Dynamic Coalitions and Communication: Public versus Private Negotiations*

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Abstract

We present a laboratory experiment to study the formation of dynamic coalitions in a bargaining setting where the current status quo policy is determined by the policy implemented in the previous period. Our main experimental treatment is the ability of subjects to negotiate with one another through unrestricted cheap-talk communication before a proposal comes to a vote. We compare committees with no communication, committees where communication is public and messages are observed by all committee members, and committees where communication is private and any committee member can send private messages to any other committee member. We find that the ability to communicate has a significant impact on outcomes and coalitions. When communication is public, committees more frequently agree on outcomes which give a significant fraction of the resources to every member. With private communication, we observe a significant increase in the share of allocations that give a positive amount to a minimal winning coalition. When either type of communication is allowed, dynamic coalitions emerge more frequently and majoritarian coalitions last longer. The content of communication is correlated with outcomes and with the persistence of a dynamic coalition. These findings suggest a coordination role for communication that varies with the mode of communication.

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1 Introduction

We present a laboratory experiment to study the formation of durable coalitions in a dynamic legislative bargaining setting where the current status quo policy is determined by the policy implemented in the previous period. An endogenous status quo policy is a feature of many policy domains—for instance, tax rates, regulations, and entitlements—where policies can be changed by the legislature but continue in effect in the absence of a new agreement. This makes the policy-making process an intrinsically dynamic game that cannot be studied as a static competition among different constituencies, or even as a sequence of independent competitions as in a repeated game. In choosing a policy proposal and coalition partners, a policy-maker must not only consider the direct effect of the agreement but also the indirect effect of the agreement on future policy decisions. This creates incentives for a coalition to continue from one period to the next. We refer to this as a dynamic coalition.

Recent theoretical research on dynamic divide-the-dollar bargaining (Kalandrakis 2004, 2010, Battaglini and Palfrey 2012, Bowen and Zahran 2012, Richter 2014, Anesi and Seidmann 2015, Baron and Bowen 2015) has produced a rich assortment of predictions. Baron and Bowen (2015) and Anesi and Seidmann (2015) predict the formation of stable coalitions in dynamic bargaining for sufficiently patient players, whereas Kalandrakis (2004, 2010) predicts a rotating dictator. These papers study Markov Perfect Equilibria (MPE). Battaglini and Palfrey (2012) compute the limit of Markov Logit Quantal Response Equilibria (MLE) and show that, with patient players and concave utilities, outcomes rotate and are most likely majoritarian, with coalitions dividing the surplus evenly among their members.

In this paper, we evaluate the predictions of these theories by studying the behavior of laboratory committees in a simple dynamic bargaining game with an endogenous status quo. In the game, one of three committee members is randomly selected to make a proposal for the allocation of a divisible resource each period. The proposed allocation is implemented if it receives at least two affirmative votes. Otherwise, the status quo policy prevails, and the resources are allocated according to that policy. The status quo policy, thus, evolves endogenously.

One aspect of bargaining processes that has received little attention in dynamic bargaining theory is that of communication, despite the fact that communication among individuals is an integral part of such processes. It is difficult to find examples in which democratic decisions are made without people engaging in negotiations beforehand.[1]

[1] The literature on sequential legislative bargaining where a committee is disbanded once it reaches a decision has considered communication. Austen-Smith (1990) and Chen and Eraslan (2014) study theoretically the effects of cheap-talk in the presence of asymmetric information between committee members in these *ad hoc* committees. Agranov and Tergiman (2014*a*), Agranov and Tergiman (2014*b*), and Baranski and Kagel

In the complete information, dynamic models studied to date there is no role for communication, and models with incomplete information are typically complex to study. Communication can play a role in complete information models with multiple equilibria by coordinating the strategies of players. In this paper, we explore experimentally how free-form communication affects bargaining outcomes and the formation and durability of coalitions in this dynamic environment. Laboratory experiments provide a direct and powerful tool for investigating the effect of communication on dynamic bargaining processes. Our main experimental manipulation is the ability of players to negotiate with one another through unrestricted cheap-talk communication before a proposal is brought to a vote. In the real world, committee members are allowed to—and do—engage in sometimes intense communication over both proposal-making and voting. Our goal is to answer the following questions: Does allowing committee members to communicate increase the frequency with which dynamic coalitions are formed and does it extend their duration? Are dynamic coalitions minimal winning or universal? How are resources allocated among the members of a dynamic coalition? To what extent do these answers depend on whether the communication is public or private?

We use the divide-the-dollar game with an endogenous status quo and the experiment in Battaglini and Palfrey (2012) (henceforth BP) as a starting point and extend it to allow committee members to engage in a cheap-talk communication. The cheap talk communication in the experiment takes place after a proposer has been selected but prior to proposal-making and voting. We compare committees with no communication, committees where communication is public and all messages are observed by all committee members, and committees where communication is private and any committee member can send private messages to any other committee member.

The opportunity to communicate has a significant impact on outcomes and coalitions. Similar to BP, we find that the incidence of dictatorial outcomes is negligible. In our no communication treatment, we find 31% majoritarian outcomes and 68% universal outcomes. Private communication results in more majoritarian outcomes (46%) relative to no communication and fewer universal outcomes (51%). In contrast, public communication results in fewer majoritarian outcomes (15%) relative to no communication and more universal outcomes (81%). Dynamic coalitions emerge more frequently and last longer when communication is allowed. The effect of communication on the allocation among committee members depends on the type of the coalition. Private communication results in more even and public communication less even allocations among members of minimal winning coalitions, whereas

(2015) study experimentally the effect of cheap talk in the perfect information setting introduced by Baron and Ferejohn (1989).

the opposite results for universal coalitions. We analyze the content of the messages sent to help understand the association of particular words, such as trust and fairness, with coalition size, durability, and type. We find that words associated with fairness are positively correlated with universal coalitions and negatively correlated with minimal winning coalitions; that the duration of universal coalitions is positively correlated with fairness terms; and that the suggestion of an alternative allocation of resources is correlated with coalition dissolution.

This paper contributes primarily to the literature on laboratory experiments evaluating models of legislative bargaining (McKelvey 1991, Diermeier and Morton 2005, Diermeier and Gailmard 2006, Frechette, Kagel and Lehrer 2003, Frechette, Kagel and Morelli 2005*a*,*b*,*c*, 2012, Frechette 2009). In contrast with what we do, this work focuses on static environments where a given amount of resources is allocated only once. The only exceptions are Battaglini and Palfrey (2012) and Nunnari (2014) who investigate experimentally dynamic models of committee bargaining with an endogenous status quo in the absence of communication.[2]

This paper also contributes to a growing literature on the impact of unrestricted communication (Charness and Dufwenberg 2006, 2011, Brandts and Cooper 2007, Goeree and Yariv 2011, Oprea, Charness and Friedman 2014). These studies show that communication facilitates greater coordination on Pareto superior outcomes. Three recent papers have allowed subjects to communicate in a legislative bargaining setting (Agranov and Tergiman 2014*a*,*b* and Baranski and Kagel 2015). These papers study sequential (one-period) games that end once the resources are allocated rather than dynamic games with an evolving status quo and cannot address the issue of coalition formation or durability. This research shows that, when communication is allowed, outcomes in these sequential bargaining games are closer to the unique stationary subgame perfect equilibrium in which the proposer captures a disproportionate share of the resources. In contrast to this finding for sequential legislative bargaining, in our experiment using a dynamic game both private and public communication result in less of an advantage for the proposer compared to no communication.

The reminder of the paper is organized as follows. In Section 2 we present the model with no communication, identify the equilibria in the existing theoretical literature, and state the testable hypotheses regarding the introduction of communication. In Section 3 we describe the experimental design. Section 4 discusses the results of the experiment, and Section 5 concludes.

[2]Roth (1995) surveys the earlier experimental literature in bargaining. These experiments are less related as they are predominantly bilateral, static, and do not allow communication.

2 Model and Theoretical Predictions

2.1 Model

We consider a committee of 3 players who repeatedly bargain over how to divide a dollar. In each period of an infinite horizon, the committee chooses an allocation $x^t = (x_1^t, x_2^t, x_3^t)$, where $x_i^t \geq 0$ for any $i = \{1, 2, 3\}$ and $\sum_{i=1}^{3} x_i^t = 1$. That is, only efficient allocations that do not waste the available resources are allowed. Player i derives utility $u(x_i^t)$ from the allocation he receives in period t, where u is increasing. Players are assumed to maximize the expectation of their discounted, infinite stream of utilities, where $\delta \in [0, 1)$ is the common discount factor.

The bargaining protocol with which allocation x^t is chosen is as follows. At the beginning of each period, a player is chosen at random to be the proposer and proposes an allocation y^t. The committee then votes between this allocation and the status quo. If a simple majority votes in favor of the proposal, it is accepted and $x^t = y^t$ is the implemented allocation in period t and the status quo for period $t + 1$. If the proposal is supported by less than a simple majority, it is rejected and the status quo allocation $x^t = x^{t-1}$ is implemented. The initial status quo x^0 is exogenously selected at random. The probability p_i that player i is selected as the proposer is one third in each period.

2.2 Theories and the Experiment

The theories developed for dynamic divide-the-dollar games show existence and characterization of different classes of Markov Perfect Equilibria (MPE) with various assumptions about committee size, payoffs, discount factors, selection probabilities, rules for breaking indifference, and the space of possible agreements. An MPE is a subgame perfect equilibrium in which strategies depend only on the payoff-relevant history (Maskin and Tirole 2001), which in this game is the status quo policy. Table 1 summarizes the restrictions on the number of players, discount factor δ, selection probabilities, and whether allocating less than a dollar is allowed. In our experimental design, we have committees composed of three players with equal agenda setting powers, and do not allow for waste—that is, the sum of allocations to the three players exhausts the dollar. Diermeier and Fong (2011) assume a persistent agenda setter. The MPE in Richter (2014) crucially depends on the possibility of waste. The MPEs in Kalandrakis (2009) and Bowen and Zahran (2012) exist only for, respectively, five or more and seven or more players. Therefore, the predictions from these four papers cannot inform behavior in our experiment.

In the MPE characterized by Kalandrakis (2004), outcomes quickly converge to a rotating

Paper	n	δ	Selection Probability	Waste Allowed
Kalandrakis 2004	$n = 3$	$\delta \in [0, 1)$	$p_i = 1/n$	no
Kalandrakis 2010	$n \geq 5$	$\delta \in [0, 1)$	$p_i \in (0, 1)$	no
Diermeier & Fong 2011	$n \geq 3$	$\delta_i \geq \delta^\circ$	$p_i = 1$, $p_{j \neq i} = 0$	yes
Battaglini & Palfrey 2012	$n = 3$	$\delta \in [0, 1)$	$p_i = 1/n$	no
Bowen & Zahran 2012	$n \geq 7$	$\delta \in [\underline{\delta}, \overline{\delta}]$	$p_i = 1/n$	no
Richter 2014	$n \geq 3$	$\delta \geq \delta^\star$	$p_i = 1/n$	yes
Anesi & Seidmann 2015	$n \geq 3$	$\delta_i \geq \widehat{\delta}$	$p_i \in (0, 1)$	yes
Baron & Bowen 2015	$n \geq 3$	$\delta_i \geq \widetilde{\delta}$	$p_i \in (0, 1)$	yes

Table 1: Theories for Dynamic Divide-the-Dollar Games.

dictatorship with an ergodic distribution where in each period the randomly selected proposer extracts all the resources. Along the convergence path to this distribution, coalitions are majoritarian and unstable, with the proposer giving a positive allocation only to one other player, either to the cheaper or to a randomly chosen one. This MPE exists for any degree of players' patience and initial status quo.

In the Markov Logit Quantal Response Equilibria (MLE) numerically computed by Battaglini and Palfrey (2012),[3] outcomes converge to a rotating dictatorship if players' utilities are linear. If players' utilities are strictly concave, players are averse to sequences of outcomes in which the status quo changes at every period and the incentives for more symmetric allocations among players are stronger. BP present numerical results for highly risk averse players: starting from a dictatorial allocation, the committee moves to a minimal-winning allocation where two players divide the dollar equally or, less frequently, to a universal allocation. These minimal-winning allocations are highly persistent but not absorbing, as the committee transition to a universal allocation about 20% of the time; universal allocations are absorbing states. The risk aversion assumed by Battaglini and Palfrey (2012) to obtain convergence to a universal allocation is too extreme to be plausible in the experiment, so their relevant predictions are rotating dictatorships or rotating minimal winning coalitions.[4]

Anesi and Seidmann (2015) show that, as players become increasingly patient, almost any outcome—the exception being dictatorial ones—is possible with MPE proposals that

[3] In Battaglini and Palfrey (2012) equilibria are computed as the limit of MLEs by gradually reducing noise in the players reaction functions. In the logit version of quantal response equilibrium, each player, at each information set uses a behavioral strategy where the log probability of choosing each available action is proportional to its continuation payoff.

[4] They specify a utility function $u(x_i) = \frac{1}{1-\gamma} x_i^{1-\gamma}$ with $\gamma = 0.95$. The certainty equivalent for a 50-50 lottery with payoffs 0 and 3, the range of payoffs in the experiment, is 0.0000028.

depend on the identity of players so as provide a punishment for at least one other player and collectively for all players (what they call *simple solutions*). Baron and Bowen (2015) characterize MPEs with dynamic coalitions, which are decisive sets of players whose members strictly prefer preserving the coalition to having it end. With three players and no waste and for a sufficiently high δ, these MPEs support minimal-winning coalitions with allocations of the form $(c, c, 1-2c)$ for all $c \in \left(\frac{1}{3}, \frac{1}{2}\right]$. The equilibrium outcomes in Anesi and Seidmann (2015) and Baron and Bowen (2015) are reached in one bargaining period and are persistent.[5]

The equilibria in these theories are driven by what Diermeier et al. (2008) refer to as the fear of exclusion. That is, a player accepts a proposal in the current period that includes him in the coalition because of fear that if he rejects the proposal he may be excluded from the coalition formed in the next period. If all proposals are required to be efficient, the universal allocation cannot be supported as a MPE for any discount factor in Baron and Bowen (2015) because there is no fear of exclusion. That is, a player expects that next period proposers will propose the universal allocation, so he has no fear of exclusion if he rejects a universal proposal in the current period.[6]

The predictions of some of these theories depend on players' degree of patience. In the experiments, we use $\delta = 0.8$ and a feasible allocation is a triplet of integers between 0 and 60 that sum to 60. With this discount factor the outcomes predicted by Baron and Bowen (2015) are $(30, 30, 0)$, $(29, 29, 2)$, $(28, 28, 4)$ and their permutations. The outcomes predicted by Anesi and Seidman (2015) are $(30, 30, 0)$, $(29, 29, 2)$, $(28, 28, 4)$, $(30, 28, 2)$, $(32, 28, 0)$, $(31, 29, 0)$, $(31, 28, 1)$, $(30, 29, 1)$, and their permutations. Figures 1 and 2 show the predicted outcomes for each paper whose theory applies to our experimental setting.

The legislative bargaining game we study is a dynamic game with an infinite horizon and has many subgame perfect equilibria. Markovian strategies are conditioned on a state that does not include the history of which individual players took which actions, so the scope for punishments and rewards is limited. It is possible that some other equilibria can sustain different outcomes through the use of history dependent strategies. For example, with three players and linear utilities, the allocation that gives an even share to each player can be supported with a player-specific punishment that perpetually excludes a deviator from any

[5] The equilibria in these theories depend importantly on how indifference in voting is broken. Kalandrakis (2004) assumes that a player votes for a proposal when indifferent between it and the status quo, and Battaglini and Palfrey (2012) assume that a player votes for the proposal with probability 0.5 when indifferent. Anesi and Seidmann (2015) assume that the players vote for the status quo when indifferent when it is a simple solution, and for the proposal when the status quo is not a simple solution. Baron and Bowen (2015) assume that players vote for the status quo when indifferent. The indifference rules in the latter two theories yield stability rather than rotation.

[6] Richter (2014) and Baron and Bowen (2015) show that the universal allocation can be supported as a MPE if there is a threat of exclusion created by the possibility of waste.

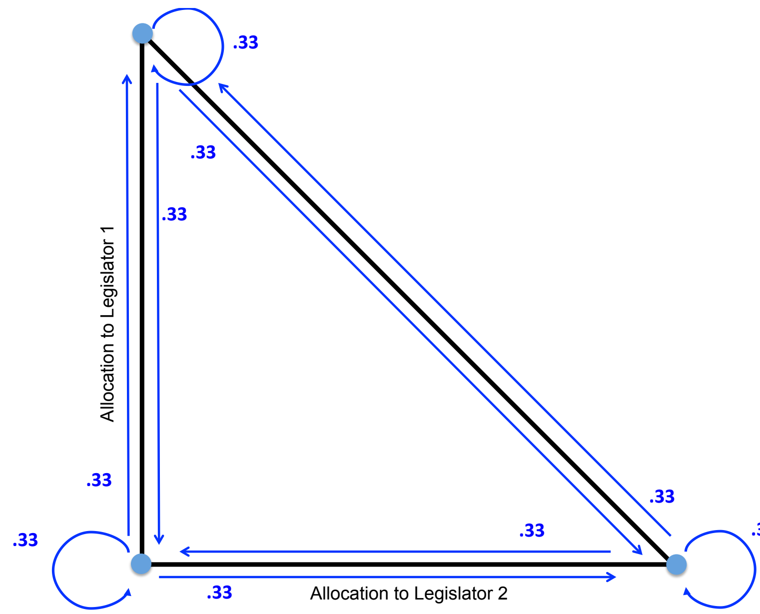
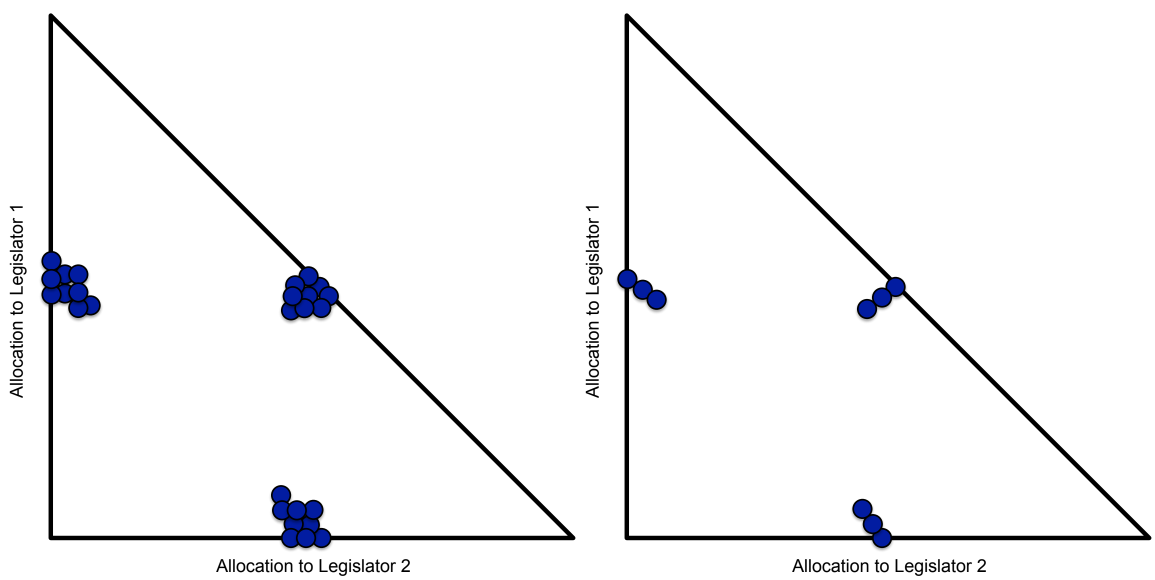


Figure 1: Stationary Distribution Induced by MPE in Kalandrakis (2004) with $\delta = 0.8$ and Battaglini and Palfrey (2012) with $\gamma = 0$, $\delta = 0.8$.



(a) Anesi and Seidmann (2015)

(b) Baron and Bowen (2015)

Figure 2: Absorbing Outcomes According to Different MPEs, $\delta = 0.8$.

future allocation as long as players' discount factor is at least a lower bound.

The dynamic bargaining games studied in the literature all assume complete information with no role for communication. That is, players are assumed to know a profile of equilibrium strategies, and the players find they individually have no incentive to deviate from those strategies. In the theories there is a set of subgame perfect equilibria, including rotating dictatorships, universal, minimal winning, and surplus coalitions, and symmetric and asymmetric allocations among coalition members. This leaves the questions of which, if any, of these equilibria would be played in a setting in which players may not know the equilibrium strategies or which strategies the other players will use. The experiment provides evidence on what players do as a function of communication that could support coordination on particular equilibria. Our main experimental treatment is the ability of players to negotiate with one another through unrestricted cheap-talk communication. Our hypothesis is that communication serves as a selection device and can make some outcomes focal. For example, the coalition equilibria in Baron and Bowen (2015) are particularly simple, are identity free, exhibit outcome and coalition stability, provide equal allocations to coalition members, and could be coordinated on through straightforward communication between the originator of the coalition and potential coalition partners.

3 Experimental Design

We assess the empirical validity of the theoretical predictions and the effect of private and public communication with the use of controlled laboratory experiments. Experiments have some important advantages over field data when studying a highly structured dynamic environment such as the one in this paper (see Falk and Heckman 2009).

The experiments were conducted at the Columbia Experimental Laboratory for Social Sciences (CELSS) in March 2014 using students from Columbia University. Subjects were recruited from a database of volunteer subjects. Six sessions were run with a total of 120 subjects, and no subject participated in more than one session. All the interactions between subjects were performed through computers.[7] In all sessions, committees were composed of three members and the amount of resources available in each period was 60 experimental tokens (corresponding to \$3). The experimental treatments are the opportunities to communicate among committee members.

In all committees the discount factor was $\delta = 0.8$. Discounting was induced by a random termination rule: after each round of the same game, a random number between 0 and 100 was drawn by the computer with the outcome determining whether the game continued to another round (with probability δ) or was terminated (with probability $1 - \delta$). This is a standard technique used in the experimental literature to preserve the incentives of infinite horizon games in the laboratory (Roth and Murnighan 1978, Palfrey and Rosenthal 1994, Dal Bo 2005, Duffy and Ochs 2009).

[7] 1Sample instructions are provided in the Appendix. The computer program used in the experiment was an extension to the open source software Multistage.

We use a novel implementation of this methodology introduced by Fréchette and Yuksel (2013), the block random termination rule: subjects play as in the standard random termination but in blocks of four rounds. Within a block subjects get no feedback about whether or not the match has continued to that round, and they make choices that will be payoff-relevant contingent on the match actually having reached that point. After each block of four rounds, subjects are told whether the match ended within that block and, if so, in what round; otherwise, they are told that the match has not ended yet, and they start a new block. Subjects are paid for rounds only up to the end of a match, and all decisions for subsequent rounds within that block are void with respect to payment. As shown by Fréchette and Yuksel (2013), this alternative implementation of an infinitely repeated game results in the same theoretical properties and in similar laboratory behavior as the standard random termination rule. This implementation is appealing for studying the formation and stability of coalitions, because it allows us to observe subjects' behavior for a greater number of rounds without changing the discount factor. In the empirical analysis, we use all available data, including data from rounds that, *ex post*, were not used in determining payments to subjects.

Sessions were conducted with a minimum of 15 subjects and a maximum of 24 subjects, divided into committees of 3 members each. Committees stayed the same throughout the rounds of a given match, and subjects were randomly rematched into committees between matches. Each match corresponded to one play of the infinitely repeated game, using the block termination rule.[8]

Our main experimental manipulation is the opportunity for subjects to negotiate with one another through unrestricted cheap-talk communication before a proposal comes to a vote. We compare committees with no communication, committees where communication is public and messages are observed by all committee members, and committees where communication is private and any committee member can send private messages to any other committee member. We conduct two sessions where communication is not allowed, two where only public communication is allowed, and two where only private communication between two committee members is allowed.

At the beginning of each match, subjects are randomly divided into committees of three members each. In each committee, subjects are assigned to be Committee Member 1, Committee Member 2, or Committee Member 3. This member assignment remains the same for all rounds of a match. An initial status quo is randomly chosen by the computer, using a uniform distribution on the set of feasible allocations. The drawing of an initial status quo

[8]The length of the matches ranged from 4 to 24 rounds.

Session	Treatment	n	δ	Matches	Subjects	Committees
1	Public Communication	3	0.8	4	21	28
2	Public Communication	3	0.8	4	21	28
3	Private Communication	3	0.8	4	21	28
4	Private Communication	3	0.8	4	24	32
5	Baseline (No Communication)	3	0.8	4	18	24
6	Baseline (No Communication)	3	0.8	4	15	20

Table 2: Experimental Design

is independent across matches and across committees. At the beginning of each period one of the three members is randomly selected to be the proposer, and his committee member number is revealed to the entire group. When communication is not allowed, the proposer proposes an allocation that is observed by all members of the group with shares to each member clearly indicated. Then, all members of the committee simultaneously vote to accept or reject the proposed allocation. If the allocation is supported by a simple majority of members, it passes, determines the distribution of the 60 tokens in this period, and becomes the new status quo allocation for the next round. If the allocation is rejected, the shares in this period are determined by the status quo, which becomes the status quo for the next period. After each match, subjects are randomly re-matched to form new committees and assigned new committee member numbers. At the end of the experiment, we sum all the tokens earned by each subject in all rounds of all matches and convert them to US dollars using the rate 20 tokens = $1.

In the Baseline treatment, no communication was allowed. The Public Communication and Private Communication treatments are similar to the Baseline treatment except for one feature. After the proposer was selected and his committee member number revealed, but before the proposer submitted his proposal, members of the committee could communicate with each other using a chat tool. In the Private Communication treatment, subjects could send private messages that were delivered only to a particular member. When a committee member sends a message to another, the third committee member does not know the content of this communication nor the fact that communication took place.[9] In the Public Communication treatment, subjects were only allowed to send messages that would be received by all the other members of their committee. The duration of the communication was in the hands of the proposer: the chat tool was disabled when the proposer submitted his proposal for a vote or after 120 seconds had passed. The software recorded all the messages

[9]In the private communication treatment a committee member could send the same message to each other committee member, but one other member would not know the other had received the message.

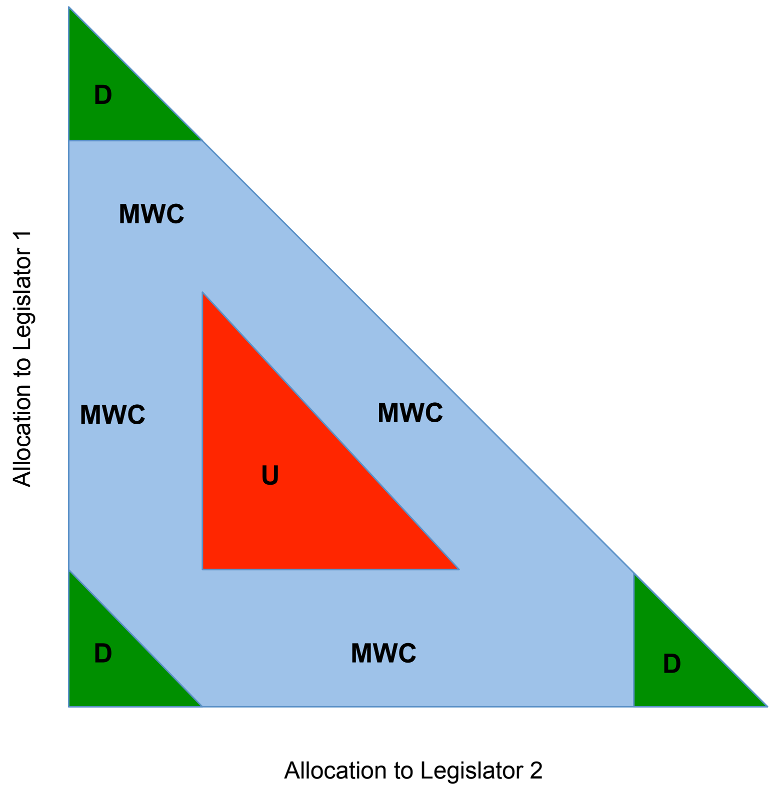


Figure 3: Allocation Types.

sent by subjects during the communication stage. Table 2 summarizes the details of all the treatments.

4 Results

4.1 The Impact of Communication on Bargaining Outcomes

We begin the analysis of the experimental results by examining the bargaining outcomes, that is, the distribution of tokens at the end of a round. We define as "Dictatorial" allocations that give at least 50 tokens to a single committee member and define as "Universal" allocations that give at least 10 tokens to every member of the committee. All the other allocations are "Minimal Winning Coalitions" (MWC). In the latter two categories, we highlight allocations that give members an even number of tokens. For the universal allocations, this correspond to the outcome [20 20 20]; for the MWC allocations, this includes all outcomes of the form $[b, b, 60-2b]$ where $b \in (25, 30]$. Figure 3 shows these allocation types on the simplex and Table 3 presents the distribution of these outcome types across different treatments.

FINDING 1: Private communication makes MWC outcomes—in particular,

Outcome Type	Baseline	Private	Public	P-Value Base vs. Private	P-Value Base vs. Public
DICTATOR	1% (4)	3% (22)	3% (15)	0.0170	0.0210
MWC	31% (123)	46% (302)	15% (69)	0.0000	0.0000
* Even	12% (47)	27% (180)	9% (39)	0.0000	0.0780
* Uneven	19% (76)	18% (122)	7% (30)	0.3430	0.0000
UNIVERSAL	68% (265)	51% (336)	81% (364)	0.0000	0.0000
* Even	43% (167)	35% (232)	73% (325)	0.0000	0.0000
* Uneven	25% (98)	16% (104)	9% (39)	0.0480	0.0000
TOTAL	100% (392)	100% (660)	100% (448)	0.0000	0.0000

Table 3: Outcome Types by Treatment. Notes: number of observations in parentheses. P-values refer to a two-tailed two-proportion z-tests.

those with even sharing among coalition members—more likely and universal outcomes less likely. Public communication makes MWC outcomes—in particular, those with uneven sharing among coalition members—less likely, and universal outcomes more likely. Table 3 shows that the frequency of MWC outcomes is 31% when communication is not allowed, 46% when only private communication is allowed, and 15% when public communication is allowed. The frequency of universal outcomes is 68% with no communication, 51% with private communication, and 81% with public communication. These differences are statistically significant. The difference in the incidence of MWC between the treatment with no communication and the treatment with private communication is due to the difference in MWC with equa resource sharing between two committee members, which goes from 12% to 27%. The difference in the incidence of MWC between the treatment with no communication and the treatment with public communication is due to the difference in MWC with uneven resource sharing between two committee members, which goes from 19% to 7%.

FINDING 2: Private communication increases the fraction of resources allocated to the two committee members with the largest allocations. Public communication decreases the amount of resources allocated to the two committee members with the largest allocations. Pooling all outcomes, the committee member with the largest allocation receives on average 26.2 in the Baseline treatment, 27.3 in the Private Communication treatment, and 23.6 in the Public Communication treatment.[10] The com-

[10]From the outcomes for each round, we identify the highest share, the second-highest share, and the third-highest share. We then take the average of the highest shares, the average of the second highest shares, and the average of the third highest shares across all rounds of the same treatment.

mittee member with the second largest allocation receives on average 21.6 in the Baseline treatment, 23.1 in the Private Communication treatment and 20.7 in the Public Communication treatment. The committee member who receives the smallest allocation receives on average 12.3 tokens in the Baseline treatment, 9.6 in the Private Communication treatment and 15.8 in the Public Communication treatment. These differences are statistically significant.

Communication increases the frequency of outcomes with even distributions, which is consistent with the prediction of Baron and Bowen (2015) and supportive of the even distribution outcome in Anesi and Seidmann (2015). The findings are inconsistent with a rotating dictator equilibrium as in Kalandrakis (2004) and Battaglini and Palfrey (2012) (for a linear utility function), where the largest allocation is 1 in every period.

FINDING 3: Both private and public communication decrease the resources allocated to the proposer. The results in Table 3 suggest that the opportunity to communicate favors the emergence of outcomes where a coalition of two or three players share the resources more evenly than in the baseline treatment where no communication is allowed. What does this mean for the share allocated to the proposer, or for the *proposer's advantage*? Table 4 shows the results of OLS regressions where the dependent variable is the share to the proposer in the approved allocation. As expected, this amount positively depends on the share to the proposer in the status quo. Interestingly, it also negatively depends on the presence of communication and on experience (the number of matches previously played). This result is in stark contrast with experiments on the static bargaining game a la Baron and Ferejohn (1989) studied by Agranov and Tergiman (2014) and Baranksi and Kagel (2013), where the proposer gains from the introduction of communication—and more so with experience—due to the reduction in uncertainty and to the competition among potential coalition partners for inclusion in the coalition. This suggests that a different mechanism might be at play in the dynamic game studied here. However, notice that, in both the static and the dynamic game, communication gets the observed allocations closer to the allocations from an equilibrium. In the static bargaining game there is a unique stationary SPE outcome, and the question is whether play is according to that equilibrium. In our dynamic legislative bargaining game, proposers can prefer to sacrifice proposal power for durability of their coalition. Many outcomes are supported by a stationary MPE, and the question is which equilibrium is selected with communication. To explore this question, we next move to the analysis of coalitions.

Dependent Variable: Share Allocated to Proposer	
Share to Proposer in Status Quo	0.49***
	(0.034)
Private Communication	-1.60***
	(0.499)
Public Communication	-3.76***
	(0.509)
Experience (# Matches)	-0.76***
	(0.172)
Constant	17.33***
	(0.994)
Observations	1500
R-Squared	0.2890

Table 4: OLS Regressions for Share to the Proposer. Robust SE in Parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2 The Impact of Communication on Coalition Formation

In Table 3 we classified outcomes in three regions. These regions do not take into account the identity of the members who share the resources (in particular, for the "Dictatorial" and "MWC" allocations). To analyze the emergence and the duration of coalitions we need a finer classification of outcomes. We will use a similar taxonomy but consider three dictatorial regions D_i (those that give most of the resources, respectively, to member 1, 2, or 3) and three MWC regions M_{ij} (those where the resources are allocated to members 1 and 2, between members 1 and 3, or between members 2 and 3). Using this classification, how do we identify a dynamic coalition in the data?

We define a *weak dynamic coalition* as a group that continues from one round to the next with an outcome in the same region. We also use an alternative, more stringent definition. We define a *strong dynamic coalition* as a group that continues from one round to the next with the same outcome. To investigate the emergence and persistence of weak and strong dynamic coalitions, we study the evolution of outcomes over time.

Table 5 shows the *transition probabilities* for the three treatments. For each table, the last column gives the total number of committees with an outcome of each type. Each cell in the other columns gives the probability of moving to an outcome in the column region when starting from an outcome in the row region. That is, for the first row, the column D_i gives the probability that a dictatorial status quo leads to a dictatorial outcome where the same player gets most of the resources; for the second row, the column M_{ij} gives the probability that a minimal winning status quo leads to a minimal wining outcome where

PANEL A: Baseline Treatment

<table>
<tr><th></th><th colspan="6">Status Quo at $t+1$</th></tr>
<tr><th>Status Quo at t</th><th>$\mathbf{D_i}$</th><th>$\mathbf{D_{\neq i}}$</th><th>$\mathbf{M_{ij}}$</th><th>$\mathbf{M_{\neq ij}}$</th><th>$\mathbf{U}$</th><th>n</th></tr>
<tr><td>$\mathbf{D_1/D_2/D_3}$</td><td>0.33</td><td>0.00</td><td colspan="2">0.67</td><td>0.00</td><td>3</td></tr>
<tr><td>$\mathbf{M_{12}/M_{13}/M_{23}}$</td><td colspan="2">0.02</td><td>0.38</td><td>0.29</td><td>0.31</td><td>135</td></tr>
<tr><td>$\mathbf{U}$</td><td colspan="2">0.00</td><td colspan="2">0.12</td><td>0.88</td><td>254</td></tr>
</table>

PANEL B: Private Communication Treatment

<table>
<tr><th></th><th colspan="6">Status Quo at $t+1$</th></tr>
<tr><th>Status Quo at t</th><th>$\mathbf{D_i}$</th><th>$\mathbf{D_{\neq i}}$</th><th>$\mathbf{M_{ij}}$</th><th>$\mathbf{M_{\neq ij}}$</th><th>$\mathbf{U}$</th><th>Obs.</th></tr>
<tr><td>$\mathbf{D_1/D_2/D_3}$</td><td>0.55</td><td>0.05</td><td colspan="2">0.28</td><td>0.14</td><td>22</td></tr>
<tr><td>$\mathbf{M_{12}/M_{13}/M_{23}}$</td><td colspan="2">0.03</td><td>0.62</td><td>0.17</td><td>0.18</td><td>303</td></tr>
<tr><td>$\mathbf{U}$</td><td colspan="2">0.00</td><td colspan="2">0.17</td><td>0.83</td><td>335</td></tr>
</table>

PANEL C: Public Communication Treatment

<table>
<tr><th></th><th colspan="6">Status Quo at $t+1$</th></tr>
<tr><th>Status Quo at t</th><th>$\mathbf{D_i}$</th><th>$\mathbf{D_{\neq i}}$</th><th>$\mathbf{M_{ij}}$</th><th>$\mathbf{M_{\neq ij}}$</th><th>$\mathbf{U}$</th><th>Obs.</th></tr>
<tr><td>$\mathbf{D_1/D_2/D_3}$</td><td>0.27</td><td>0.20</td><td colspan="2">0.27</td><td>0.27</td><td>15</td></tr>
<tr><td>$\mathbf{M_{12}/M_{13}/M_{23}}$</td><td colspan="2">0.08</td><td>0.42</td><td>0.11</td><td>0.40</td><td>93</td></tr>
<tr><td>$\mathbf{U}$</td><td colspan="2">0.01</td><td colspan="2">0.05</td><td>0.95</td><td>340</td></tr>
</table>

Table 5: Transition Matrix by Treatment.

the same pair of players gets most of the resources; for the third row, the column U gives the probability that universal status quo leads to a universal outcome. These three cells represent the probability that an outcome stays in the same region or, in other words, the probability that a weak dynamic coalition is in place.

FINDING 4: Private communication increases the persistence of weak MWC coalitions and decreases the persistence of weak universal coalitions. Public communication increases the persistence of weak universal coalitions. Table 5 shows that the same pair of subjects continues to divide resources in a majoritarian way 38% of the time without communication, 62% with private communication, and 42% with public communication. The difference between private communication and no communication is statistically significant. If a committee starts a period with a universal status quo, the chance it continues with this type of agreement is 88% with no communication, 83% with private communication, and 95% with public communication. The difference between private communication and no communication and the difference between public communication and no communication are statistically significant.

Private communication, thus, is associated with coordinating on MWCs and sustaining the coalition over time, and public communication is associated with coordinating on universal outcomes and sustaining the coalition. This finding suggests that players are less willing to participate in coalitions that disadvantage one player when communication is public and exposed to all players. This could be due to a fear that they will be the disadvantaged player in a future round. It could also be due to a desire to be fair to all players in public. This interpretation is supported by the players' use of words corresponding to fairness as discussed in Findings 11-13. As shown in Finding 14 this coordination is more effective as subjects gain experience in playing the game. That is, with private communication MWCs are more frequent in later than earlier matches, and with public communication universal coalitions are more frequent in later than earlier matches.

As indicated above universal coalitions can be explained by history-dependent strategies that yield player-specific punishments if a player defects from a universal coalition. The results presented in Tables 11 and 12, however, show that there is no positive correlation between the presence or duration of universal coalitions and words associated with the history of play. Indeed, there is weakly significant negative correlation between these words and universal coalitions when communication is private.

Table 6 shows the probability an outcome is identical to the initial status quo, for each treatment.

	Pr(Outcome = Status Quo)		
Status Quo at t	**Baseline**	**Private Comm.**	**Public Comm.**
$\mathbf{D_1/D_2/D_3}$	0.33 (3)	0.36 (22)	0.20 (15)
$\mathbf{M_{12}/M_{13}/M_{23}}$	0.24 (135)	0.47 (303)	0.32 (93)
U	0.62 (254)	0.65 (335)	0.80 (340)

Table 6: Incidence of Strong Coalitions by Treatment. Observations in Parentheses.

FINDING 5: Private communication increases the persistence of strong MWC coalitions. Public communication increases the persistence of strong MWC coalition and strong universal coalitions. Private communication significantly increases the probability that outcomes with a MWC remain the same from one period to the next, and public communication significantly increases the probability that outcomes in U remain the same. More specifically, Table 6 shows that the same majoritarian outcome persists 24% of the time without communication, 47% with private communication and 32% with public communication. The difference between private communication and no communication and the difference between public communication and no communication are statistically significant. If a committee starts a period with a universal status quo, the chance it continues with this exact agreement is 62% with no communication, 65% with private communication, and 80% with public communication. The differences between public communication and no communication are statistically significant. The interpretations of these findings are similar to those discussed for Finding 4.

Finally, we investigate whether the duration of a coalition is affected by the opportunity to communicate. To do this, we focus on minimal winning and universal coalitions.[11]

FINDING 6: Each type of communication increases the duration of (weak or strong) MWC coalitions but does not affect the duration of (weak or strong) universal coalitions. Table 7 presents the average length of different types of dynamic coalitions by treatment. The average duration of a weak MWC coalition is 1.32 periods without communication, 3.52 periods with private communication and 4 periods with public communication. The average duration of a weak universal coalition is 5.10 periods without communication, 4.87 periods with private communication and 5.57 periods with public communication. The average duration of a strong MWC coalition is 1.26 periods without communication, 2.59 periods with private communication and 3.5 periods with public communication. The average duration of a weak universal coalition is 4.02 periods with-

[11]We exclude persisting dictatorial outcomes, which are approximately 1% of the data.

	No Comm	Private Comm	Public Comm
Average length of weak MWC coalition	1.32	3.52	4.00
Average length of weak U coalition	5.10	4.87	5.57
Average length of strong MWC coalition	1.26	2.59	3.5
Average length of strong U coalition	4.02	4.37	4.52

Table 7: Duration of Dynamic Coalitions.

out communication, 4.37 periods with private communication and 4.52 periods with public communication.

Coalitions exogenously dissolve when a match ends. Since the length of a match is stochastic, it is important to control for the number of rounds in a match when assessing whether the average durations of coalitions are statistically different in different treatments. To do so, we run a Tobit regression where the dependent variable is the number of rounds a dynamic coalition persists.[12] The independent variables are the treatment (public communication or private communication, compared to the baseline, that is, no communication), the type of coalition (minimal winning compared to the baseline, that is, universal), the length of a match, and experience. The results from Table 8 indicate that the duration of a minimal winning coalition is positively affected by either type of communication (with respect to the baseline with no communication). As expected, longer universal coalitions result from longer matches, where the length of a match depends on an exogenous stochastic process. Experience has no effect on the length of a coalition.

4.3 Analysis of Conversations

Subjects used the messaging system in most bargaining rounds, especially at the beginning of a match: the fraction of rounds with some conversation is 63% for the Private Communication treatment and 59% for the Public Communication treatment; 85% of committees communicated in the first round of the Private Communication treatment; 89% of committees communicated in the first round of the Public Communication treatment. The differences between the two treatments are not statistically significant. Moreover, almost every committee has conversations in at least one round: 98% of committees in Private Communication and 100% of committees in Public Communication. We now investigate the intensity and content of these conversations.

FINDING 7: At the beginning of a match, communication is more intense—in

[12]We use a Tobit regression because the duration of a coalition is left-censored at a length of 1.

	Dependent Variable: Coalition Duration			
Private Communication	5.27***	-1.66	5.03***	-0.01
	(1.497)	(1.088)	(1.647)	(1.350)
Public Communication	5.91**	1.50	6.87**	1.65
	(2.413)	(0.972)	(3.194)	(1.171)
Match Length	-0.01	0.32***	-0.10	0.23**
	(0.072)	(0.090)	(0.078)	(0.099)
Experience (# Match)	0.35	-0.09	0.44	0.54
	(0.557)	(0.387)	(0.485)	(0.500)
Constant	-3.49	1.43	-3.72	-1.38
	(2.210)	(1.540)	(2.790)	(2.162)
Coalition Type	Weak MWC	Weak U	Strong MWC	Strong U
Observations	83	149	81	146
Pseudo R^2	0.0482	0.0313	0.0427	0.0129

Table 8: Tobit Regressions for Length of a Coalition. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Private Communication	**Public Communication**
Average Number of Messages		
All Rounds, All Members	3.90	3.92
First Round	5.18	3.50
Sent by Proposers	1.37	1.33
Sent by Non-Proposers	2.53	2.59
Average Number of Words		
All Rounds, All Members	13.90	12.06
First Round	19.28	9.88
Sent by Proposers	5.14	4.35
Sent by Non-Proposers	8.78	7.71

Table 9: Average Number of Messages and Words Sent

Figure 4: Word Cloud of Private Communications Content

the sense that more messages and more words are sent—in Private Communication. Table 8 shows the average number of messages and words exchanged by committee members for each of the two treatments. The average number of messages exchanged by committee members in a match is 3.9 in both treatments. The average number of words used in a match is 13.9 with private communication and 12.1 with public communication. The difference is not statistically significant. The difference is significant if we focus on the initial rounds of a match, when plans are made and conversations are more intense. Both the number of messages and the number of words are larger with private communication than with public communication: 5.2 vs. 3.5 messages and 19.3 vs. 9.9 words. If fairness concerns are influencing play, less communication would be needed the stronger are the concerns.

FINDING 8: Proposers are not more likely than non-proposers to start a conversation in either treatment. The proposer speaks first 35% of the time in Private Communication and 32% in Public Communication. This difference is not significant. The proposer speaks last 33% of the time in Private Communication and 43% in Public Communication. This difference is significant at 5%. There is no correlation between the likelihood a proposer speaks first/last and the status quo allocation. Moreover, there is weak evidence that players who receive more in the status quo are more likely to speak in Private Communication.

We now investigate the content of communication. Figures 4 and 5 show the word

Figure 5: Word Cloud of Public Communications Content

clouds corresponding to the two treatments. We conduct two more structured forms of analysis. First, we identify all messages that include numerical suggestions on how to allocate resources, and then we investigate the properties of the proposed allocations.

FINDING 9: Both proposers and non-proposers are more likely to suggest an allocation in Private Communication than in Public Communication. The fraction of conversations that mention a numerical allocation from proposers is 15% in Private Communication and 3% in Public Communication. This difference is significant at the 1% level. The fraction of conversations that contain a request from non-proposers is 14% in Private Communication and 9% in Public Communication. This difference is significant at the 5% level. One interpretation of this finding is that negotiating over an allocation is easier with private than with pubic communication because a disadvantaged player is unaware of the negotiations.

FINDING 10: When they suggest an allocation, both proposers and non-proposers ask for more in Private than in Public Communication. Define the *suggested premium* to a player as the amount in the suggested proposal minus the amount in the status quo to that player. The average suggested premium to proposers is 5.29 in Private Communication vs. -0.29 in Public Communication. The average suggested premium to non-proposers is 2.80 in Private Communication vs .12 in Public Communication. These differences are statistically significant.

	Private Communication	Public Communication
Coalition Formation		
Average number of words in a round	0.32	0.07
Percentage of rounds with at least one word	19%	7%
Trust		
Average number of words in a round	0.05	0.03
Percentage of rounds with at least one word	4%	2%
Fairness		
Average number of words in a round	0.24	0.20
Percentage of rounds with at least one word	16%	15%
Lobbying for Oneself		
Average number of words in a round	0.09	0.03
Percentage of rounds with at least one word	8%	3%
Personal Claim		
Average number of words in a round	3.90	3.92
Percentage of rounds with at least one word	63%	59%
History-Dependent Strategies		
Average number of words in a round	0.08	0.05
Percentage of rounds with at least one word	7%	5%

Table 10: Content of Conversations. Frequency of Semantic Domains.

Next, we systematically search for words in semantic domains that might be relevant when discussing the game. In particular, we search for words related to coalition formation (‘alliance’, ‘team’, ‘coalition’, ‘we’, ‘let’s’, ‘together’, ‘cooperate’, ‘stick’, ‘pact’, ‘30-30’); words related to trust (‘trust’, ‘trustworthy’, ‘honest’, ‘true’, ‘promise’); words related to advocating for fairness (‘even’,‘equal’,‘fair’,‘20-20-20’); expressions related to attempts to lobby for oneself (‘give me’, ‘for me’, ‘to me’); expressions related to personal claims (‘I’ll’ or ‘I will’); and words related to deviations and history-dependent strategies (‘defect’, ‘change’, ‘switch’, ‘deviate’, ‘revenge’, ‘punish’, ‘retaliate’, ‘reward’, ‘repay’).[13] Table 10 shows the frequency of words that are related to each semantic domain.

FINDING 11: Messages associated with forming a coalition or lobbying for oneself are more frequent in Private Communication than in Public Communication. Personal claims, messages about trust, messages advocating for fairness, and messages related to history dependent strategies have similar frequencies in

[13]We implement this search with a computer algorithm which captures all words whose root is in a list. The lists we use for each semantic domain are exactly those detailed in the text above. The Python code is available from the authors.

both communication treatments.

Finally, we investigate whether we can relate the content of conversations to actual outcomes and coalitions. Tables 11 and 12 show how outcome type and coalition persistence are correlated with the total number of words exchanged, whether at least one numerical proposal on how to allocate resources was made in the messages, and the fraction of words in each semantic domain from the communication took place before a binding proposal was made in that round. These tables do not identify whether the words help in attaining a particular outcome or coalition or whether the words are used to explain an action taken on other grounds.

FINDING 12: The content of conversations is significantly correlated with outcomes in both communications treatments. In both treatments, speaking about fairness is negatively correlated with MWC outcomes and positively correlated with universal outcomes; and making personal claims is positively correlated with MWC outcomes and negatively correlated with universal outcomes. When communication is private, lobbying for oneself and speaking about history-dependent strategies are positively correlated with MWC outcomes and negatively correlated with universal outcomes; and speaking about trust is positively correlated with universal outcomes. When communication is public, speaking about trust is positively correlated with MWC outcomes and negatively correlated with universal outcomes. This suggests that trust may be used for a different purpose when communication is public than when it is private.

FINDING 13: The content of conversations is significantly correlated with the persistence of a coalition. In both communications treatments, numerical proposals for an allocation made in the communication phase are correlated with lower persistence of the status quo—that is, a higher chance of a new agreement. With private communication, the persistence of a universal status quo is negatively correlated with attempts to lobby for oneself and with personal claims. With public communication, the persistence of a universal status quo is negatively correlated with personal claims and speaking about fairness.[14] These findings are consistent with the interpretation of lobbying for oneself and personal claims as negotiating over allocations and the exclusion of a player.

With both private and public communication words associated with fairness are positively correlated with the presence of universal coalitions and negatively correlated with the presence of MWCs, and the duration of universal coalitions also is positively correlated with

[14]There are relatively few observations of MWC with public communication which limits the statistical significance of estimates.

	Pr{MWC}	Pr{Universal}	Pr{MWC}	Pr{Universal}
# Words	0.004	-0.001	-0.006	0.007
	(0.006)	(0.006)	(0.009)	(0.008)
Numerical Proposals	0.274	-0.137	0.085	-0.303
	(0.229)	(0.231)	(0.639)	(0.557)
% Coalition Words	1.704	-2.526	-0.678	-4.540
	(1.820)	(1.905)	(4.634)	(3.694)
% Trust Words	-21.987	23.277*	36.535**	-32.459*
	(13.986)	(13.998)	(17.874)	(17.254)
% Fairness Words	-7.341**	8.271***	-18.686*	22.010**
	(3.004)	(3.125)	(10.434)	(10.031)
% Lobbying Words	10.579**	-16.447***	-2.273	-15.341
	(4.835)	(6.087)	(27.248)	(20.519)
% Personal Claim	0.921***	-0.718**	0.907**	-0.751*
	(0.287)	(0.281)	(0.421)	(0.405)
% History Words	9.235*	-10.321*	-24.616	2.578
	(5.219)	(5.614)	(27.228)	(6.562)
Constant	-0.537***	0.296**	-1.764***	1.525***
	(0.122)	(0.119)	(0.193)	(0.178)
Treatment	Private	Private	Public	Public
Observations	660	660	448	448
Pseudo R^2	0.049	0.048	0.054	0.050

Table 11: Logit regressions. Dependent variables are probability outcome is an MWC allocation (Columns 1 and 3); probability outcome is a universal allocation (Columns 2 and 4). Observations are committee-rounds. SE in Parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

fairness terms. The finding for public communication is consistent with players with preferences for fairness using those terms to obtain even allocations, and it is also consistent with players viewing a universal outcome as focal using fairness terms to communicate their view. The finding that fairness terms are negatively related to the presence of MWCs suggests that players with self-interested preferences use terms relating to lobbying for oneself to either obtain a MWC allocation and to communicate why MWCs are focal. The extent to which the use of these terms is causal is not clear from the experiment.

Words associated with history-dependent strategies are uncorrelated with coalition duration or the presence of universal coalitions, but they are weakly correlated with the presence of MWCs. This suggests that universal coalitions are not supported by threats or punishment.

	Pr{M Persists}	Pr{U Persists}	Pr{M Persists}	Pr{U Persists}
# Words	-0.008	-0.018**	-0.010	-0.007
	(0.008)	(0.009)	(0.028)	(0.008)
Numerical Proposals	-1.548***	-0.987***	1.131	-1.467***
	(0.356)	(0.343)	(1.819)	(0.435)
% Coalition Words	2.119	-2.039	18.752	0.098
	(2.426)	(3.066)	(16.894)	(4.976)
% Trust Words	46.515	15.267	42.741	-19.104
	(29.252)	(15.179)	(35.766)	(21.814)
% Fairness Words	4.055	-3.090	-42.158	-14.213***
	(6.662)	(2.477)	(41.613)	(3.875)
% Lobbying Words	- 0.926	-36.931**	–	-13.029
	(3.025)	(15.696)	–	(24.708)
% Personal Claim	0.314	-0.821*	-0.850	-0.902*
	(0.350)	(0.467)	(0.899)	(0.481)
% History Words	-1.229	-17.465	–	2.592
	(1.834)	(11.666)	–	(7.288)
Constant	-0.193	1.479***	0.027	1.957***
	(0.188)	(0.199)	(0.394)	(0.221)
Treatment	Private	Private	Public	Public
Observations	302	336	66	364
Pseudo R^2	0.080	0.141	0.062	0.193

Table 12: Logit regressions. Dependent variables are probability an MWC status quo persists (Columns 1 and 3); probability a universal status quo persists (Columns 2 and 4). Observations are committee-rounds. SE in Parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. In Column 3, having zero words about lobbying or zero words about history-dependent strategies perfectly predicts persistence of an MWC status quo and hence the regressors are dropped.

4.4 The Effect of Experience

Finding 14: With private communication experience results in more frequent minimal winning coalitions, and with public communication experience results in more frequent universal coalitions.

The experience of players can affect outcomes and the use of communication. Table 13 shows that in the absence of communication MWCs resulted significantly more frequently in the first two matches than in their third and fourth matches played, and universal coalitions were more frequent in the final two matches than in the first two. These effects are strengthened with public communication, but with private communication MWCs become more frequent with experience. One interpretation of experience is that players are learning how to play the game, and as they learn they change their strategies. That the directions of change are different with private and public communication, however, suggests a different interpretation. In the absence of communication coordination on MWCs may be difficult, whereas communication allows coordination to be achieved more easily. That is, with private communication players are willing to exhibit their self-interest, and as they gain experience they converge on MWCs. With public communication players are less willing to exhibit their self-interest, and play converges to universal coalitions with experience. This convergence may be in the form of implicit coordination, and if there is learning it may be learning about how to coordinate or on what to coordinate. Associated with convergence are outcomes that more frequently have even distribution within the coalition. This may explain the lower proposer advantage identified in Table 4.

The pattern of communication also depends on experience, as indicated in Table 14. With private communication there are more and longer messages in matches 3 and 4 than in the earlier matches, whereas with public communication the opposite tends to be true. The more intense communication with private communication may be due to proposers in the first round trying to induce quick coordination on MWCs. With public communication, inducing coordination is needed less because in the first two rounds almost all players had been in universal coalitions (77%).

5 Discussion and Conclusions

In this paper, we present a laboratory experiment to study the formation of durable coalitions in a dynamic bargaining setting. Our experimental manipulation is the opportunity of players to communicate with one another. The three treatments in the experiment are: committees that cannot communicate, committees that can engage in private conversations before a

Outcome Type	Baseline M 1-2	Baseline M 3-4	Private M 1-2	Private M 3-4	Public M 1-2	Public M 3-4
DICTATOR	3%	1%***	1%	6%***	4%	1%***
MWC	43%	25%***	38%	53%***	19%	4%***
* Even	15%	10%**	17%	37%***	11%	1%***
* Uneven	28%	15%***	21%	16%***	8%	4%***
UNIVERSAL	54%	74%***	62%	41%***	77%	95%***
* Even	23%	52%***	42%	30%***	67%	89%***
* Uneven	31%	22%***	20%	12%***	10%	5%**

Table 13: The Effect of Experience on Outcome Types by Treatment. Test of Proportions: * p-value < 0.1, **p-value < 0.05, *** p-value < 0.01.

	Private Communication		Public Communication	
	Matches 1-2	Matches 3-4	Matches 1-2	Matches 3-4
Average Number of Messages				
All Rounds, All Members	3.32	4.40*	4.70	1.58***
First Round	3.73	6.63***	3.54	3.46
Sent by Proposers	1.11	1.60**	1.60	0.55***
Sent by Non-Proposers	2.21	2.81	3.11	1.03***
Average Number of Words				
All Rounds, All Members	11.98	15.57*	14.50	4.78***
First Round	13.87	24.7***	9.43	10.32
Sent by Proposers	3.97	6.17***	5.15	1.95***
Sent by Non-Proposers	8.01	9.45	9.34	2.82***

Table 14: The Effect of Experience on Average Number of Messages and Words Sent. Mann-Whitney-Wilcoxon Tests: * p-value < 0.1, **p-value < 0.05, *** p-value < 0.01.

proposal is made, and committees that can engage in public conversations before a proposal is made. With regard to the research questions posed in the Introduction, we find that the opportunity to communicate has a significant impact on the formation of coalitions and, consequently, on how resources are allocated. When communication is possible, dynamic coalitions emerge more frequently and last longer. Players take advantage of the opportunity to discuss the game with others with communication at the beginning of the game being more intense with private communication than with public communication; players who can communicate privately engage in more lobbying for themselves and are more likely to suggest the formation of a coalition. Words relating to fairness are positively correlated with the presence of universal coalitions and negatively correlated with the presence of minimal winning coalitions, whereas words relating to self-interest (lobbying for oneself) have the opposite correlations. The extent to which the content of communication has a causal effect on behavior and outcomes and the extent to which it accompanies or describes actions cannot be assessed from the experiment.

Communication increases the frequency and duration of dynamic coalitions and selects different outcomes. With public communication, universal coalitions are focal outcomes, and with private communication, minimal-winning coalitions and universal coalitions are both focal. Compared to the treatment with no communication, private communication increases the selection of minimal winning coalitions and decreases the selection of universal coalitions, whereas public communication has the opposite effect. This suggests that there is a role for communication in theories of dynamic legislative bargaining, and that role may be in coordinating players' strategies to attain particular types of equilibria. Selection could be reinforced by experience. With private communication play results in a higher frequency of minimal winning coalitions as players become more experienced, whereas with public communication universal coalitions become more frequent.

The experiment is not a test of the existing theories on the dynamic divide-the-dollar game. Instead, the theories help us understand the incentives present in the experiment. The gap in that understanding pertains to universal coalitions. The modal outcome in all the experimental treatments is a universal allocation, and most of the universal outcomes have even sharing among the coalition members. Three explanations of this are consistent with theory.[15] The first is extreme risk aversion as in the Battaglini and Palfrey (2012) model, but the required risk aversion is so extreme as to be unbelievable in the experimental setting. The second is player-specific punishments that deter individual players from deviating from

[15]The universal allocation is also not explained, for example, by the von Neuman-Morgenstern solution concept in cooperative game theory, which selects minimal winning coalitions with even allocations within the coalitions.

the equilibrium path to take short-term gains. This takes fairly sophisticated strategies and implicit threats of punishment. As discussed in Section 4.3, words related to such history-dependent strategies are uncorrelated with the presence and duration of universal coalitions. Instead, communication emphasizes fairness. The third possible explanation is preferences that are not selfish but instead exhibit a degree of altruism that could generate a norm of fairness that supports universal allocations. This explanation is consistent with the overall experimental findings, but experiments designed to identify the foundations of and measure the strength of a norm of fairness are needed before concluding that a norm explains outcomes. As Cooper and Kagel (Forthcoming) note in their survey of the empirical finding in sequential (one-shot) legislative bargaining that distributions within coalitions are more even than predicted by theory, "more is going on in games of this sort than we currently understand."

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Appendix A - Instructions (Private Communication)

This is an experiment in group decision making. The instructions are simple, and if you follow them carefully and make good decisions, you can earn a considerable amount of money which will be paid to you in cash at the end of the experiment. The currency in this experiment is called tokens. The total amount of tokens you earn in the experiment will be converted into US dollars using the rate of 20 Tokens = \$1. In addition, you will get a \$5 participation fee.

This experiment consists of 4 Matches. In every Match you will each be randomly and anonymously matched with two other participants in the room to form groups of three. Each member of the group will be assigned a group member number (from 1 to 3). Your group as well as your group member number will remain the same within a Match but will change between Matches. Each Match consists of a number of Rounds.

The number of Rounds in a Match is not fixed. Instead, it depends on chance. After each Round in a Match, there is an 80% chance that another Round will take place. In other words, after each Round there is an 80% chance that the Match continues, and a 20% chance that the Match ends.

After each round, there is an 80% probability that the match will continue for at least another round. Specifically, after each round, whether the match continues for another round will be determined by a random number between 1 and 100 generated by the computer. If the number is lower than or equal to 80 the match will continue for at least another round, otherwise it will end. For example, if you are in round 2, the probability that there will be a third round is 80% and if you are in round 9, the probability that there will be a tenth round is also 80%. That is, at any point in a match, the probability that the match will continue is 80%. However, you will play every match in blocks of 4 rounds. At the end of each block you will learn if the match ended in the previous block of 4 rounds or not. If it has not, you will play another block of 4 rounds. If the match has ended in this block, you will see in which round it had actually ended.

In each Round, your group has 60 tokens to allocate among the three members. At the beginning of the first Round of a Match, the computer randomly selects an initial allocation and displays it on your computer as what we call the Status Quo. One of the members of your group then is selected at random by the computer to be the Proposer for this Round. The Proposer makes a Proposal for an alternative allocation he would like the group to choose. This proposal can be any three numbers (including 0s) that add to exactly 60. Once the Proposer in a Round has submitted his Proposal, all members of his group will vote for the Status Quo or the Proposal. If the Proposal receives a simple majority of votes (that is, two or more members in your group vote in favor of the Proposal), then the Proposal passes and each of you in the group will receive the number of tokens indicated in the Proposal. If the Proposal is rejected instead, each of you receives the number of tokens given in the Status Quo.

Each round, the match continues for another round with probability 80%. When you move to another round of the same match, your group's allocation decision in the previous Round becomes the Status Quo in the new Round. Therefore, if the original Status Quo received a majority of the votes in the previous round, it continues as the Status Quo in this new round. But if the Proposal in the previous round received a majority of the votes, it becomes the Status Quo in this new round. The proposal and voting process then follows the same rules as before. A group member will be selected at random to submit an allocation proposal and a vote is taken between the Status Quo and the Proposal.

Once a match ends, a new Match will begin in which you will be randomly assigned to a new group. If your group finishes early, you may have to wait for other groups to finish. Remember that in each Match you are randomly matched into groups and group member numbers are randomly assigned. Thus, your group member number is likely to vary from Match to Match, while it remains the same within a Match from Round to Round. Once five matches have been completed, the experiment is over. Your total earnings for the experiment are the sum of your earnings over all rounds before each match ends. You will NOT receive any payoff from rounds you've played within a block after the match had ended.

Now please, have a look at the screen in front of the room.

[SHOW SLIDE 1]

This is the first screen you will see in each round of a match if you are not the proposer for this round. You have been assigned by the computer to a group of 3 members, and assigned a group member number 1, 2, or 3. This group number stays the same for all rounds of this match, but will change with each match. The initial Status Quo, which was determined randomly by the computer, is displayed in blue. Information specific to you is highlighted in red. One of the group members (1, 2, or 3) has been randomly selected to be the Proposer for this round in your group.

In each Round, before the Proposer submits his proposal, members of your group will have the opportunity to communicate with each other using the chat box. The communication is structured as follows. On the left of the screen, you will see a box that displays all messages sent to you. You will not see whether the other members have communicated among themselves. In the box below that one, you can type your own message and send it to a particular member of the group. To select the member to receive your message, simply click on the button that corresponds to the member to whom you want to send the message.

The chat box will be available until the Proposer submits his proposal or 120 seconds have passed, whatever comes first. At that moment the chat box will be disabled.

[SHOW SLIDE 2]

This is the first screen you will see in each round of a match if you are the proposer for this round. A proposal consists of three numbers, A1, A2, and A3, where A1 is the allocation to group member 1, A2 is the allocation to group member 2, and A3 is the allocation to group member 3. The three allocations must add to exactly 60. To make a proposal, enter the 3 numbers using your keyboard and then click on the confirm button. If you enter three numbers that do not add to 60 or if you enter a negative allocation, the computer will ask you to try again. As everyone else, you have the opportunity to communicate with any other group member before you submit your proposal, using the same chat interface we described before.

[SHOW SLIDE 3]

Once the Proposer has submitted his allocation proposal, you will see a similar screen where a vote is taken between this Proposal and the Status Quo. Your payoffs for the Status Quo and the Proposal are displayed in red in the table on your screen. You will now have an opportunity to vote for the Status Quo or the Proposal by clicking on the corresponding button.

[SHOW SLIDE 4]

Finally, a screen similar to this will summarize the voting results. Each group member's vote is displayed in the table along with the outcome and your payoff. This marks the end of the round.

[SHOW SLIDE 5]

You will automatically continue on to the next round if you're within a block of 4 rounds. If you're at the end of a block, you will see a screen similar to this one. The computer generated random numbers for all rounds. If all the random numbers are less than 80, this means that the match continues, and you will start another block of 4 rounds. Otherwise, the match will be considered to have ended in the first round where the random number was greater than 80. You will only receive payoffs for rounds before the match ended. Once you're informed that a match had ended, you will be randomly assigned to a new group.

In the second round of a match, you will see a screen similar to this: you have the same group member number as in the first round, and the members of your group all stay the same. The round 2 Status Quo is whatever alternative received a majority of the votes in the first round. The proposal and voting process then follows the same rules as before. A group member will be selected at random to submit an allocation proposal and a vote is taken between the Status Quo and the Proposal.