *Effects of Cost on Electoral Characteristics*

High Cost v. Low Cost									
N	n_A	n_B	Comm. mode	ΔTie		ΔPivotal		ΔUpset	
40	6	4	NC	−0.067	(0.411)	0.127	(0.211)	−0.055	(0.469)
80	–	–	GC	0.056	(0.533)	0.225***	(0.002)	0.132	(0.141)
–	–	–	PC	−0.075	(0.291)	−0.022	(0.838)	0.057	(0.227)
40	7	3	NC	0.126	(0.535)	0.200**	(0.034)	0.108	(0.266)
80	–	–	GC	0.068	(0.217)	0.080	(0.142)	0.044	(0.416)
–	–	–	PC	0.053	(0.590)	0.129	(0.116)	0.047	(0.478)

Notes: Two-sided p-values in parentheses. Significance codes: *** < 0.01, ** < 0.05, * < 0.1.

Table A.7: *Effects of Changing the Relative Party Size on Turnout*

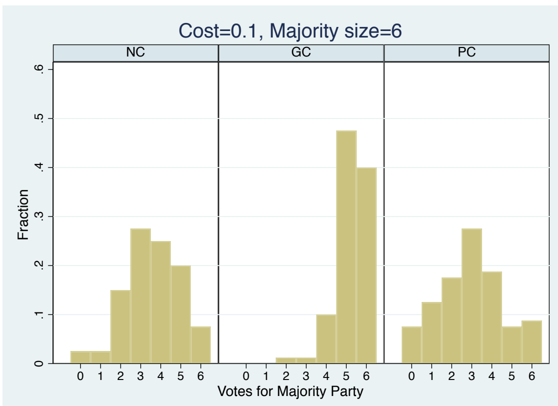
Minority Size 4 v. Minority Size 3								
N	c	Comm. mode	$\Delta\hat{T}_A$		$\Delta\hat{T}_B$		$\Delta\hat{T}$	
40	0.1	NC	0.156^{***}	(0.000)	0.198^{***}	(0.001)	0.165^{***}	(0.000)
80	–	GC	0.222^{***}	(0.000)	-0.076	(0.355)	0.088^{**}	(0.011)
–	–	PC	0.082^{*}	(0.079)	0.165^{***}	(0.000)	0.092^{***}	(0.000)
40	0.3	NC	0.067^{*}	(0.084)	0.021	(0.732)	0.049	(0.139)
80	–	GC	0.161^{***}	(0.000)	0.134^{**}	(0.019)	0.126^{***}	(0.000)
–	–	PC	0.076	(0.108)	0.108^{***}	(0.007)	0.074^{**}	(0.021)

Notes: Two-sided p-values in parentheses. Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$.

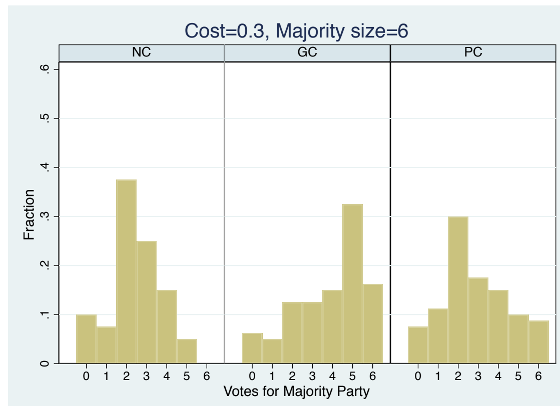
Table A.8: *Effects of Changing the Relative Party Size on Electoral Characteristics*

Minority Size 4 v. Minority Size 3								
N	c	Comm. mode	ΔTie		ΔPivotal		ΔUpset	
40	0.1	NC	0.161	(0.396)	0.177	(0.147)	0.143	(0.147)
80	–	GC	-0.013	(0.874)	-0.056	(0.389)	-0.024	(0.748)
–	–	PC	0.093	(0.369)	0.211^{*}	(0.064)	0.130^{**}	(0.044)
40	0.3	NC	-0.032	(0.773)	0.104	(0.104)	-0.020	(0.791)
80	–	GC	-0.026	(0.703)	0.089	(0.139)	0.063	(0.384)
–	–	PC	-0.035	(0.585)	0.060	(0.396)	0.140^{***}	(0.006)

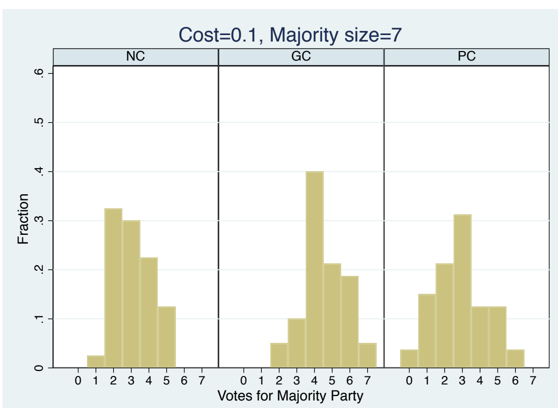
Notes: Two-sided p-values in parentheses. Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$.



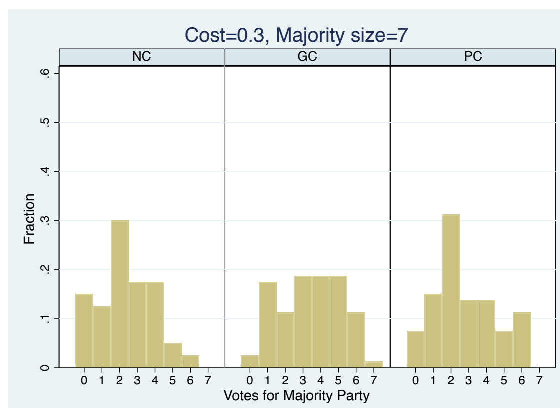
(a) Low Cost, partition $(6, 4)$



(b) High Cost, partition $(6, 4)$

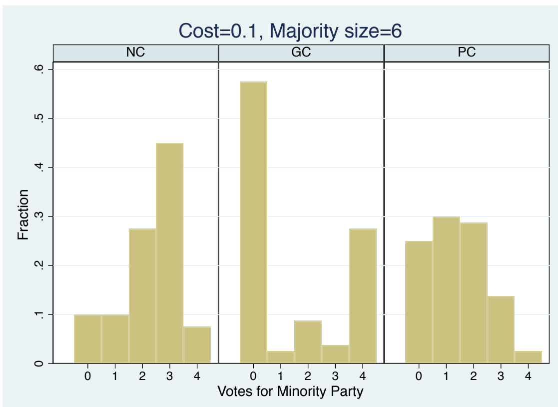


(c) Low Cost, partition $(7, 3)$

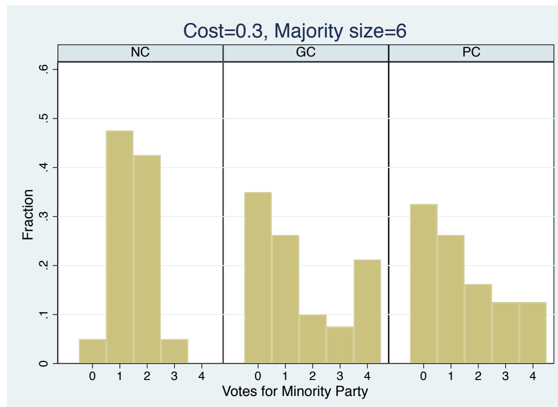


(d) High Cost, partition $(7, 3)$

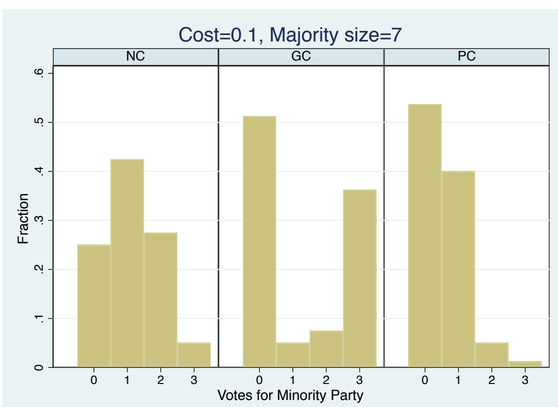
Figure A.2: *Voting Patterns for Majority Party.*



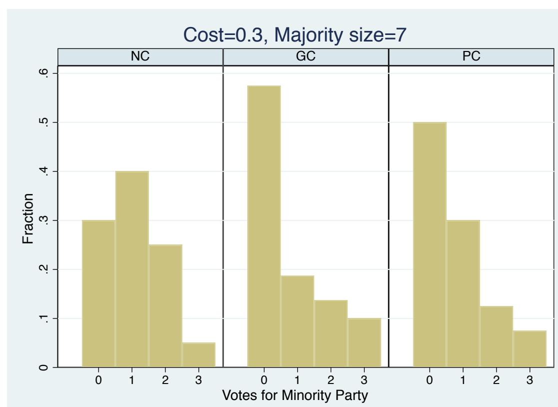
(a) Low Cost, partition $(6, 4)$



(b) High Cost, partition $(6, 4)$

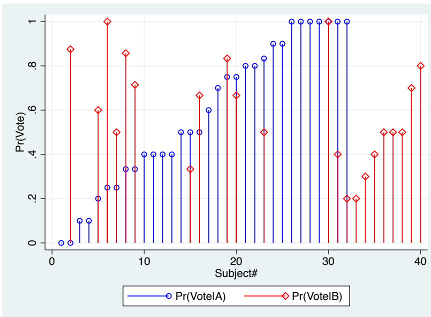


(c) Low Cost, partition $(7, 3)$

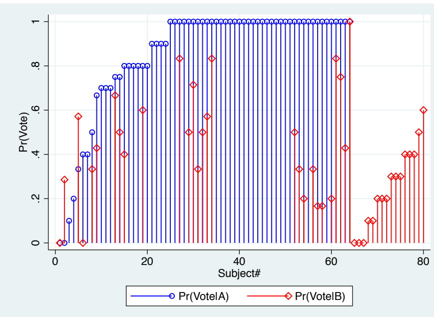


(d) High Cost, partition $(7, 3)$

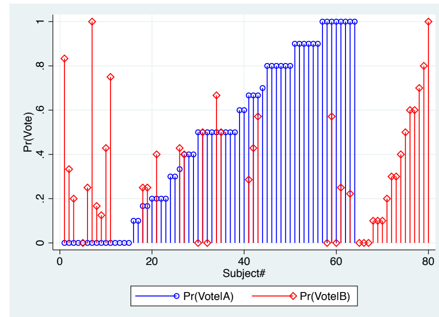
Figure A.3: *Voting Patterns for Minority Party.*



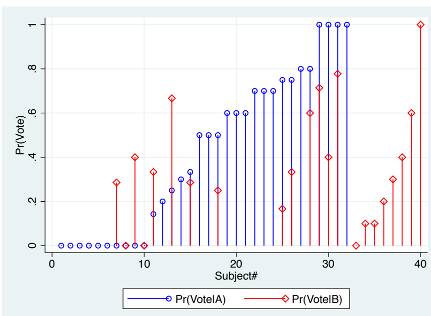
(a) NC, partition $(6, 4)$, $c = 0.1$



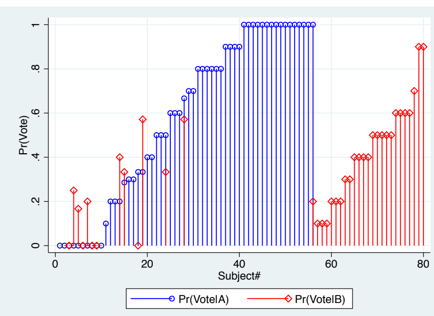
(b) GC, partition $(6, 4)$, $c = 0.1$



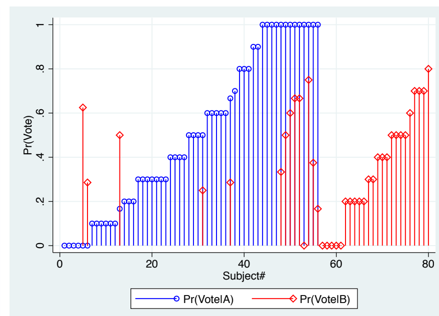
(c) PC, partition $(6, 4)$, $c = 0.1$



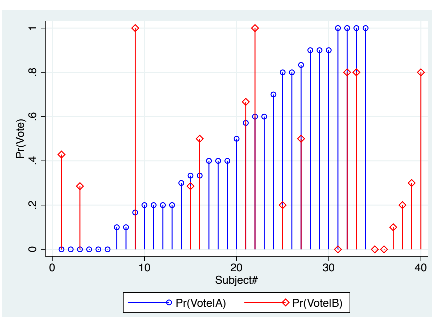
(d) NC, partition $(6, 4)$, $c = 0.3$



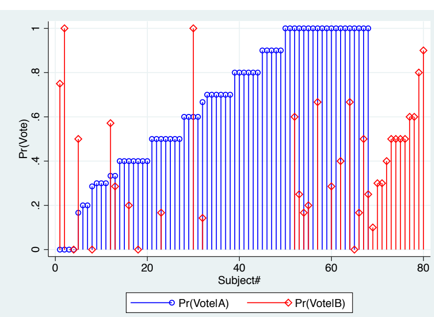
(e) GC, partition $(6, 4)$, $c = 0.3$



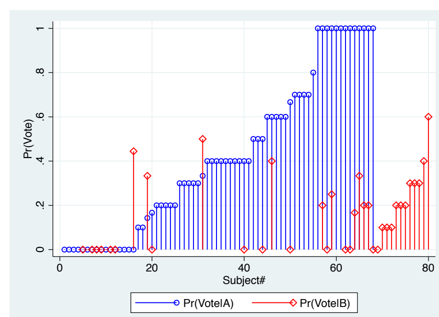
(f) PC, partition $(6, 4)$, $c = 0.3$



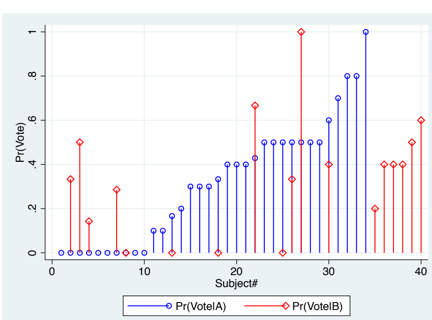
(g) NC, partition $(7, 3)$, $c = 0.1$



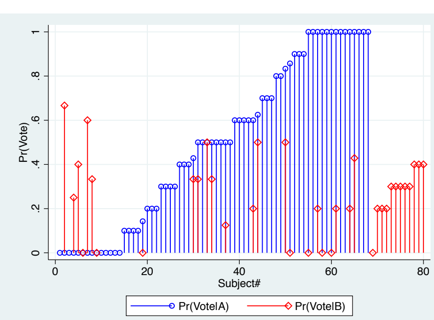
(h) GC, partition $(7, 3)$, $c = 0.1$



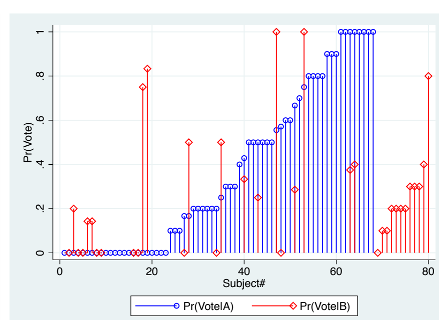
(i) PC, partition $(7, 3)$, $c = 0.1$



(j) NC, partition $(7, 3)$, $c = 0.3$

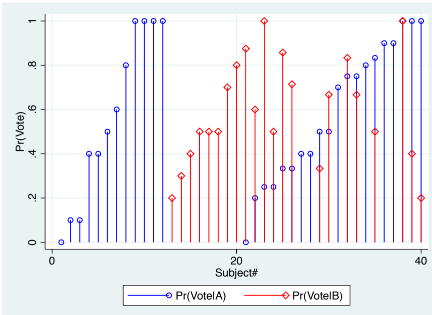


(k) GC, partition $(7, 3)$, $c = 0.3$

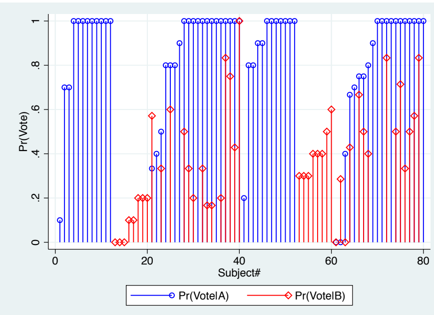


(l) PC, partition $(7, 3)$, $c = 0.3$

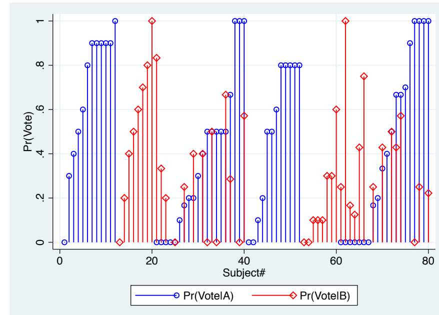
Figure A.4: *Individual Turnout Frequencies.*



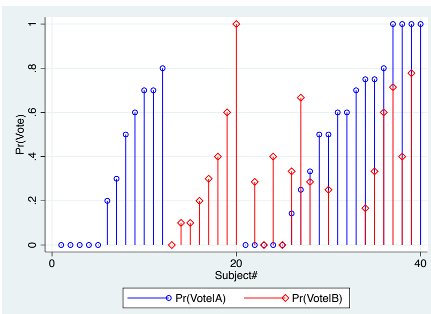
(a) NC, partition $(6, 4)$, $c = 0.1$



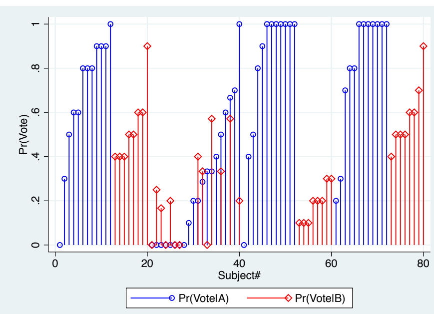
(b) GC, partition $(6, 4)$, $c = 0.1$



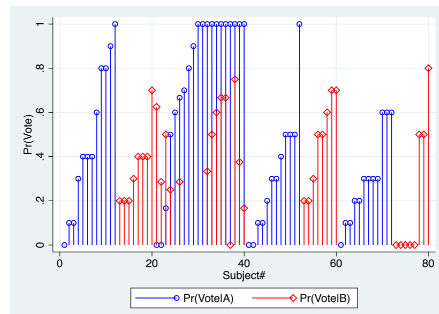
(c) PC, partition $(6, 4)$, $c = 0.1$



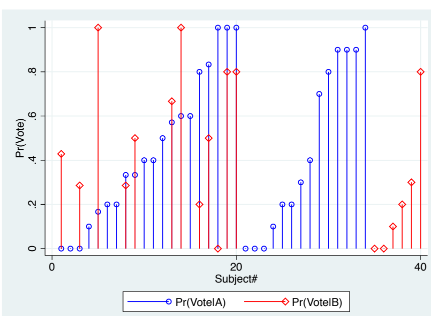
(d) NC, partition $(6, 4)$, $c = 0.3$



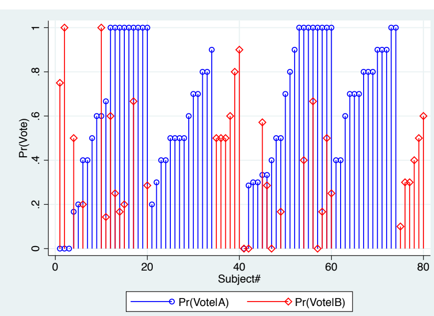
(e) GC, partition $(6, 4)$, $c = 0.3$



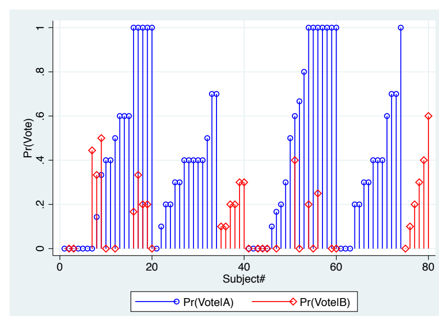
(f) PC, partition $(6, 4)$, $c = 0.3$



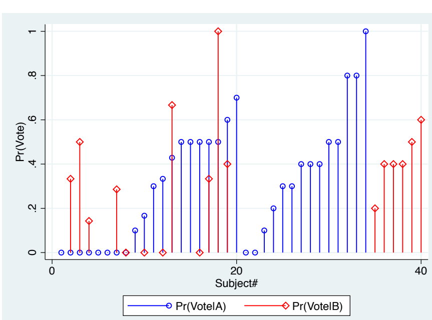
(g) NC, partition $(7, 3)$, $c = 0.1$



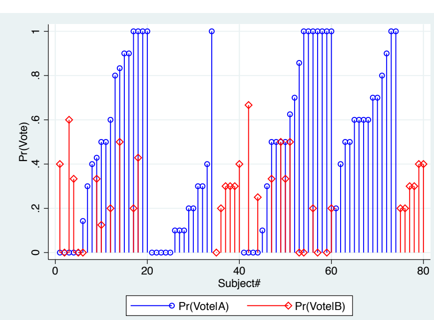
(h) GC, partition $(7, 3)$, $c = 0.1$



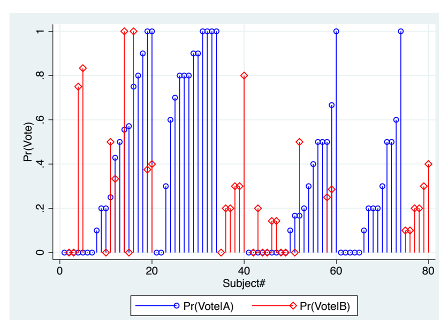
(i) PC, partition $(7, 3)$, $c = 0.1$



(j) NC, partition $(7, 3)$, $c = 0.3$



(k) GC, partition $(7, 3)$, $c = 0.3$



(l) PC, partition $(7, 3)$, $c = 0.3$

Figure A.5: *Individual Turnout Frequencies with Subjects Grouped by Treatment and Session (with 20 Subjects per Session). Sessions in which the same subject has two overlapping frequencies represent part 2 (last 10 rounds) of each session in Table 2.*

Appendix A.1 Tests for the presence of correlation

We test Hypothesis 1 as follows. First, estimate the probabilities of the joint profiles $\mu_{a,b}$ from the data for each pair of vote counts (a, b), obtaining the estimated distribution $\hat{\mu}$. Next, estimate independent and group-symmetric probability of a voter turning out in each party, p_A and p_B, from the data as averages over individual subjects' voting probabilities in each group (depicted in Figure A.4 for all subjects in all treatments), obtaining $\hat{p}_A$ and $\hat{p}_B$. Given these estimates, we compute the induced group voting probabilities $\tilde{\gamma}$ and $\tilde{\delta}$ by plugging in $\hat{p}_A$ and $\hat{p}_B$ into the formulas for the probability of a majority group profile with a votes:

$$\gamma(a) = \binom{n_A}{a} p_A^a (1 - p_A)^{n_A - a}, \tag{A.1}$$

and probability of a minority group profile with b votes

$$\delta(b) = \binom{n_B}{b} p_B^b (1 - p_B)^{n_B - b}, \tag{A.2}$$

and compute the induced joint distribution *under the null* as $\tilde{\mu}_{a,b} = \tilde{\gamma}(a)\tilde{\delta}(b)$. Finally, we compare the resulting distribution with the actual distribution (i.e., $\tilde{\mu}$ with $\hat{\mu}$) by means of a two-sample Epps-Singleton test, obtaining the W_2 test statistic. Epps-Singleton is a powerful non-parametric alternative to the Kolmogorov-Smirnov and Mann-Whitney tests suited for comparing discrete distributions. The caveat of this approach is that one needs to account for variance in the estimates $\hat{p}_A$ and $\hat{p}_B$ when generating the induced distribution. Therefore we supplement the results of Epps-Singleton test with a maximum likelihood ratio test (cf. Moreno and Wooders (1998, pp.57-58)). Let $n_{a,b}$ be the number of times vote count (a, b) was observed, and $N = \sum_{a=0}^{n_A} \sum_{b=0}^{n_B} n_{a,b}$ be the total number of observations in a given treatment. The log-likelihood that a sample was generated by a multinomial distribution μ can be written as

$$\ell(\mu) = C + \sum_{a=0}^{n_A} \sum_{b=0}^{n_B} n_{a,b} \ln \mu_{a,b} \tag{A.3}$$

where C is a normalisation constant. Under the null of Hypothesis 1, the log-likelihood is maximised at

$$\hat{\mu}^0_{a,b} = \binom{n_A}{a}\binom{n_B}{b}\left(\frac{\sum_{a,b}\frac{a}{n_A}n_{a,b}}{N}\right)^a\left(1-\frac{\sum_{a,b}\frac{a}{n_A}n_{a,b}}{N}\right)^{n_A-a}\left(\frac{\sum_{a,b}\frac{b}{n_B}n_{a,b}}{N}\right)^b\left(1-\frac{\sum_{a,b}\frac{b}{n_B}n_{a,b}}{N}\right)^{n_B-b}$$

Under the alternative hypothesis of μ being an arbitrary multinomial distribution, the log-likelihood is maximised at $\hat{\mu}^1_{a,b} = \frac{n_{a,b}}{N}$. The null and the alternative have 2 and $(n_A+1)(n_B+1)-1$ degrees of freedom, respectively. The likelihood ratio, $-2\left(\ell(\hat{\mu}^0)-\ell(\hat{\mu}^1)\right)$, is then asymptotically distributed as χ^2 with $(n_A+1)(n_B+1)-1-2$ degrees of freedom, so we can compare the LR statistic with the χ^2 critical value at 0.05 level.

To test Hypothesis 2, we plug in the Nash equilibrium probabilities in (A.1) and (A.2) (e.g., we set p_A and p_B equal to T_A and T_B from Table 1, respectively) and again compare the predicted distribution with the actual one using Epps-Singleton test.

Appendix A.2 Tests for consistency with correlated and subcorrelated equilibrium

Correlated Equilibrium. Rewrite conditions (9)–(12) as the following system of four inequalities, two for players in N_A, and two for players in N_B, with respect to $(n_A+1)(n_B+1)$ variables of the form $\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}$:

$$\phi^0_A \equiv \frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B}\frac{\binom{n_A-1}{a}}{\binom{n_A}{a}}\binom{n_A}{a}\binom{n_B}{a}\mu_{a,a}+\sum_{a=0}^{n_B-1}\frac{\binom{n_A-1}{a}}{\binom{n_A}{a}}\binom{n_A}{a}\binom{n_B}{a+1}\mu_{a,a+1}\right)-$$
$$\left[\sum_{a=1}^{n_A-1}\sum_{b=0}^{\min\{a-1,n_B\}}\frac{\binom{n_A-1}{a}}{\binom{n_A}{a}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}+\sum_{a=0}^{n_B-2}\sum_{b=a+2}^{n_B}\frac{\binom{n_A-1}{a}}{\binom{n_A}{a}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}\right]\leq 0 \qquad \text{(A.4)}$$

$$\phi^1_A \equiv \sum_{a=2}^{n_A}\sum_{b=0}^{\min\{a-2,n_B\}}\frac{\binom{n_A-1}{a-1}}{\binom{n_A}{a}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}+\sum_{a=1}^{n_B-1}\sum_{b=a+1}^{n_B}\frac{\binom{n_A-1}{a-1}}{\binom{n_A}{a}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}-$$
$$\frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B}\frac{\binom{n_A-1}{a}}{\binom{n_A}{a+1}}\binom{n_A}{a+1}\binom{n_B}{a}\mu_{a+1,a}+\sum_{a=1}^{n_B}\frac{\binom{n_A-1}{a-1}}{\binom{n_A}{a}}\binom{n_A}{a}\binom{n_B}{a}\mu_{a,a}\right)\leq 0 \qquad \text{(A.5)}$$

and

$$\phi_B^0 \equiv \frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B-1}\frac{\binom{n_B-1}{a}}{\binom{n_B}{a}}\binom{n_A}{a}\binom{n_B}{a}\mu_{a,a}+\sum_{a=0}^{n_B-1}\frac{\binom{n_B-1}{a}}{\binom{n_B}{a}}\binom{n_A}{a+1}\binom{n_B}{a}\mu_{a+1,a}\right)-$$

$$\left[\sum_{a=2}^{n_A}\sum_{b=0}^{\min\{a-2,n_B-1\}}\frac{\binom{n_B-1}{b}}{\binom{n_B}{b}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}+\sum_{a=0}^{n_B-2}\sum_{b=a+1}^{n_B-1}\frac{\binom{n_B-1}{b}}{\binom{n_B}{b}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}\right]\leq 0 \tag{A.6}$$

$$\phi_B^1 \equiv \sum_{a=2}^{n_A}\sum_{b=1}^{\min\{a-1,n_B\}}\frac{\binom{n_B-1}{b-1}}{\binom{n_B}{b}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}+\sum_{a=0}^{n_B-2}\sum_{b=a+2}^{n_B}\frac{\binom{n_B-1}{b-1}}{\binom{n_B}{b}}\binom{n_A}{a}\binom{n_B}{b}\mu_{a,b}-$$

$$\frac{\frac{1}{2}-c}{c}\left(\sum_{a=0}^{n_B-1}\frac{\binom{n_B-1}{a}}{\binom{n_B}{a+1}}\binom{n_A}{a}\binom{n_B}{a+1}\mu_{a,a+1}+\sum_{a=1}^{n_B}\frac{\binom{n_B-1}{a-1}}{\binom{n_B}{a}}\binom{n_A}{a}\binom{n_B}{a}\mu_{a,a}\right)\leq 0 \tag{A.7}$$

Let $\boldsymbol{\phi} = [\phi_A^0, \phi_A^1, \phi_B^0, \phi_B^1]$ be a 4×1 vector of the left hand sides of the incentive compatibility constraints (A.4)–(A.7). Notice that we can write $\boldsymbol{\phi} = \boldsymbol{J}\boldsymbol{\mu}$, where $\boldsymbol{J} \in \mathbb{R}_{4\times(n_A+1)(n_B+1)}$ is a constant Jacobian matrix, and $\boldsymbol{\mu} \in \Delta(\{0,\dots,n_A+1\}\times\{0,\dots,n_B+1\})$ is a group-symmetric probability distribution over joint voting profiles. Then $\boldsymbol{\mu}$ is a group-symmetric CE if and only if $\boldsymbol{\phi} \leq \mathbf{0}$.

We now apply the inequality-based testing procedure described in Wolak (1989). Define $\boldsymbol{\nu} \equiv -\boldsymbol{\phi} = -\boldsymbol{J}\boldsymbol{\mu}$, and let $\hat{\boldsymbol{\nu}}$ be its estimate from the experimental data, obtained from K independent trials. Given $\boldsymbol{\mu}$, interpreted as a multinomial distribution with K trials and $(n_A+1)(n_B+1)$ outcomes, and a $(n_A+1)(n_B+1)\times(n_A+1)(n_B+1)$ variance-covariance matrix $\boldsymbol{\Sigma}$, we can derive by the Delta method that $\hat{\boldsymbol{\nu}} \overset{a}{\sim} N(\boldsymbol{\nu_0}, \boldsymbol{\Omega})$ and $\boldsymbol{\Omega} = \boldsymbol{J}\boldsymbol{\Sigma}\boldsymbol{J'}$.

We want to test $H_0 : \boldsymbol{\nu_0} \geq \mathbf{0}$ $vs.\boldsymbol{\nu_0} \ngeq \mathbf{0}$. Following Wolak (1989), we define the test statistic as

$$IU \equiv (\hat{\boldsymbol{\nu}} - \tilde{\boldsymbol{\nu}})'\boldsymbol{\Omega}^{-1}(\hat{\boldsymbol{\nu}} - \tilde{\boldsymbol{\nu}}), \tag{A.8}$$

where

$$\tilde{\boldsymbol{\nu}} \equiv \arg\min_{\boldsymbol{\nu}\geq\mathbf{0}}(\hat{\boldsymbol{\nu}} - \boldsymbol{\nu})'\boldsymbol{\Omega}^{-1}(\hat{\boldsymbol{\nu}} - \boldsymbol{\nu}).$$

In our computations, we estimate $\hat{\boldsymbol{\nu}} = -\boldsymbol{J}\hat{\boldsymbol{\mu}}$, where $\hat{\boldsymbol{\mu}}$ is a vector of estimated joint frequencies from K experimental trials, and replace $\boldsymbol{\Omega}$ with its consistent estimate $\hat{\boldsymbol{\Omega}} = \boldsymbol{J}\hat{\boldsymbol{\Sigma}}\boldsymbol{J'}$. Suppose the IU test statistic computed from the data equals s, then Wolak (1989, Corollary 1) allows us to compute the p-value under the null hypothesis $\boldsymbol{\nu_0} \geq \mathbf{0}$ as follows.

$$\sup_{\boldsymbol{\nu_0} \geq \mathbf{0}} \Pr_{\boldsymbol{\nu}, \boldsymbol{\Omega}}[IU \geq s] = \sum_{k=0}^{4} \Pr(\chi_k^2 \geq s) w(4, 4-k, \boldsymbol{\Omega}),$$

where $\Pr(\chi_k^2 \geq s)$ denotes the probability that a χ_k^2 random variable exceeds s, and $w(4, 4-k, \boldsymbol{\Omega})$ is the probability that exactly $4-k$ out of 4 elements in $\tilde{\boldsymbol{\nu}}$ are strictly positive. These weights can be computed by Monte Carlo simulations.[35]

Subcorrelated Equilibrium. In order to test the subcorrelated equilibrium hypothesis, we slightly modify the moment inequality procedure using the fact that now $\hat{\boldsymbol{\nu}} = -\boldsymbol{J}[\hat{\boldsymbol{\delta}} \otimes \hat{\boldsymbol{\gamma}}]$, where $\hat{\boldsymbol{\delta}} \in \Delta(\{0, \ldots, n_B + 1\})$, $\hat{\boldsymbol{\gamma}} \in \Delta(\{0, \ldots, n_A + 1\})$ have sample covariance matrices $\hat{\boldsymbol{\Sigma}}_1$ and $\hat{\boldsymbol{\Sigma}}_2$, respectively (each estimated as a covariance matrix of a corresponding multinomial distribution over group profiles), and $\otimes$ stands for Kronecker product. Using the Delta method, we obtain that $\hat{\boldsymbol{\nu}} \overset{a}{\sim} N(\boldsymbol{\nu_0}, \boldsymbol{\Omega})$ and

$$\boldsymbol{\Omega} = H \begin{bmatrix} \hat{\boldsymbol{\Sigma}}_1 & 0 \\ 0 & \hat{\boldsymbol{\Sigma}}_2 \end{bmatrix} H',$$

where

$$H_{4 \times (n_B + 1 + n_A + 1)} = \begin{bmatrix} \boldsymbol{J}[\boldsymbol{I}_{[n_B+1]} \otimes \hat{\boldsymbol{\gamma}}] & \boldsymbol{J}[\hat{\boldsymbol{\delta}} \otimes \boldsymbol{I}_{[n_A+1]}] \end{bmatrix},$$

and $\boldsymbol{I}_{[x]}$ is an identity matrix of size $x \times x$. The rest of the testing procedure is the same: we compute the IU test statistic and test the null of $H_0 : \boldsymbol{\nu_0} \geq \mathbf{0}$ $vs. \boldsymbol{\nu_0} \ngeq \mathbf{0}$.

[35] For the case with up to 4 restrictions analytical expressions for the weights are available in Kudo (1963) and Shapiro (1985).

Table A.9: *Joint Profile Frequencies and Test for Correlated Equilibrium, Partition* $(6, 4)$

			NC								
		$c = 0.1$							$c = 0.3$		
$a \backslash b$	0	1	2	3	4	$a \backslash b$	0	1	2	3	4
0	0	0	0	0.025	0	0	0.025	0	0.050	0.025	0
1	0	0.025	0	0	0	1	0	0.050	0.025	0	0
2	0	0	0.075	0.050	0.025	2	0.025	0.225	0.125	0	0
3	0.025	0	0.050	0.175	0.025	3	0	0.100	0.150	0	0
4	0.050	0.050	0.100	0.050	0	4	0	0.075	0.075	0	0
5	0.025	0	0.025	0.125	0.025	5	0	0.025	0	0.025	0
6	0	0.025	0.025	0.025	0	6	0	0	0	0	0
ϕ_A^0			0.621						−0.311		
ϕ_A^1			−0.379						0.071		
ϕ_B^0			0.263						−0.017		
ϕ_B^1			−0.613						0.223		
IU stat			9.682^{**}, $p = 0.014$						24.747^{***}, $p = 0.000$		
			GC								
		$c = 0.1$							$c = 0.3$		
$a \backslash b$	0	1	2	3	4	$a \backslash b$	0	1	2	3	4
0	0	0	0	0	0	0	0.025	0.038	0	0	0
1	0	0	0	0	0	1	0.025	0.013	0.013	0	0
2	0	0	0	0	0.013	2	0.025	0.075	0	0.013	0.013
3	0	0	0	0	0.013	3	0.038	0.038	0.025	0	0.025
4	0.050	0.013	0.013	0	0.025	4	0.038	0.025	0.013	0.038	0.038
5	0.288	0.013	0.038	0.013	0.125	5	0.138	0.063	0.050	0.013	0.063
6	0.238	0	0.038	0.025	0.100	6	0.063	0.013	0	0.013	0.075
ϕ_A^0			−0.054						−0.159		
ϕ_A^1			0.269						0.403		
ϕ_B^0			−0.647						−0.387		
ϕ_B^1			0.165						0.233		
IU stat			5.487^{*}, $p = 0.085$						67.698^{***}, $p = 0.000$		
			PC								
		$c = 0.1$							$c = 0.3$		
$a \backslash b$	0	1	2	3	4	$a \backslash b$	0	1	2	3	4
0	0.025	0.025	0.025	0	0	0	0.013	0.038	0	0	0.025
1	0.050	0.050	0.025	0	0	1	0.075	0.013	0.025	0	0
2	0.025	0.050	0.063	0.038	0	2	0.038	0.100	0.063	0.075	0.025
3	0.063	0.125	0.050	0.038	0	3	0.063	0.063	0.013	0.025	0.013
4	0.025	0.013	0.063	0.063	0.025	4	0.075	0.025	0.038	0	0.013
5	0.025	0.038	0.013	0	0	5	0.025	0.025	0.013	0.025	0.013
6	0.038	0	0.050	0	0	6	0.038	0	0.013	0	0.038
ϕ_A^0			0.523						−0.197		
ϕ_A^1			−0.290						0.300		
ϕ_B^0			0.503						−0.275		
ϕ_B^1			−0.372						0.105		
IU stat			12.893^{***}, $p = 0.003$						38.335^{***}, $p = 0.000$		

Notes: ϕ_j^i refers to incentive compatibility condition i for group N_j (see (A.4)–(A.7)). Correlated equilibrium requires all IC constraints not to exceed zero. The sum of frequencies may exceed one due to rounding. IU stat is defined in (A.8). Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$.

Table A.10: *Joint Profile Frequencies and Test for Correlated Equilibrium, Partition* $(7,3)$

				NC					
		$c = 0.1$					$c = 0.3$		
$a \backslash b$	0	1	2	3	$a \backslash b$	0	1	2	3
0	0	0	0	0	0	0.050	0.075	0.025	0
1	0	0	0.025	0	1	0.050	0.075	0	0
2	0.125	0.100	0.075	0.025	2	0.100	0.075	0.125	0
3	0.075	0.150	0.050	0.025	3	0.025	0.125	0.025	0
4	0.025	0.125	0.075	0	4	0.050	0.025	0.075	0.025
5	0.025	0.050	0.050	0	5	0.025	0	0	0.025
6	0	0	0	0	6	0	0.025	0	0
7	0	0	0	0	7	0	0	0	0
ϕ_A^0		-0.021					-0.200		
ϕ_A^1		0.032					0.169		
ϕ_B^0		-0.083					-0.233		
ϕ_B^1		-0.208					0.128		
IU stat		0.065, $p = 0.954$					11.031^{***}, $p = 0.008$		
				GC					
		$c = 0.1$					$c = 0.3$		
$a \backslash b$	0	1	2	3	$a \backslash b$	0	1	2	3
0	0	0	0	0	0	0	0.013	0.013	0
1	0	0	0	0	1	0.088	0.075	0.013	0
2	0.013	0	0	0.038	2	0.025	0.050	0.025	0.013
3	0.050	0.013	0	0.038	3	0.150	0.025	0.013	0
4	0.175	0.038	0.038	0.150	4	0.113	0.013	0.050	0.013
5	0.138	0	0.025	0.050	5	0.125	0	0.013	0.050
6	0.138	0	0	0.050	6	0.063	0.013	0.013	0.025
7	0	0	0.013	0.038	7	0.013	0	0	0
ϕ_A^0		-0.111					-0.322		
ϕ_A^1		0.139					0.392		
ϕ_B^0		-0.571					-0.440		
ϕ_B^1		0.054					0.143		
IU stat		1.364, $p = 0.548$					91.712^{***}, $p = 0.000$		
				PC					
		$c = 0.1$					$c = 0.3$		
$a \backslash b$	0	1	2	3	$a \backslash b$	0	1	2	3
0	0.025	0.013	0	0	0	0.063	0.013	0	0
1	0.050	0.088	0	0.013	1	0.088	0.038	0.013	0.013
2	0.138	0.075	0	0	2	0.163	0.088	0.050	0.013
3	0.150	0.125	0.038	0	3	0.088	0.025	0.013	0.013
4	0.075	0.050	0	0	4	0	0.075	0.038	0.025
5	0.075	0.038	0.013	0	5	0.025	0.038	0	0.013
6	0.025	0.013	0	0	6	0.075	0.025	0.013	0
7	0	0	0	0	7	0	0	0	0
ϕ_A^0		-0.029					-0.319		
ϕ_A^1		0.123					0.261		
ϕ_B^0		0.158					-0.318		
ϕ_B^1		0.013					0.119		
IU stat		15.938^{***}, $p = 0.001$					44.282^{***}, $p = 0.000$		

Notes: ϕ_j^i refers to incentive compatibility condition i for group N_j (see (A.4)–(A.7)). Correlated equilibrium requires all IC constraints not to exceed zero. The sum of frequencies may exceed one due to rounding. IU stat is defined in (A.8). Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$.

Table A.11: *Group Profile Frequencies and Test for SubCorrelated Equilibrium, Partition* (6, 4)

			NC				
	$c = 0.1$				$c = 0.3$		
a	$\gamma(a)$	b	$\delta(b)$	a	$\gamma(a)$	b	$\delta(b)$
0	0.025	0	0.100	0	0.100	0	0.050
1	0.025	1	0.100	1	0.075	1	0.475
2	0.150	2	0.275	2	0.375	2	0.425
3	0.275	3	0.450	3	0.250	3	0.050
4	0.250	4	0.075	4	0.150	4	0
5	0.200			5	0.050		
6	0.075			6	0		
ϕ_A^0	0.419				−0.206		
ϕ_A^1	−0.496				0.098		
ϕ_B^0	0.253				−0.120		
ϕ_B^1	−0.466				0.136		
IU stat	11.657***, $p = 0.006$				21.235***, $p = 0.000$		
			GC				
	$c = 0.1$				$c = 0.3$		
a	$\gamma(a)$	b	$\delta(b)$	a	$\gamma(a)$	b	$\delta(b)$
0	0	0	0.575	0	0.063	0	0.350
1	0	1	0.025	1	0.050	1	0.263
2	0.013	2	0.088	2	0.125	2	0.100
3	0.013	3	0.038	3	0.125	3	0.075
4	0.100	4	0.275	4	0.150	4	0.213
5	0.475			5	0.325		
6	0.400			6	0.163		
ϕ_A^0	−0.066				−0.193		
ϕ_A^1	0.218				0.450		
ϕ_B^0	−0.635				−0.463		
ϕ_B^1	0.192				0.237		
IU stat	16.430***, $p = 0.001$				213.204***, $p = 0.000$		
			PC				
	$c = 0.1$				$c = 0.3$		
a	$\gamma(a)$	b	$\delta(b)$	a	$\gamma(a)$	b	$\delta(b)$
0	0.075	0	0.250	0	0.075	0	0.325
1	0.125	1	0.300	1	0.113	1	0.263
2	0.175	2	0.288	2	0.300	2	0.163
3	0.275	3	0.138	3	0.175	3	0.125
4	0.188	4	0.025	4	0.150	4	0.125
5	0.075			5	0.100		
6	0.088			6	0.088		
ϕ_A^0	0.371				−0.240		
ϕ_A^1	−0.139				0.287		
ϕ_B^0	0.337				−0.316		
ϕ_B^1	−0.234				0.147		
IU stat	17.462***, $p = 0.000$				95.414***, $p = 0.000$		

Notes: ϕ_j^i refers to incentive compatibility condition i for group N_j (see (A.4)–(A.7)). Subcorrelated equilibrium requires all IC constraints not to exceed zero and also satisfy group independence. The sum of frequencies may exceed one due to rounding. IU stat is defined in (A.8). Significance codes: *** < 0.01, ** < 0.05, * < 0.1.

Table A.12: *Group Profile Frequencies and Test for SubCorrelated Equilibrium, Partition* $(7, 3)$

			NC				
	$c = 0.1$				$c = 0.3$		
a	$\gamma(a)$	b	$\delta(b)$	a	$\gamma(a)$	b	$\delta(b)$
0	0	0	0.250	0	0.150	0	0.300
1	0.025	1	0.425	1	0.125	1	0.400
2	0.325	2	0.275	2	0.300	2	0.250
3	0.300	3	0.050	3	0.175	3	0.050
4	0.225			4	0.175		
5	0.125			5	0.050		
6	0			6	0.025		
7	0			7	0		
ϕ_A^0	-0.062				-0.258		
ϕ_A^1	-0.135				0.176		
ϕ_B^0	0.189				-0.258		
ϕ_B^1	-0.120				0.131		
IU stat	1.268, $p = 0.587$				21.406^{***}, $p = 0.000$		
			GC				
	$c = 0.1$				$c = 0.3$		
a	$\gamma(a)$	b	$\delta(b)$	a	$\gamma(a)$	b	$\delta(b)$
0	0	0	0.513	0	0.025	0	0.575
1	0	1	0.050	1	0.175	1	0.188
2	0.050	2	0.075	2	0.113	2	0.138
3	0.100	3	0.363	3	0.188	3	0.100
4	0.400			4	0.188		
5	0.213			5	0.188		
6	0.188			6	0.113		
7	0.050			7	0.013		
ϕ_A^0	-0.170				-0.350		
ϕ_A^1	0.131				0.389		
ϕ_B^0	-0.544				-0.471		
ϕ_B^1	0.145				0.139		
IU stat	4.759, $p = 0.123$				124.498^{***}, $p = 0.000$		
			PC				
	$c = 0.1$				$c = 0.3$		
a	$\gamma(a)$	b	$\delta(b)$	a	$\gamma(a)$	b	$\delta(b)$
0	0.038	0	0.538	0	0.075	0	0.500
1	0.150	1	0.400	1	0.150	1	0.300
2	0.213	2	0.050	2	0.313	2	0.125
3	0.313	3	0.013	3	0.138	3	0.075
4	0.125			4	0.138		
5	0.125			5	0.075		
6	0.038			6	0.113		
7	0			7	0		
ϕ_A^0	-0.067				-0.327		
ϕ_A^1	0.126				0.277		
ϕ_B^0	0.210				-0.369		
ϕ_B^1	-0.039				0.100		
IU stat	30.390^{***}, $p = 0.000$				64.876^{***}, $p = 0.000$		

Notes: ϕ_j^i refers to incentive compatibility condition i for group N_j (see (A.4)–(A.7)). Subcorrelated equilibrium requires all IC constraints not to exceed zero and also satisfy group independence. The sum of frequencies may exceed one due to rounding. IU stat is defined in (A.8). Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$.

Appendix A.3 Analysis of chat data

Table A.13: *Message Frequencies by Round under GC*

n_A	n_B	Cost	Round	N	Message Code 0 (Irr.)	1 (Disagr.)	2 (Agr.)	3 (Rules)	4 (Hist.)	5 (Q?)	6 (Strat.)	7 (Vote)	8 (Abst.)	9 (Amb.)
6	4	0.1	1	318	22.96	2.20	11.32	23.58	1.89	2.83	28.93	4.72	1.26	0.31
–	–	–	2	413	15.01	0.97	9.20	21.79	4.60	2.91	42.86	2.18	0.48	0.00
–	–	–	3	362	22.38	2.76	7.73	25.14	6.63	1.10	29.01	2.76	2.49	0.00
–	–	–	4	321	22.43	0.62	9.03	34.58	3.74	2.49	23.05	1.56	1.56	0.93
–	–	–	5	322	22.36	0.93	7.45	31.68	9.01	1.55	16.46	9.32	1.24	0.00
–	–	–	6	330	42.12	0.91	6.36	17.88	4.55	2.42	19.39	5.76	0.30	0.30
–	–	–	7	325	32.62	0.31	6.77	27.08	2.15	2.46	16.92	7.08	4.62	0.00
–	–	–	8	353	37.96	0.00	7.08	20.68	5.95	1.98	17.56	5.67	2.55	0.57
–	–	–	9	383	33.42	0.52	4.18	31.85	4.18	1.57	17.75	5.74	0.52	0.26
–	–	–	10	412	28.37	0.93	7.23	25.77	4.97	2.01	24.19	4.78	1.50	0.25
–	–	0.3	1	276	25.72	2.17	17.03	22.10	2.17	4.71	20.29	4.71	0.72	0.36
–	–	–	2	281	17.79	1.42	11.39	24.91	6.41	5.69	24.20	3.20	4.63	0.36
–	–	–	3	296	27.70	1.35	11.49	22.97	4.05	4.39	21.62	2.03	4.39	0.00
–	–	–	4	287	31.01	2.09	11.15	23.00	6.27	2.09	19.16	1.74	3.14	0.35
–	–	–	5	253	20.95	4.35	7.11	28.85	5.14	1.58	23.32	3.16	5.14	0.40
–	–	–	6	289	22.15	1.73	10.03	27.34	9.69	1.04	22.49	3.46	1.73	0.35
–	–	–	7	303	32.67	1.65	3.63	24.42	7.26	1.32	24.09	3.63	1.32	0.00
–	–	–	8	269	36.06	1.49	6.69	13.75	9.67	1.12	24.91	3.72	2.60	0.00
–	–	–	9	305	36.72	1.64	6.56	21.97	5.25	1.97	20.33	2.30	3.28	0.00
–	–	–	10	288	44.44	0.69	7.64	14.24	10.76	2.08	17.71	1.39	1.04	0.00
7	3	0.1	1	357	31.37	0.84	13.73	23.25	1.12	2.24	19.89	4.48	3.08	0.00
–	–	–	2	366	28.96	1.09	8.20	22.40	3.28	1.91	25.68	3.83	3.28	1.37
–	–	–	3	329	30.09	0.00	13.37	22.19	10.03	3.34	16.72	1.82	2.13	0.30
–	–	–	4	331	36.56	0.60	9.67	22.36	6.95	1.51	18.13	2.42	1.81	0.00
–	–	–	5	403	34.00	0.25	5.46	16.13	7.69	0.74	30.77	3.23	1.74	0.00
–	–	–	6	328	29.27	0.61	4.88	29.27	8.54	0.91	17.99	6.71	1.52	0.30
–	–	–	7	362	32.60	2.21	6.91	21.82	11.88	0.83	19.06	3.87	0.83	0.00
–	–	–	8	352	30.11	0.57	8.24	24.72	10.51	2.56	17.05	3.41	2.27	0.57
–	–	–	9	353	40.51	1.13	5.38	11.05	14.73	1.13	23.80	1.70	0.57	0.00
–	–	–	10	384	32.55	1.04	4.95	26.56	8.33	3.12	19.01	3.91	0.00	0.52
–	–	0.3	1	345	28.99	2.03	8.99	29.86	2.32	4.35	18.55	2.03	1.74	1.16
–	–	–	2	310	26.77	0.65	6.77	21.94	7.42	3.23	26.45	1.94	4.52	0.32
–	–	–	3	289	30.80	0.69	4.50	25.26	4.50	2.08	25.26	6.57	0.35	0.00
–	–	–	4	296	28.38	1.01	5.07	25.00	7.43	3.38	20.95	6.08	2.70	0.00
–	–	–	5	354	31.07	3.11	5.37	20.06	7.91	1.13	23.45	5.08	2.82	0.00
–	–	–	6	284	28.52	0.35	5.63	20.77	17.25	3.87	19.01	1.06	1.76	1.76
–	–	–	7	296	39.86	0.00	6.42	17.57	10.14	1.01	18.24	3.72	3.04	0.00
–	–	–	8	319	34.17	0.63	4.39	22.88	8.15	1.88	24.14	2.19	1.57	0.0
–	–	–	9	303	37.29	0.33	2.97	15.18	17.16	1.65	18.15	4.29	2.97	0.00
–	–	–	10	362	38.67	0.83	3.59	26.80	8.56	1.93	12.43	4.97	1.93	0.28

Notes. Table cells contain for each message code percentages of the total number of messages in a given round. For code category description see Table 13.

Table A.14: *Message Frequencies by Round under PC*

n_A	n_B	Cost	Round	N	Message Code									
					0	1	2	3	4	5	6	7	8	9
					(Irr.)	(Disagr.)	(Agr.)	(Rules)	(Hist.)	(Q?)	(Strat.)	(Vote)	(Abst.)	(Amb.)
6	4	0.1	1	325	23.08	1.23	4.62	20.92	0.92	4.31	41.54	1.54	1.54	0.31
–	–	–	2	253	20.16	1.58	7.11	25.69	2.37	1.58	37.15	0.40	3.95	0.00
–	–	–	3	595	15.13	0.34	4.37	12.77	2.52	1.34	62.52	0.34	0.67	0.00
–	–	–	4	440	18.86	0.91	1.36	16.59	4.09	1.14	55.23	0.91	0.91	0.00
–	–	–	5	479	23.59	1.25	2.51	13.57	3.34	0.63	54.07	0.21	0.84	0.00
–	–	–	6	406	29.56	0.25	2.96	12.07	5.17	2.22	46.06	0.99	0.49	0.25
–	–	–	7	355	26.48	0.28	1.69	18.03	5.63	0.56	43.10	1.41	2.82	0.00
–	–	–	8	348	51.44	0.86	2.59	13.22	7.18	1.72	20.40	0.57	1.44	0.57
–	–	–	9	343	34.99	0.00	2.33	16.62	2.92	3.79	36.15	0.87	2.33	0.00
–	–	–	10	358	53.63	0.28	2.51	12.29	4.19	1.40	24.86	0.00	0.84	0.00
–	–	0.3	1	234	26.07	1.71	7.26	29.91	1.71	2.56	29.06	0.85	0.85	0.00
–	–	–	2	290	28.97	2.07	6.21	20.69	9.31	1.03	28.97	2.41	0.34	0.00
–	–	–	3	281	20.64	1.42	6.05	35.94	4.63	2.49	25.27	3.20	0.36	0.00
–	–	–	4	285	27.37	1.40	4.21	31.93	6.67	0.70	24.21	2.11	1.40	0.00
–	–	–	5	728	10.58	1.24	1.10	14.01	2.20	0.69	68.68	1.24	0.27	0.00
–	–	–	6	394	15.74	1.78	3.55	30.96	6.35	1.02	37.82	2.28	0.25	0.25
–	–	–	7	332	25.90	3.31	3.31	24.40	6.63	1.20	31.33	1.51	2.11	0.30
–	–	–	8	506	31.23	1.19	3.36	9.29	4.74	1.38	47.04	0.79	0.99	0.00
–	–	–	9	299	40.80	2.34	4.35	16.05	8.03	0.67	24.41	2.34	1.00	0.00
–	–	–	10	314	42.68	1.91	2.87	19.43	6.05	1.91	19.43	4.14	1.59	0.00
7	3	0.1	1	346	22.54	0.87	9.54	15.03	2.60	2.02	41.62	2.89	2.02	0.87
–	–	–	2	299	22.07	2.01	8.36	14.05	9.70	3.01	37.12	1.34	2.34	0.00
–	–	–	3	329	19.45	0.00	7.90	21.28	3.65	2.74	41.03	1.22	2.74	0.00
–	–	–	4	317	34.07	1.89	3.79	24.92	4.73	1.26	28.39	0.63	0.32	0.00
–	–	–	5	326	43.56	0.31	4.91	19.02	2.76	1.23	27.61	0.31	0.00	0.31
–	–	–	6	415	38.31	1.45	1.93	19.04	3.37	2.17	32.05	0.00	1.20	0.48
–	–	–	7	323	42.41	0.62	5.26	18.27	5.26	0.93	25.39	0.31	0.93	0.62
–	–	–	8	342	42.69	0.58	1.75	21.64	3.80	1.46	26.90	1.17	0.00	0.00
–	–	–	9	389	40.87	0.00	3.08	18.25	2.83	1.29	32.65	0.77	0.26	0.00
–	–	–	10	458	45.63	0.66	1.31	10.70	3.28	0.87	36.90	0.44	0.22	0.00
–	–	0.3	1	285	30.88	1.05	9.12	24.56	2.46	4.56	22.46	2.81	1.05	1.05
–	–	–	2	270	34.81	1.85	6.30	26.67	4.07	1.11	21.85	1.85	0.37	1.11
–	–	–	3	277	37.18	4.69	2.89	23.83	7.94	1.08	19.13	1.08	1.81	0.36
–	–	–	4	279	31.90	3.23	3.94	27.24	8.60	1.79	22.58	0.36	0.00	0.36
–	–	–	5	346	27.75	12.72	2.02	20.52	13.29	0.87	18.79	1.73	2.31	0.00
–	–	–	6	278	39.93	3.24	3.24	23.02	7.55	1.08	18.35	0.36	2.52	0.72
–	–	–	7	270	30.00	1.85	4.81	25.93	11.85	2.96	13.70	5.19	2.96	0.74
–	–	–	8	316	37.03	0.95	1.58	21.52	13.61	2.85	13.61	6.01	1.27	1.58
–	–	–	9	307	43.00	2.28	1.30	22.48	7.49	3.26	14.01	2.61	3.26	0.33
–	–	–	10	278	61.15	0.72	0.72	16.55	2.88	1.44	15.11	0.00	1.44	0.00

Notes. Table cells contain for each message code percentages of the total number of messages in a given round. For code category description see Table 13.

Table A.15: *Effects of the Number of Messages on Normalised Total Turnout in Communication Treatments*

Communication	N	Message Code						
		0+3+9	1	2	4	5+6	7	8
		(Irr)	(Disagr.)	(Agr.)	(Hist.)	(Q&S)	(Vote)	(Abst.)
Group	320	0.008	0.028	0.085^{***}	0.029	0.013^{***}	0.140^{***}	-0.130^{***}
		(0.006)	(0.050)	(0.026)	(0.018)	(0.005)	(0.033)	(0.044)
		[0.169]	[0.582]	[0.001]	[0.100]	[0.006]	[0.000]	[0.004]
Public	320	0.003	-0.038^{***}	0.025	-0.002	-0.001	0.333^{***}	-0.276^{***}
		(0.005)	(0.013)	(0.031)	(0.027)	(0.001)	(0.056)	(0.055)
		[0.501]	[0.004]	[0.415]	[0.995]	[0.342]	[0.000]	[0.000]

Notes. Table cells contain for each message code ordered probit estimates of the effects of the total number of messages per electorate in that category on the normalised total turnout in a given treatment. For detailed message code description see Table 13. Standard errors (in parentheses) are computed using N electorate-round level observations. Corresponding p-values are in brackets. Significance codes: $^{***} < 0.01$, $^{**} < 0.05$, $^{*} < 0.1$.

Appendix B Sample Instructions (for online publication)

Thank you for agreeing to participate in this research experiment on group decision making. During the experiment we require your complete, undistracted attention. So we ask that you follow instructions carefully. Please do not open other applications on your computer, chat with other students, read books, or do homework. Also make sure to turn off your cell phone.

For your participation, you will be paid in cash, at the end of the experiment. Different participants may earn different amounts. What you earn depends partly on your decisions, partly on the decisions of others, and partly on chance. So it is important that you listen carefully and fully understand the instructions before we begin. There will be a short comprehension quiz after the upcoming practice session, which you all need to pass before we can begin the paid matches.

The entire experiment will take place through computer terminals, and all interaction among you will take place through the computers. It is important that you not talk or in any way try to communicate with other participants during the experiments, except according to the rules described in these instructions. We will start with a brief instruction period. During the instruction period, you will be given a complete description of the experiment and will be shown how to use the computers. If you have any questions during the instruction period, raise your hand and your question will be answered out loud so everyone can hear. If any difficulties arise after the experiment has begun, raise your hand, and an experimenter will come and assist you privately.

This experiment consists of two different parts. The instructions for part 2 will be delivered after part 1 is completed. At the end of the experiment you will be paid the sum of what you have earned in both parts, plus the show-up fee of $7. Everyone will be paid in private, and you are under no obligation to tell others how much you earned.

[Turn on the projector and start the multistage server]

Here are the instructions for part 1. Part 1 consists of several matches. Your earnings in part 1 will be determined as follows: the computer will randomly select two matches from part 1, and you will be paid what you earned in those two matches. All matches are equally likely to be chosen as the paid matches. Your earnings during the experiment are denominated in points. Your US dollar earnings are determined by multiplying your earnings from the paid matches in points by a conversion rate. In this experiment, the conversion rate is 0.07, meaning that 100 points is worth $7.

Please click on the Client Multistage icon. This window will appear (SHOW SCREEN 2 [client information].) Enter your computer name (e.g., SSEL01) in the box that appears and then click Submit. You will then see this screen. (SHOW SCREEN 3 [initialising].)

Please turn your attention to the screen at the front of the room. We will demonstrate how the matches are played. Please do not begin unless we tell you to do so. Please have your attention focused on the stage during this demonstration period.

Once everyone has logged in, you will be randomly assigned to one of two types: type A or type B. You will see this screen (SHOW SCREEN 4 [user interface, either with or without chat, depending on treatment].)

At the top of the screen is your player id number. This is your id within your type. Once the first practice match starts, you will be randomly assigned a type label (A or B) and an id within this type. You will have the same type label, but your player id may change from match to match. Below the screen informs you which type you are in and how many members there are of each type. As you can see, type A has 6 (reverseSequence: 7) members and type B has 4 (reverseSequence: 3) members.

[start here for COMMUNICATION treatments]

Next on the screen is a time counter showing how many seconds you are allowed to chat with the other [(GC): players of your type /(PC): players] before making your choice. All matches will have two stages. At the first stage you can use the chat feature to communicate with other [(GC): players of your type /(PC): players] about the decision making problem. Each message you send or receive in this chat stage is visible to all players of [(GC): your type, but not to players of the other type. /(PC): both types]. At the second stage, everyone will be asked to independently choose between two options, as will be described shortly. Messages sent by you are displayed in red and have '[you]' at the identifying string. Messages sent by other players are displayed in black. All messages include the sender's player id and type label. During the communication stage we require you to be courteous and polite to other participants, and also preserve the anonymity of interaction. That is, you are not allowed to communicate any personal information that might identify you to other participants. Once the time counter reaches zero, the communication stage is over, and you will see this screen (SHOW SCREEN 5 [user interface when chat is over, GC or PC].)

[start here for CONTROL CASE (NC); continue here for other treatments]

Next on the screen is a table, describing how your earnings depend on your choice of either X or Y and on which type has the most members choosing X. The display in front of the room shows you what the screen looks like for a player of type A. You will choose either X or Y by highlighting the corresponding row label and clicking with your mouse. (SHOW SCREEN 5x and 5y and 6 [showing highlighting], use screens with chat for communication treatments.) After you and the other participants have all made your choices of X or Y in a match the screen will change to highlight the row corresponding to your own choice, and the column of the type which had the greatest number of players choosing X (SHOW screen for completed match). Your earnings from each match are computed in the following way. It is very important that you understand this, so please listen carefully. Suppose you choose X. If your type has more players choosing X than the other type, then you will earn 105 points, if both types have the same number of players choosing X, then you will earn 55 points, and if the other type has more players choosing X than your type, then you will earn 5 points. Alternatively, suppose you choose Y. If your type has more players choosing X than the other type, then you will earn 115 (high-cost: 135) points, if both types have the same number of players choosing X, then you will earn 65 (high-cost: 85) points, and if the other type has more players choosing X than your type, then you will earn 15 (high-cost: 35) points Here is an example: suppose that one player of type A chose X and two players of type B chose X. Then the B type has more players choosing X than the A type. Each player of type A who chose X earns 5 points; each player of type A who chose Y earns ten (high-cost: thirty) additional points making it 15 (high-cost: 35) points; the players of type B who chose X earn 105 points, and each player of type B who chose Y earns ten (high-cost: thirty) additional points making it 115 (high-cost: 135) points. The bottom of the screen contains a history panel. During the experiment, this panel will be updated to reflect the history of your past matches. For each match you can see the match number, your type in that match, your choice, your earnings from that match if it is chosen to be a paid match by the computer, and the number of each type choosing X. Your type will remain the same for all matches. However, the actual membership in your type will be randomly reshuffled after each match. Here is how the matching works (SHOW MATCHING SLIDE). There are 20 people in this room. First, we randomly divide you into two types, A and B. Next, we randomly pick 6 (reverseSequence: 7) people of type A, 4 (reverseSequence: 3) people of type B, randomly assign ids within each type and put them together in one group. Then we pick 6 (reverseSequence: 7) remaining people of type A, 4 (reverseSequence: 3) people of type B, randomly assign ids and put them together in the second group. Next match, we repeat the same process again. Thus, you will remain the same type, but your player id as well as the other players of your type in your group will change from match to match. If you have any questions at this time, please raise your hand and ask your question so that everyone in the room may hear it.

PRACTICE [BRING UP PAYMENT SCREEN FOR PRACTICE SESSION]

We will now give you a chance to get used to the computers with a short practice session. Please take your time, and do not press any keys or use your mouse until instructed to do so. You will NOT be paid for this session; it is just to allow you to get familiar with the experiment and your computers. Please pull out your dividers. [start practice]

[NC] Everyone please choose X. Once everyone has made their selection, the results from this first practice match are displayed on your screen. The outcome of the match is now highlighted. The number of players who chose X is greater for type A, so the potential payoff from this match (if it is selected by the computer) is 105 points for players of type A. For players of type B, the potential payoff is 5 points, since for them it is the other type that has more players choosing X. Remember, you are not paid for this practice match. We will now proceed to the second practice match. Notice that you may have been assigned a new player id. Now please everyone chose Y. Once everyone has made their selection, the results from this second practice match are displayed on your screen. The number of players who chose X is the same (zero) for both types, so the potential payoff from this match (if it is selected by the computer) is 65 (high cost: 85) points for players of either type. We have now completed the practice session, and the quiz popped up.

[COMMUNICATION] Notice that the 110-second communication stage has started. To send a message [GC: to the other players of your type/ (PC): to other players], click on the text field, type in your message and either press Enter or click ‘Send’. [(GC): Remember, each message you send or receive in this chat is visible to all players of your type, but not to the players of the other type. / (PC): Remember, each message you send or receive in this chat is visible to all players of both types.] During the communication stage we require you to be courteous and polite to other participants, and also preserve the anonymity of interaction. That is, you are not allowed to communicate any personal information that might identify you to other participants. After the communication stage is over, please wait for further instructions, and don’t click anywhere.

[Wait for the subjects to chat]

Now that the communication stage is over, please everyone choose X. Once everyone has made their selection, the outcome of the match is highlighted. The number of players who chose X is greater for type A, so the potential payoff from this match (if selected by the computer) is 105 points for players of type A. For players of type B, the potential payoff is 5 points, since for them it is the other type that has more players choosing X. Remember, you are not paid for this practice match. We will now proceed to the second practice match. Notice that you may have been assigned a new player id. This time a 60-second communication stage has started, so that we can move on to the paid matches quicker. After the communication stage is over, please wait for further instructions.

[Wait for the subjects to chat]

Now please everyone chose Y. Once everyone has made their selection, the results from this second practice match are displayed on your screen. The number of players who chose X is the same (zero) for both types, so the potential payoff from this match (if it is selected by the computer) is 65 (high cost: 85) points for players of either type. We have now completed the practice session, and the quiz popped up.

[QUIZ] Please read each question carefully and check the correct answer. Once everyone has answered the questions correctly, you may all go on to the second stage of the quiz. After successfully completing the second round of questions, we will commence with the first paid session. If you have questions during the quiz, please raise your hand. [END QUIZ]

The next remaining matches in Part 1 will follow the same rules as the practice session. Let me summarise those rules before we start. Please listen carefully. In each match, 6 (reverseSequence: 7) players are assigned to type A, and 4 (reverseSequence: 3) players are assigned to type B. You may choose X or Y. As you can see on the table of this screen, if you choose X, your payoff will be 105 points if your type has more players choosing X than the other type, 5 points if your type has fewer players choosing X, and 55 points if both types have the same number of members choosing X. If you choose Y, your match payoff will be 115 (high-cost: 135) points if your type has more players choosing X than the other type, 15 (high-cost: 35) points if your type has fewer players choosing X than the other type, and 65 (high-cost: 85) points, if both types have the same number of players choosing X. Computer will randomly select two matches from part 1, and in part 1 you will be paid what you earned in those two matches. All matches are equally likely to be chosen as paid matches. Are there any questions before we begin the paid matches? [Answer questions.]

[BRING UP PAYMENT SCREEN FOR part 1]

Please begin. (Play matches 1–10.) Part 1 is now over.

[SESSION 2] Here are the instructions for part 2 of the experiment.

[BRING UP PAYMENT SCREEN FOR SESSION 2]

The second part will be slightly different from the first part. Let me summarise those rules before we start. Please listen carefully. There will be a series of matches in this part. In each match, 7 (reverseSequence: 6) players will be assigned to type A, and 3 (reverseSequence: 4) players will be assigned to type B. In the first match your type label will be assigned as follows. [SHOW MATCHING SCREEN] If you were of type B during part 1, you will now be assigned to type A for all matches. If you were of type A during part 1, in each match there is an equal chance that you either remain assigned to type A, or will be assigned to type B. So if you were of type A during part 1, each match now you may have a different type label and player id. If you were in type B during part 1, your type label will remain the same for all matches in part 2. As before, the actual membership in your type will be randomly reshuffled after each match, so the other members of your type will change from match to match, as well as your player id even if your keep the same type. In any case, there is always information at the top of the screen telling you your player id and which type you are. Your earnings in part 2 will be determined similarly as before. The computer will randomly select two matches from part 2, and you will be paid what you earned in those two matches. All matches are equally likely to be chosen as paid matches. Your total earnings from the experiment will be the sum of your earnings from both parts, plus the show-up fee. Are there any questions before we begin the second paid session? Please begin. (Play matches 1–10.) Part 2 is now over. The experiment is now completed. Thank you all very much for participating in this experiment. Please record your total payoff in U. S. dollars at the experiment record sheet. Please add your show-up fee of $7 and write down the total, rounded up to the nearest dollar. After you are done with this, please remain seated. You will be paid in the office at the back of the room one at a time. Please bring all your things with you when you go to the back office. You can leave the experiment through the back door of the office. Please refrain from discussing this experiment while you are waiting to receive payment so that privacy regarding individual choices and payoffs may be maintained.