Majority rule or dictatorship? The role of collective-choice rules in self-governance through institutional design

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Abstract

Collective-choice rules aggregate individual choices into a collective decision. This experimental study addresses the role of collective-choice rules in self-governance via institutional design in a social dilemma situation. Groups decide repeatedly on whether to establish any institution, and if so which institutions, to sustain cooperation in a public goods game. We hypothesize that collective-choice rules may directly affect cooperation, conditional on having the same institutions and indirectly affect cooperation through institutional choices. We implement three collective-choice rules: majority voting, dictatorship, and rotating dictatorship. Our main findings are: (1) Cooperation level is not higher with the institutions chosen via a democratic rule than with the same institutions chosen via a non-democratic rule. (2) Institutional choices made via majority voting or a fixed dictator are more stable over time than those chosen by rotating dictators. (3) The instability of institutions is associated with lower cooperation level. These results have implications for the organization of group decision-making in self-governance.

Keywords: collective decision-making; social dilemma; institutions; majority rule; dictatorship

JEL Classification: C92; D02; D71

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1 Introduction

Social dilemmas are situations characterized by a conflict between individual interests and collective interests. In such situations, an individual is better off if she/he defects instead of cooperates, but the group is better off if all cooperate than if all defect. In order to sustain cooperation and to achieve self-governance in such social dilemma situations, groups often appeal to institutions. The optimal institutional design, however, is usually not obvious, because it depends on the incentives institutions provide, the group members' characteristics, and the group dynamics. We therefore consider groups' self-governance through institutional design as a problem-solving process. In this process, a group needs a collective-choice rule to aggregate its members' preferences over institutions into a collective decision. In this study, we focus on the role of collective-choice rules in the problem-solving process. Specifically, we explore whether, and if so how, collective-choice rules affect groups' cooperation behavior and performance in a social dilemma situation.

We use an experiment to simulate a social dilemma situation where groups can choose from a variety of institutions to achieve self-governance. The basic game is a repeated standard public goods game. Every three rounds, group members select institutions as additional rules on top of the basic game. Individual institutional choices are aggregated via a given collective-choice rule into a group institutional choice. Groups then play the public goods game with the chosen institutions for three rounds. We employ a between-subjects design: every group uses only one collective-choice rule throughout the game. Specifically, we implement three collective-choice rules: majority voting, dictatorship (i.e. a single decision maker) and rotating dictatorship (i.e. single decision makers on a rotating basis). These rules are natural candidates to start with because they are simple, representative, and they constitute the basis for more complicated collective-choice rules.

In our social dilemma context, collective-choice rules may have a direct or an indirect effect on cooperation. The direct effect refers to the influence of collective-choice rules on cooperation, conditional on institutions. The indirect effect describes the influence of collective-choice rules on cooperation behavior through the choice of institutions.

Collective-choice rules may *directly* influence behavior because people have a preference for democratic participation right and value decision right (Bartling et al., 2014; Fehr et al., 2013). Their preference for participation right might be translated into support for the resulting decision (Castore and Murnighan, 1978). For instance, some studies on endogenous institutions find an "endogeneity premium" in the sense that policies chosen by the subjects are more effective than if they are selected randomly by the computer or imposed exogenously by the experimenter (Arbak and Villeval, 2011; Bó et al., 2010; Casari and Luini, 2009; Kamei, 2016; Markussen et al., 2013; Rivas and Sutter, 2011; Tyran and Feld, 2006). In a similar vein, we explore in this study whether there exists a "democracy premium". That is, given that the institutions are chosen endogenously, do people behave more pro-socially if these institutions are produced by a democratic rule compared to a situation in which the same institutions are generated by a non-democratic rule?

Collective-choice rules may also *indirectly* affect cooperation behavior through their influence on institutions. The indirect effect may come from at least two sources, namely

through the types of the institutions chosen and through the stability of the institutional outcomes. As to the types of institutions, we see institutional design as a solution to social dilemma specific to groups. The solution is not necessarily unique and is at each group's discretion. We do not have any supporting theories or evidences to predict the best fitting institutions given a certain collective-choice rule. Nor do we intend to identify the good types of institutions from the bad types. Therefore, we do not form any *ex ante* hypothesis regard this source in this paper. The second source concerns the stability of the institutions. Different collective-choice rules may produce more stable or more unstable institutions over time, and this may affect cooperation. The instability of collective choices, in particular of majority rule outcomes, has been of concern to political scientists and some economists (Haney et al., 1992; Hoffman and Plott, 1983; McKelvey and Ordeshook, 1984; Plott and Levine, 1978; Riker, 1980; Wilson, 1986). And research has shown that political instability can be detrimental to economic performance (Aisen and Veiga, 2013; Alesina et al., 1996; Barro, 1991; Dixit, 2009; Feng, 1997). In our paper, we focus on the indirect effect of collective-choice rules via the (in)stability of institutions rather than via the types of institutions.

A distinct feature of our experiment is that we allow for a rather broad range of institutional design. Existing experimental research on endogenous institutions focuses largely on the emergence of a certain type of institution. Groups are typically offered a take-it-or-leave-it option, in the sense that they can implement a particular institution or not (Bischoff, 2007; Ertan et al., 2009; Fehr and Williams, 2013; Guillen et al., 2007; Gürerk et al., 2009; Potters et al., 2005; Sutter et al., 2010). We provide participants with a "menu" of institutions with three items on it: communication, punishment, and reputation. Groups can choose any combination of the three items as their institutional choice, which gives them in total eight possibilities for institutional design. We believe that our menu includes common and crucial institutional features. Communication, punishment, and reputation are among the most intensively studied institutions in economic experiments. Perhaps even more importantly, Rockenbach and Wolff (2016) show that when people can create any institution they prefer, their creations are often limited to a handful of institutions, including communication, punishment, and information feedback.

Another novel characteristic of our design is that we explicitly incorporate institutional costs. Running and maintaining an institution typically entails costs. Some institutions have the property of being a public good. Once they are established and made to work, each group member can benefit from increased cooperation regardless of whether she pays for it or not. A second-order social dilemma is thus formed. For example, punishing someone else typically entails costs for the punisher, while other group members can benefit from enforced cooperation without paying any additional cost.[1] Therefore, the successful establishment and use of an effective institution also calls for agreement on who pays for the institutional costs. In our experiment, subjects need to decide collectively on how to divide the costs for each institution (through the given collective-choice rule).

[1]Related literature finds that people suffer as much from higher order social dilemmas as from first-order social dilemma (Sigmund et al., 2010; Zhang et al., 2014). Fehr and Gächter (2002) claim that free riding can only be solved if sufficient agents are willing to "altruistically" provide the second-order public good.

Our main findings are as follows. First, we do not find evidence of a "democracy premium". On the contrary, fixed dictatorship has a positive direct effect on contribution behavior and earnings compared with rotating dictatorship. Second, institutional choices generated by rotating dictators are significantly more unstable than those generated via majority voting or fixed dictatorship. Third, the instability of institutional choices is associated with lower level of cooperation. Finally, overall, groups in the fixed dictatorship treatment achieve higher cooperation levels, spend less on institutions, and hence earn more than those in rotating dictatorship.

To our knowledge, this paper is the first to investigate the role of collective-choice rules in self-governance in a controlled environment and to study the direct and indirect effects of collective-choice rules on cooperation and on groups' performance. Our findings have implications for the organization of group decision-making in self-governance. In choosing the collective-choice rule for a group, it is useful to think about different channels through which collective-choice rules can play a role. We provide two perspectives: participation right and stability. In our setting with small-scale self-governing communities, people might value the participation right ensured by democratic collective-choice rules, but our findings suggest that such rules do not necessarily bring better performance nor lead to a more cooperative community. Our results also imply that the stability of collective decisions may be important and therefore deserves to be included when discussing the impact of collective-choice rules on group decision-making.

2 Related literature

Our paper is related to two strands of literature. The first strand of literature examines the endogenous emergence of a certain type of institution. In most experimental studies, subjects are offered an exogenously given institution, and they can choose to implement this institution or not (Bischoff, 2007; Ertan et al., 2009; Fehr and Williams, 2013; Guillen et al., 2007; Gürerk et al., 2009; Markussen et al., 2013; Potters et al., 2005; Sutter et al., 2010). For example, in Guillen et al. (2007), after having experienced a central sanction mechanism for several rounds, groups can choose whether to keep it; they all choose to remove the sanction system. Potters et al. (2005) let two players decide unanimously whether to apply a sequential structure in a voluntary contribution mechanism. Groups predominantly choose to move sequentially. Some studies have expanded the institution set to examine variations of a certain type of institution. For instance, Sutter et al. (2010) provide subjects with three institutions to choose from: standard voluntary contribution mechanism (VCM), VCM with punishment, and VCM with reward. They find that groups prefer the reward option, although punishment turns out to be more effective in sustaining cooperation. Fehr and Williams (2013) offer four communities different forms of a punishment system to choose from, including one without punishment. They find that a centralized punishment system dominates and almost eliminated free-riding.

An expansion of this strand of the research compares the effectiveness of endogenous institutions with the same institutions exogenously imposed by the experimenters (Arbak

and Villeval, 2011; Bó et al., 2010; Casari and Luini, 2009; Kamei, 2016; Markussen et al., 2013; Rivas and Sutter, 2011; Tyran and Feld, 2006). Findings from these studies provide the basis for our conjecture about the direct effect of collective-choice rules.

We contribute to this strand of literature by pushing endogenous institutions to the direction of institutional design. The study of Rockenbach and Wolff (2016) mostly resembles such an idea of institutional design. In their study, subjects can create any rules for a public good game , and they can repeatedly improve their design. The authors then decompose the subjects' rule sets into rule components and classify these components along different categories. They find that subjects usually combine two or more rule components, rather than use exclusively a single category of institution. In particular, designers often implement vertical communication and punishment and abstain from giving feedback on contributions. A critical difference between our setting and theirs is that we have more control on the collective decisions process by providing a preset menu of institutions. The institutions we offer are the ones that were chosen most frequently by subjects in the paper by Rockenbach and Wolff (2016), communication, punishment and information.

The second strand of literature investigates the difference between collective-choice rules from various perspectives. Some papers view collective-choice rules as information aggregation devices and look at how these rules influence the accuracy of group decisions (Nitzan and Paroush, 1982; Shapley and Grofman, 1984; Sorkin et al., 2001). For instance, Shapley and Grofman (1984) shows theoretically that collective-choice rules affect the likelihood of a correct choice and suggests that simple majority rule may be near optimal for large groups. Sorkin et al. (2001) compares super majority, simple majority, and unanimity from a signal detection theory perspective. They find that simple majority performs the best and unanimity is the worst. Other studies use collective-choice rules as devices to resolve conflicts of individual distributional preferences (Buchanan and Tullock, 1962; Dougherty et al., 2014; Walker et al., 2000). For example, Walker et al. (2000) studies how majority voting and unanimity affect the allocation proposals and efficiency gains in a common pool resources game. Their results suggest that unanimity rules lead to higher efficiency in symmetric groups with complete information.

We contribute to the research on collective-choice rules by adding another perspectives. We see collective-choice rules as problem-solving devices that involve more than information and preference aggregation. In our study, subjects are placed in a relatively rich decision environment, in which they interact with each other under strategic uncertainty. The complex but arguably more realistic setting enables us to see how collective-choice rules affect behavior and performance from new angles.

3 Experimental design and procedure

3.1 The Institutional Design Game

We use what we call an "Institutional Design Game" (IDG) to simulate a social dilemma environment where groups can design their own institutions. The main body of the IDG is a standard public goods game. The standard game can be modified by using institutions

which affect the rules of the game. Groups choose institutions via a collective-choice rule. Therefore, a group's choices of institutions pin down a personalized version of a modified public goods game for the group.

Many things can be varied in the IDG, depending on the research interest. Since our main aim is to examine whether, and to what extent, collective-choice rules affect cooperation behavior in such a social dilemma situation, we fix the collective-choice rule for each group. The details on the basic game, the available institutions, and how the collective-choice rules work are provided in the following subsections. In the last subsection we formulate the hypotheses.

3.1.1 Standard public goods game

The main body of the IDG is a standard three person public goods game widely used in studies into social dilemmas (Ledyard, 1994). The public goods game is repeated for 18 rounds, which are divided into six terms of three rounds. In every round, group members are assigned ID numbers as their temporary identity; ID numbers change every round. The three participants form a fixed group (partner matching). We use subscript $i \in 1,2,3$ to denote individual level decisions and subscript j to denote group level decisions or outcomes. In every round, all group members receive an endowment $e = 20$ points, and they decide simultaneously how much to invest in a public project. Every point invested into the project yields a return $\alpha = 0.5$ to each group member. Points that are kept in private remain unchanged. The payoff function of player i in round t if he chooses to invest x_{it} into the public project is then:

$$\pi_{it} = 20 - x_{it} + 0.5 * \sum_{k}^{3} x_{kt}$$

The marginal per capita return $\alpha = 0.5$ ensures that there is a conflict between group interest and individual interest since $0.5 < 1$ while $3 * 0.5 > 1$. That is, there are incentives to achieve a higher contribution level; full cooperation gives every group member 30 while fully selfish group members earn 20. After contributions have been made, group members receive information on every group member's contribution and payoff in the current round. However, without reputation, the contribution and payoff information is shown in match with the temporary IDs in the current round. With reputation, the contribution and payoff information is shown together with IDs fixed for the current term (see the next section for more details).

3.1.2 Institutions

In the experiment, several institutions can be established to extend the rules of the basic game. At the beginning of each term, groups can choose the institution(s) to be implemented in that term. We provide a menu with three available institutions: communication, reputation, and punishment. Subjects can choose any combination of these three items from the menu, or none of the institutions. Hence, there are eight possible institu-

tional choices. To avoid connotation, in the experiment, these institutions are referred to as mechanism A, B and C, respectively. For each group, the individual choices are aggregated to determine if an institution will be implemented in a term. How individual choices are aggregated depends on the collective choice rule, i.e. on the treatment.

One property of institutions is that they are typically costly to establish and/or to maintain. To capture this characteristic in the experiment, the establishment of an institution in a group costs 3 points per round, and these costs will be shared equally among group members in each of the three rounds of the term. On top of that, every time the function of communication/punishment is executed, a variable cost arises, as will be described in more detail below. Variable costs can be shared equally among group members or burdened by the individual who initiates it, depending on the cost-sharing rules chosen by the group members. Table 1 summarizes the fixed costs and variable costs for each institution. This table was also presented in the instructions. We will now elaborate on the details of the institutions.

With communication (mechanism A), group members can simultaneously send messages to a "blackboard" that every group member can see before making a contribution decision. The content of the message is semi-specified, and participants are required to fill in the blank before they send the message. Every message they send entails a variable cost of 1 point. They can choose one or more messages from the following set:

- "I propose we invest ___(integer number from 0 to 20) points in the project."
- "I propose we use mechanism A/B/C/none."
- "I propose we share the variable costs of mechanism A/C/none."

Reputation (mechanism B) makes a person's (term) history tractable and known to all group members. With reputation, the temporary IDs assigned to group members are fixed for this term; group member 1 remains group member 1 throughout the term. And subjects see each group member's record of contribution and payoff in this term, after making contributions. They can thus see six numbers (the contribution and payoff of each group member) in the first round of this term and 18 numbers in the last round of this term. Unlike the other two institutions, reputation does not incur any variable cost. Once it is established at fixed costs of 3 per round, it keeps working for the entire term without any further variable costs.

The last institution, punishment (mechanism C), enables group members to directly reduce others' payoffs at some costs after they have seen every member's contribution and payoffs. The fine-to-fee ratio is 3 in this experiment, following the standard practice in public good experiments (Nikiforakis and Normann, 2008). That is, it costs one point to reduce another individual's payoff by 3 points. To rule out anti-social punishment behavior, subjects can only punish those who contribute less than them.[2]

[2]Anti-social punishment widely exists when punishment is possible (Fehr and Gachter, 2000; Herrmann et al., 2008). We forbid antisocial punishment in order to keep the function of the "punishment" institution straightforward and to avoid inducing more complicated motives and interactions.

Subjects are informed of all of the above information in the instructions they receive (see Appendix B).

Table 1: Overview of costs (in points) per treatment

Institution	Fixed Cost per round	Variable Cost per use
Communication	3	1 per message
Punishment	3	1/3 per unit of deduction
Reputation	3	-

3.1.3 Treatments: Collective-choice rules

Our experiment consists of three treatments, which only differ in the collective-choice rules employed to translate individual preferences into one collective decision: majority voting (MV), fixed dictatorship (FD), and rotating dictatorship (RD). The rules of the basic game and the institutions explained in previous sections apply to all treatments.

At the beginning of each term, group members choose institutions and the corresponding cost-sharing rules of each institution individually and simultaneously. For each item (or institution) on the menu, they answer two questions: (1) whether they want this institution to be established with fixed costs that will be shared by all group members and (2) whether they would like to share the potential variable cost of that institution, if it is put into use.

In the MV treatment, whether an institution will be established depends on whether the majority of the group votes yes or no concerning question (1). If the majority votes yes, the cost-sharing rule will be also determined by majority rule according to their answers to question (2).

In the FD treatment, one of the group members will be randomly chosen as the decision maker (fixed dictator) and remains the decision maker throughout the entire game. In the very first round, all group members are asked to answer questions (1) and (2) without knowing whether they are the decision maker or not. After the voting phase in the first round, each subject knows whether he is assigned as the decision maker or not. Nevertheless, to minimize procedural differences between the treatments, non-dictators are still required to privately indicate their preferences over institutions at the beginning of each term, even though their choices do not affect the institutional outcome.

In the RD treatment, participants take turns to be the decision maker (rotating dictator). The order is randomly determined by the computer. All group members answer questions (1) and (2) in all six terms without knowing whether they are going to be the decision maker in that term. Only after the voting phase will they be informed of whether their choices have been selected and implemented or not. There are six terms, and hence six institutional choices. Subjects know that only two times their decision(s) will actually be implemented as the collective-choice. If a group member has been selected twice as the decision maker, she can therefore conclude that her institutional choice would not matter

anymore in later terms.

3.2 Procedure

The experiment was conducted at CentERlab at Tilburg University, and it was programmed using zTree (Fischbacher, 2007). Participants were recruited via the UvTlab system of Tilburg University. We employed a between-subjects design. Participants could only participate in one experimental session, and in each session, only one treatment (i.e. collective-choice rule) was conducted. We implemented in total six sessions, with two sessions per treatment.

We start by reading aloud instructions. Subjects are first introduced to the standard public good game as described in section 3.1.1. A test of their understanding of the public good game is performed before entering the next stage of instruction. Then we introduce the available institutions as described in section 3.1.2 and the collective-choice rule used in their collective-decision process. Subjects can ask questions, which are answered privately. Finally, the experiment starts without any practice round. The complete procedure of the game is presented in Appendix A.

In each treatment, subjects are randomly matched in fixed groups of three (partner matching). There are in total 18 rounds, which are divided into six terms of three rounds each. In rounds 1, 4, 7, 10, 13, 16, groups play a full Institutional Design Game consisting of two phases: a collective decision phase and a simultaneous contribution phase. In all other rounds participants skip the collective decision phase and only make contribution decisions. Every round participants are randomly (re)assigned an ID number 1, 2 or 3 (except for the case where they have established reputation institution).

In the collective decision phase, group members choose which institutions they would like to implement in the next three rounds and the corresponding cost-sharing rule individually and simultaneously. Their choices are aggregated into group decisions via the collective-choice rule assigned to the group. At the end of this collective decision phase, the group decisions are displayed on the screen and hence known to all group members. Individual votes are not revealed.

Then follows the second phase of simultaneous contribution. Participants play a standard public game with the institutions that they have chosen themselves. The first stage of the contribution phase is the communication stage. Only groups that have chosen the communication institution are eligible to participate in this stage. Subjects of eligible groups can choose and fill in the message(s) that they would like to convey to his/her group members. Not sending any message is also possible. Messages from each member are shown on the group's blackboard. In the second stage, participants play the standard public good game and make their contribution decisions simultaneously. In the succeeding stage, individual contribution and payoffs of this round are shown to all group members. The fourth stage is the punishment stage. If the punishment institution is established in a group, participants indicate whom they want to punish and by how many points. These decisions are made individually and simultaneously. In the final stage, punishment and final payoffs of each group member in this round are shown on the screen. Groups that have chosen

reputation can identify contributions and payoffs of the group member in a term; without reputation this information cannot be linked to individual group members (only to random IDs).

The monetary payoff of each participant in the experiment is determined by the sum of individual tokens earned in all 18 rounds plus a show-up fee of 3 euros. 100 tokens are translated into 3 euros.

In total, 114 subjects participated in the experiment (39 in MV, 36 in FD, and 39 in RD), of whom 43% are women. In the questionnaire conducted at the end of the experiment, around 74% of the subjects claimed that they had participated in a "similar" experiment. This suggests that these participants generally have a good understanding of the game, or at least they believe so. Subjects earned on average 16.9 euros in about 1 hour 15 minutes.

3.3 Hypotheses

Our first hypothesis is that collective-choice rules have a direct effect on contribution behavior. The direct effect is reflected in the difference in contribution behavior by collective-choice rules conditional on having the same institutions. This hypothesis builds on people's preference for democratic participation right. Participation right provides a feeling of inclusion and lends legitimacy to the collective decisions. Being able to participate and decide may increase group members' mental attachment to the selected institutions and hence enhance compliance with the resulting institutions (Arbak and Villeval, 2011; Bó et al., 2010; Casari and Luini, 2009; Castore and Murnighan, 1978; Frey et al., 2004). In our setting, majority voting guarantees every group member participation right in all six terms. With rotating dictatorship, group members share participation rights equally over all terms, but each group member has decision power only 1/3 of the time. Fixed dictatorship assigns all the decision power to only one of the three group members, which likely undermines the legitimacy of the selected institutions. Based on these arguments, we formulate the first hypothesis as follows.

Hypothesis 1. *(Direct effect). Given the same endogenous institution combination, contributions to the public good are greater with majority voting than with rotating dictatorship, and are greater with rotating dictatorship than with fixed dictatorship.*

Our second hypothesis consists of two parts. First, we hypothesize that collective-choice rules affect the stability of institutional outcomes. Second, the stability of institutional outcomes in turn affects cooperation behavior. As to the first part, intuitively, rotating dictatorship is expected to produce the least stable institutional outcomes. Regarding majority voting, a number of studies use controlled experiments to test the stability of majority rule. They have shown that the resulting collective decisions under the majority voting framework are not necessarily predictable and may depend on details of the voting procedure, for example, agenda setting, or pre-communication (Haney et al., 1992; Hoffman and Plott, 1983; McKelvey and Ordeshook, 1984; Plott and Levine, 1978; Wilson, 1986). Following these results, we hypothesize that institutional outcomes produced via

a fixed dictatorial collective-choice rule are more stable than those produced via majority voting.

Hypothesis 2a. *Institutional choices generated under fixed dictatorship are the most stable among the three collective-choice rules, and those generated under rotating dictatorship are the least stable.*

The second part of the second hypothesis is based on extensive empirical research on the relationship between political stability and economic performance (Aisen and Veiga, 2013; Alesina et al., 1996; Barro, 1991; Dixit, 2009; Feng, 1997). Literature sometimes finds instability to be the cause of poor economic performance and sometimes the consequence of it. We therefore expect to observe a positive correlation between the institutional stability and cooperation in our setting.

Hypothesis 2b. *The stability of institutional choices is positively correlated with cooperation.*

Collective-choice rules may also affect the type of institutions groups choose. As explained in section 1, we cannot formulate a testable hypothesis about the relationship between collective-choice rules and the type of institutions groups prefer. Nor can we say anything about the effects of a certain combination of collective-choice rule and institutional design on cooperation behavior. Therefore, we remain open to any result that surfaces from our data.

4 Results

We first present some general results on subjects' behavior in the public goods game, including the performance, contributions and institutional choices. Bearing these results in mind, we will then proceed to investigate the direct and indirect effects of the collective-choice rules.

4.1 General results

4.1.1 Performance

The first result we are interested in is how well groups perform in self-governance, or their "performance". Performance is measured by the earnings of an individual or a group in the game: subtracting the costs related to the establishment and usage of institutions from the total profits made in the public goods game. Performance is the materialized individual or social welfare. For a group, performance is also a net measure of cooperation, broadly considered. It increases when group members contribute more to the public good, and it decreases when the group achieves that cooperation level at greater costs.

As a benchmark, if a group never establishes any institution and all group members contribute nothing to the public good, each individual group member will earn 360 experimental points over the 18 rounds of the game. Full contributions without any costs of

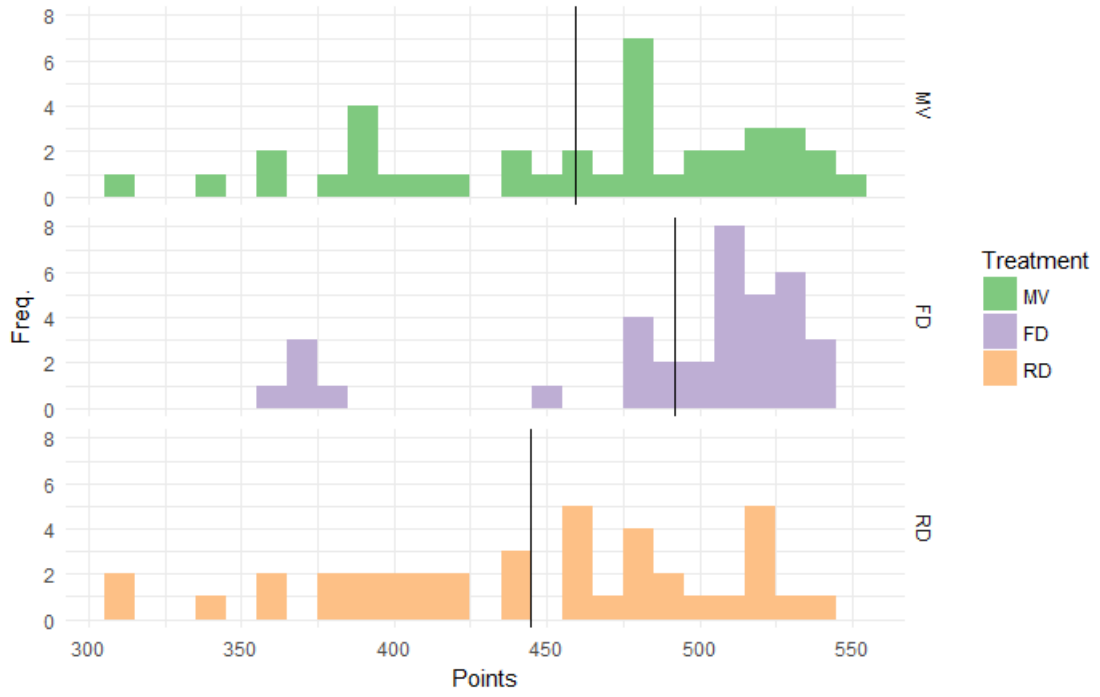

Figure 1: Distribution of individual earnings

institutions would yield maximum individual earnings of 540 points. Figure 1 presents the distributions of individual accumulated earnings (in experimental points, one observation per individual) in each treatment, where the vertical lines are drawn at the mean value. Over all treatments subjects earn on average 483.2 points, which is an increase of more than 34% compared to the benchmark earnings of 360 points.

The average earnings of subjects are highest in the FD treatment and lowest in the RD treatment. As can bee seen in Figure 1, the variation in individual earnings is smaller in the FD treatment than in the other two treatments. Using independent observations at the group level, Mann–Whitney U tests show that average group earnings in the FD treatment are significantly higher than in the RD treatment (p=0.034, n_1=12, n_2=13), but not significantly higher than in the MV treatment (p=0.211, n_1=12, n_2=13). Earnings in the MV and RD treatment do not differ significantly from each other (p=0.457, n_1=13, n_2=13). Figure 9 in Appendix C presents the earnings in the three treatments over rounds.

Result 1. *Total earnings with fixed dictatorship are significantly higher than with rotating dictatorship.*

As group performance depends on how much a group contributes to the public good and how intensively it uses the institutions a group's total earnings can be decomposed into two parts: the profits from the public and private good, and the costs associated with the usage of institutions. Figure 2 and Table 6 (in Appendix C) give more detailed information on the two parts. In Figure 2, the darker and lighter dots are located at the mean of per round group contributions and group institution-related costs across terms for the three treatments, respectively. The box-and-whisker plots show the distribution of group earnings in each treatment across terms.

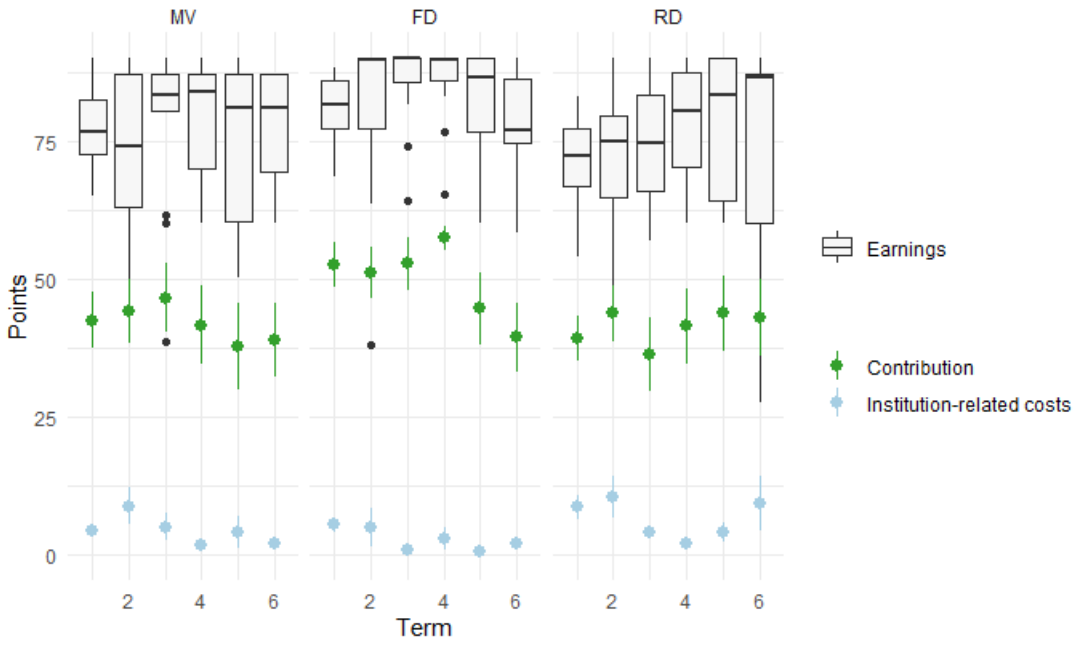

Figure 2: Per round group earnings, group contributions, and group institution-related costs over terms.
Note: The tails of the dots cover one standard deviation. The bold line in the box represents the median earnings. The end of the box shows the first and the third quartiles. The vertical extreme lines show the highest and lowest earnings excluding outliers.

Figure 2 suggests that contributions to the public good play a decisive part in determining the group performance. Institution-related costs, including the fixed and variable costs of institutions and the loss from punishment, are relatively small in magnitude. However, both parts contribute to the differences between treatments.

In the subsequent sections, we look more closely into contribution behavior and institutional choices.

4.1.2 Contribution behavior

For each treatment, the development of the average group contributions over 18 rounds is shown in Figure 3. In all three treatments of our institutional design game, groups manage to sustain cooperation at a rather high level. Per round group contributions to the public good are between 28 and 59 points, with an average group contribution of 44.18 points, which is approximately 73.6% of the group endowment.

Contributions to the public good do not demonstrate a declining trend over time. This result is not in line with the stylized fact of declining cooperation found in repeated public goods experiments (Ledyard, 1994; Neugebauer et al., 2009), but such a pattern is typically observed in public good games with punishment. In the FD treatment, cooperation even seems to be climbing up until round 12. In the very last term, we observe a sharp falling of group contributions in the FD and MV treatment, which suggests that cooperation in previous rounds is more of a strategic play rather than purely driven by social preferences.

Interestingly, we observe a declining trend within terms in the MV and RD treatment.

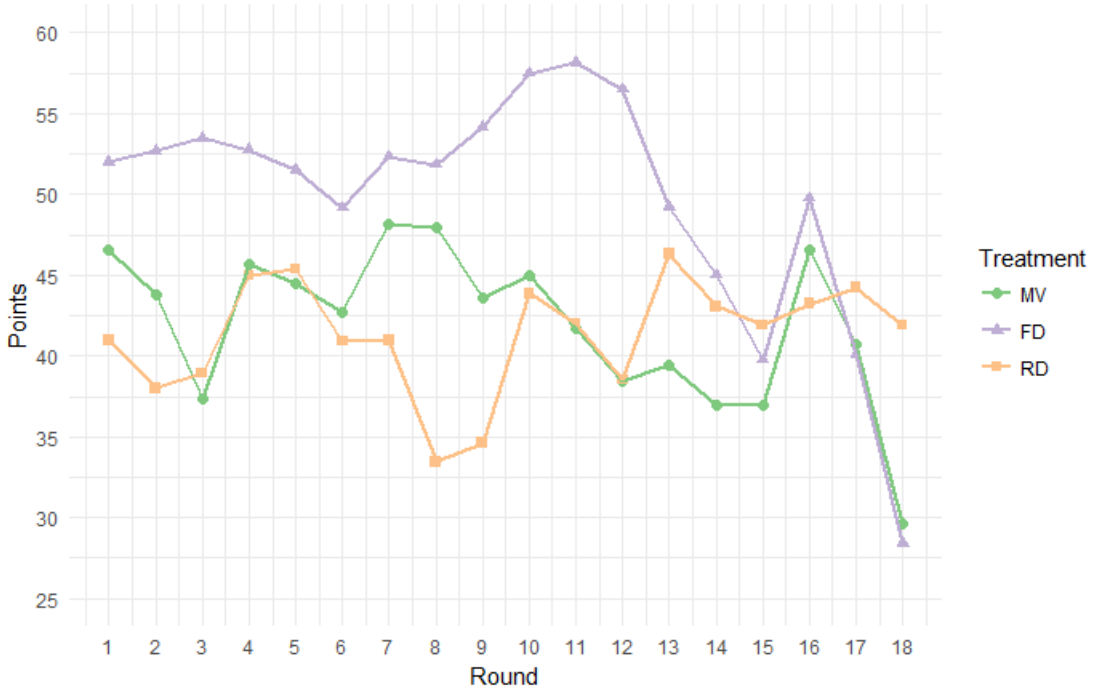

Figure 3: Group contributions over rounds

In these two treatments subjects contribute significantly less in the third round of a term than in the first round of that same term (both treatments $p<0.01$, $n=13$); we may call this the "draining" effect. In contrast, they contribute significantly more upon entering a new term, compared with their contributions in the last round of the previous term (both treatments $p<0.01$, $n=13$); we call this the "boosting" effect.[3] Furthermore, we find that a change in the institutions between two consecutive terms is positively correlated with the boosting effect and the draining effect. That is, a new set of institutions gives a boost to cooperation, but at the same time cooperation declines more than if the institutions do not change. This suggests a correlation between the stability of institutions and the stability of cooperation behavior. We will consider this in more detail in Section 4.1.2.

Turning to the differences in cooperation across treatments, Figure 3 shows that groups in the FD treatment constantly and consistently have higher contribution levels than MV and RD groups with the exception of some of the very last rounds. This can also be seen from Table 7 in Appendix C, which shows the average contributions per term and treatment as well as results of comparisons between treatments. Average group contributions in the FD treatment are about 20% higher than in the other two treatments. Although the differences are substantial in most terms, only the differences between the two treatments with dictatorship are significant in several terms while the differences between contribution with majority voting and with fixed dictatorship are not.

Result 2. *In early terms and over all six terms, groups contribute significantly more with fixed dictatorship than with rotating dictatorship.*

[3]This boosting effect resembles the so-called restart effect (Andreoni, 1988). In our experiment the (new) term was not unexpectedly announced, however, but announced ex ante. Furthermore, it is not a pure restart effect as the rules in the new term may be different, depending on the institution combination selected.

4.1.3 Institutional choices

We will first look at the overall institutional choices in all six terms. The frequency of each institution combination chosen is displayed in Figure 4. Of in total 228 group institutional choices (38 groups x 6 terms), 51.32% are "no institution". The most frequently selected institutions are (only) punishment (14.9%) and (only) communication (11.4%). Then it follows with the combination of punishment and communication (8.3%) and the combination of all three institutions (6.6%). Participants show little interest in reputation, neither alone nor combined with other institutions. The reason could be that reputation in this experiment is rather weak while still costly.[4]

If we look at the institutional choices over time, groups seem to prefer communication in the beginning of the game and then turn to punishment when they approach the end of the game; see Figure 5 which shows choices of institutions in the first term (top panel) and last term (bottom panel). One explanation could be that in early rounds, communication may be a useful and powerful tool to build up group morale and mutual trust, while in later rounds the credible threat offered via punishment is more useful. The patterns observed in Figure 5 offer some support for such a "carrots first, then sticks" conjecture: between terms 1 and 6 the percentages of groups using communication, either alone or combined with other institutions, decreases strongly (from 66% to 15.8%) while the use of punishment increases (from 26.3% to 45%). The willingness to share the variable costs of both institutions shows a similar development. This also suggests that subjects are (only) willing to pay for the institutions they vote for.

When comparing the use of institutions across treatments, it turns out FD groups use institutions less frequently (24 times) than MV groups (40 times) and RD groups (47 times). Less institution usage means lower institution-related costs, which contributes to the better performance of FD groups, as was shown in the previous section.

Do collective-choice rules also affect the type of institutions chosen by groups? We compare the first round institutional choices across treatments since they are made individually and simultaneously before any form of interaction. The individual institutional choices in the first round are presented in Figure 10, Appendix C. There is no evidence that initial preferences over institutions differ given different collective-choice rules. Also individual preferences over cost-sharing rules, i.e whether group members are willing to share the variable costs of institutions, do not differ significantly across treatments. Therefore, we find no evidence showing that different collective-choice rules might induce different preferences over institutions.

4.2 Direct and indirect effects of collective-choice rules

We now test our hypotheses regarding the direct and indirect effects of collective-choice rules.

[4] Rockenbach and Wolff (2016) find that institution designers tend to provide aggregate contribution information, and leave individual information vague. Our findings do not conflict theirs.

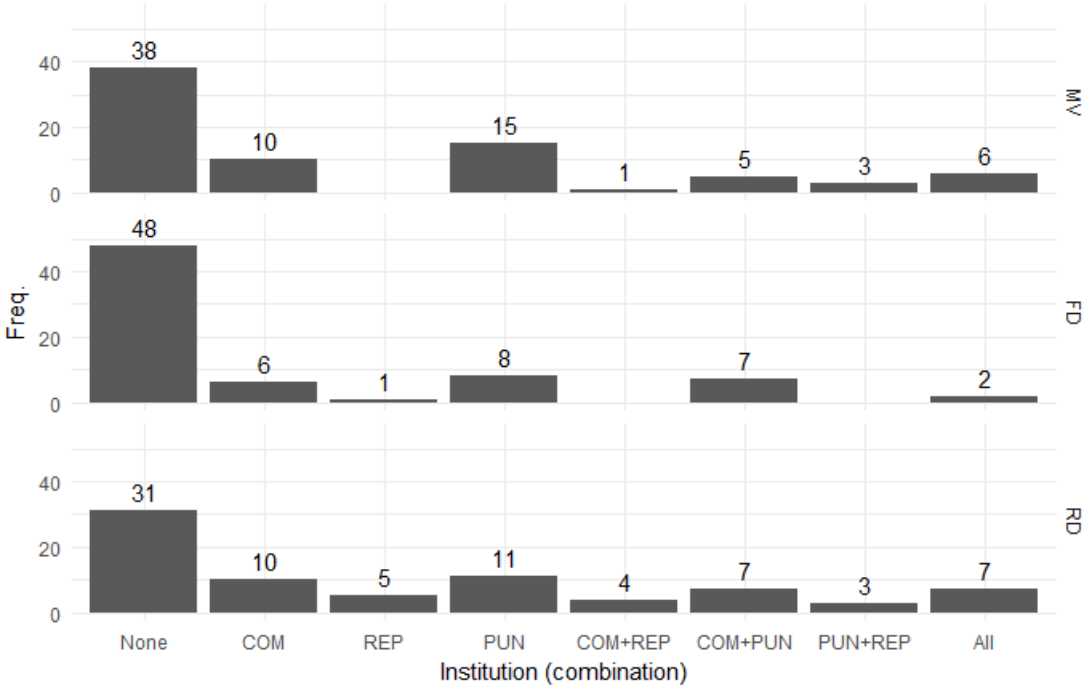

Figure 4: Group institutional choices over all six terms

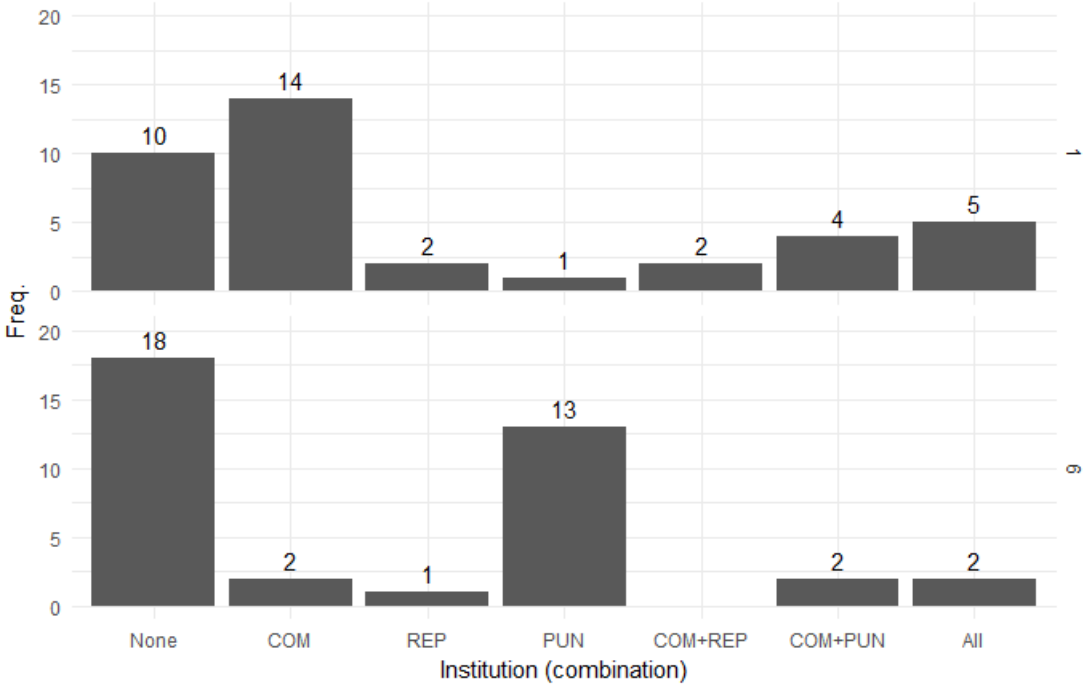

Figure 5: Group institutional choices in term 1 and term 6

4.2.1 Direct effect

The direct effect of collective-choice rules is the influence of these rules on contribution behavior conditional on institutions. To test whether there is difference in contributions between treatments, given the same institution, we run a regression on individual contribution behavior in the first round.[5]

We estimate three specifications using a censored tobit model. The first specification takes the form

$$x_{ij1} = \alpha + \beta_1 MV + \beta_2 RD + \epsilon_{i1} \tag{1}$$

where x_{ij1} is the contribution to the public good of individual i in group j, round 1. MV and RD are dummy variables indicating whether the individual is in treatment MV and whether the individual is in treatment RD respectively. The benchmark treatment in the regression is FD. The second specification is identical to the first one, except that it also takes into consideration the institutional choices of a group in round 1

$$x_{ij1} = \alpha + \beta_1 MV + \beta_2 RD + \delta_1 COM_{j1} + \delta_2 PUN_{j1} + \delta_3 REP_{j1} + \epsilon_{i1} \tag{2}$$

where COM_{j1}, PUN_{j1}, and REP_{j1} represent the establishment of the 3 available institutions in group j, term 1. Our last specification controls for more institutional features and some individual characteristics, in addition to the second specification

$$\begin{aligned} x_{ij1} =& \alpha + \beta_1 MV + \beta_2 RD + \delta_1 COM_{j1} + \delta_2 PUN_{j1} + \delta_3 REP_{j1} + \sigma_1 Share\_COM_{j1} \\ &+ \sigma_2 Share\_PUN_{j1} + \eta_1 gender_i + \eta_2 experience_i + \epsilon_{i1} \end{aligned} \tag{3}$$

where Share_COM$_{j1}$ and Share_PUN$_{j1}$ denote whether the variable costs of communication and punishment are shared among group members, respectively. $experience_i$ is a dummy variable denoting whether the individual has experience in similar experiments, and gender is a dummy variable taking value 1 for females.

Results are reported in Table 2. The results show that subjects in treatment FD contribute more than in the other two treatments and significantly so in treatment RD, in line with Result 2. This positive effect of fixed dictatorship on contributions persists in all model specifications, so even after controlling for institutions. We also find that the establishment of communication raises the contribution level significantly. Of the other variables only gender has a significant effect; women contribute significantly more than men in the first round.

Result 3. *Fixed dictatorship has an immediate and significantly positive direct effect on contributions compared with rotating dictatorship.*

Our first hypothesis is thus not supported. We do not find a positive direct effect of democratic collective-choice rules on cooperation. On the contrary, the direct effect, if

[5]Using only first-round data is a rather strict but clean test, as it rules out path dependency which may occur when using data from all rounds. Tobit is used because a substantial fraction of contributions is at the boundaries, 0 or 20.

Table 2: Determinants of contribution in 1st round

	Dependent variable:		
	Contribution		
	(1)	(2)	(3)
MV	-5.964	-3.720	-3.262
	(5.269)	(4.716)	(4.633)
RD	-13.183**	-12.446***	-10.694**
	(5.213)	(4.788)	(4.657)
Communication		16.538***	14.563***
		(4.028)	(4.865)
Punishment		0.339	1.527
		(4.557)	(5.759)
Reputation		6.579	6.065
		(4.815)	(4.956)
Share_COM			2.431
			(4.957)
Share_PUN			-1.907
			(5.860)
Gender			7.581**
			(3.727)
Experience			2.902
			(3.840)
logSigma	2.889***	2.714***	2.676***
	(0.148)	(0.145)	(0.145)
Constant	31.821***	17.981***	12.094**
	(4.548)	(4.172)	(5.235)
Observations	114	114	114
Akaike Inf. Crit.	402.159	382.923	385.595
Bayesian Inf. Crit.	413.104	402.077	415.694

Note: *p<0.1; **p<0.05; ***p<0.01

any, works in the opposite direction as predicted, with highest contributions with fixed dictatorship.

4.2.2 Indirect effect

To test our second hypothesis, we need a measure of the stability of groups' institutional choices over time. Formally, let $\mathbf{p} = (p_{COM}, p_{REP}, p_{PUN})$ be an ordered triple in a 3-dimensional Euclidean space, with each component $p \in \{0,1\}$ representing the individual or group choice on the establishment of one institution. For example, $\mathbf{p_{jt}} = (1,0,1)$ indicates that the institutional choice of group j in term t is communication and punishment. We then compute the linear distance between the institutional choices in two consecutive terms and denote it as the group *instability index* $index_{jt} = \|\mathbf{p_{j,t-1}}, \mathbf{p_{j,t}}\|$. The overall instability of group j's institutional choices over time is defined by adding up the instability index from term 2 to term 6: $instability_j = \sum_{t\in 2,\dots 6} \|\mathbf{p_{j,t-1}}, \mathbf{p_{j,t}}\|$.[6]

To examine the stability of institutions we first present for each treatment a complete and detailed picture of how institutions evolve over time, see Figures 6, 7, and 8. On theses graphs, each sub-plot shows the institutional choices of one group over six terms. Note that although the combinations on the vertical axis are not completely ordered, broadly speaking higher points correspond to more institutions. The color of dots denotes the instability index of the institutional choice in a term. A red dot suggests that institutions have changed a lot from previous term while a blue dot signals stability.

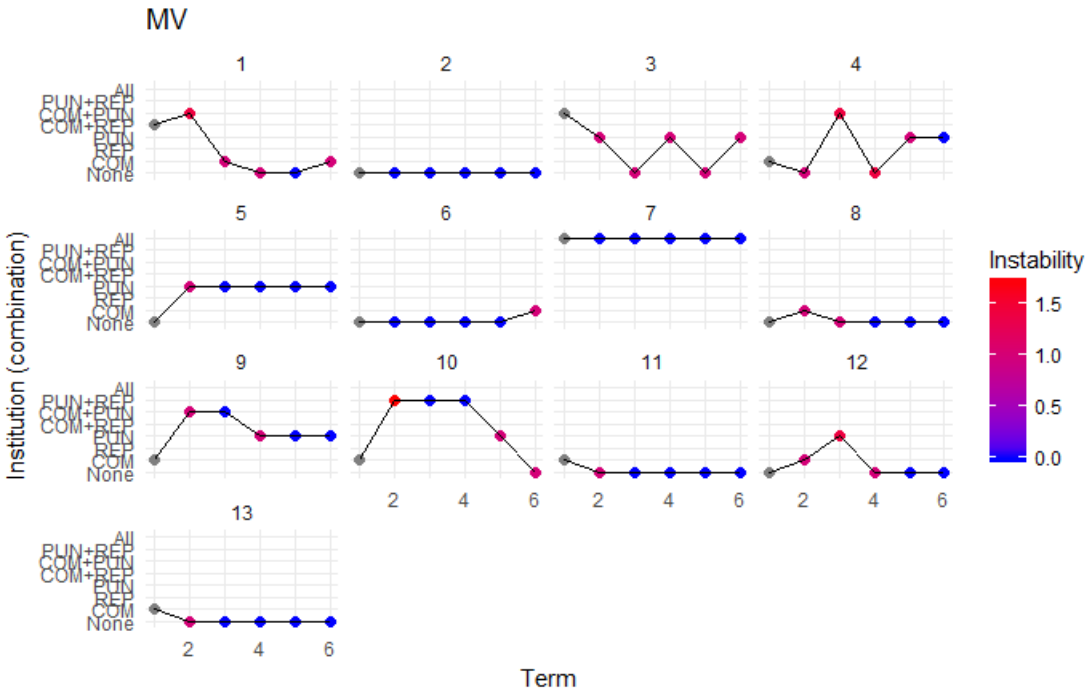

Figure 6: Evolution of institutions in treatment MV

[6]Because all individuals are asked to indicate their institutional choices in every term, we could compute an instability index at the individual level, but we focus on group (in)stability.

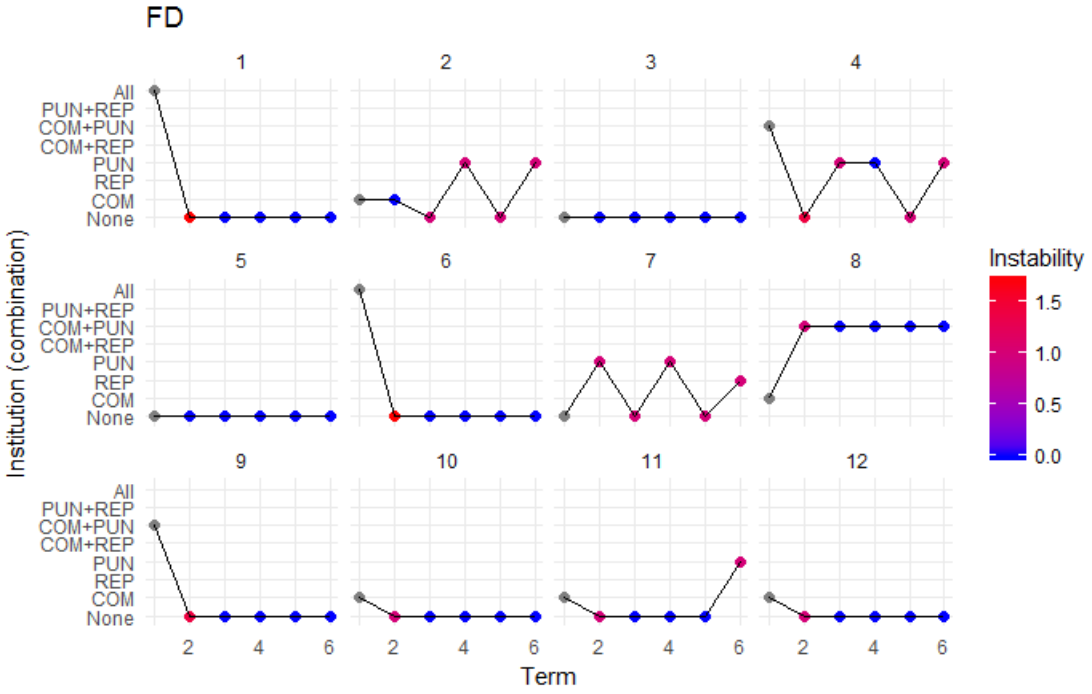

Figure 7: Evolution of institutions in treatment FD

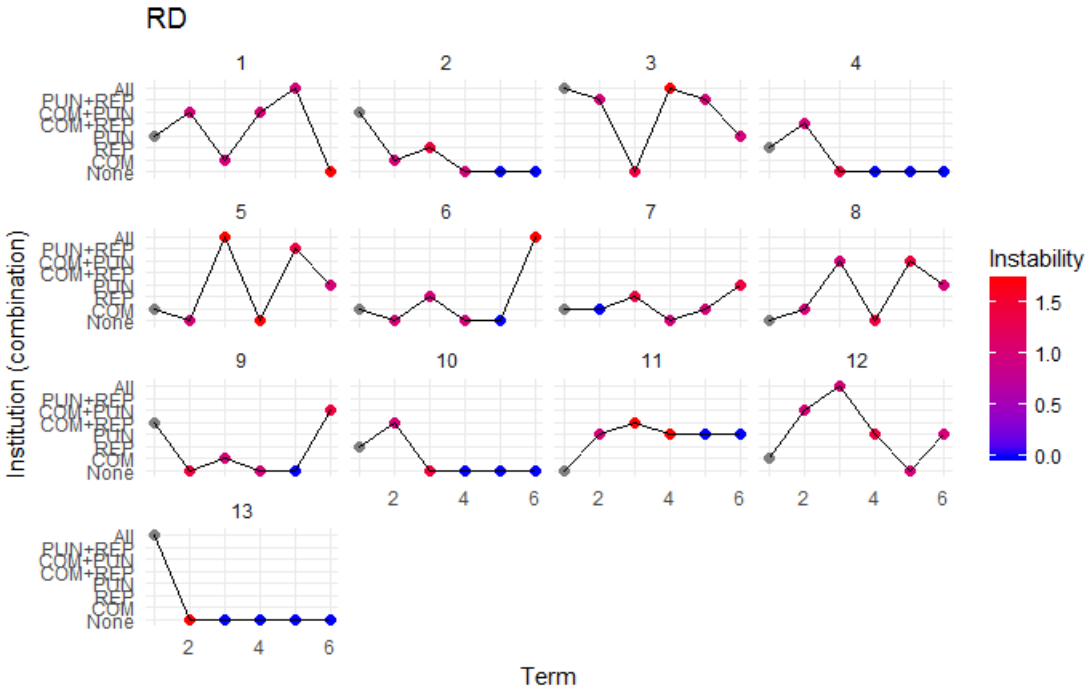

Figure 8: Evolution of institutions in treatment RD

Visual inspection shows that institutional choices of the FD groups are the most "stable" as the graph of treatment FD looks more blue. 7 out of 12 FD groups converge to no institutions immediately after the second term. In sharp contrast, the RD groups seem to be struggling with designing their (best) institutions. There is frequent and seemingly random switching among different institution combinations. What happens in the MV groups is somewhere in between the case of the FD and RD groups. The results of Mann-Whitney U tests on the instability index confirm that institutional choices in FD and MV groups are indeed significantly more stable than in RD groups (both differences p<0.01, n=12 for FD, n=13 for MV and RD) while the difference between FD and MV groups is not significant (p=0.74).

However, simple comparisons of the overall instability across treatments may suffer from endogeneity problems. For example, among the many factors that may influence a group's institutional design, cooperation history is an important one. A group might decide to try a new set of institutions because its members are currently not contributing enough. At the same time, low cooperation might be traced back to the direct effect of collective-choice rules in the very beginning. Therefore, instability could stem from the direct effect of collective-choice rules, rather than the inherent instability of collective-choice rules.

Ideally, we want to control for all other factors which are possibly correlated with collective-choice rules and which could affect institutional choices, such as previous cooperation history and group morale, and only vary the collective-choice rule. One way to achieve this is to construct counterfactual group institutional choices. A counterfactual group institutional choice is the institutional choice a group would have selected if its members' preferences were aggregated via a different collective-choice rule. We can construct these counterfactual choices by exploiting the individual institutional choices of subjects in treatment MV. Because all the decisions in this treatment are made in an incentivized manner, the individual institutional choices can be aggregated *ex post* in whichever way we want. We use each individual's six institutional choices to compute a counterfactual FD instability index, as if they were the dictators. This gives us three counterfactual FD indices for each group, one per subject. As to the counterfactual RD index, we first generate all possible permutations of random dictators for a group according to our rotating rule specified in section 3. We compute the counterfactual RD instability index in each permutation and then take the average of the counterfactual instability index for all permutations. The counterfactual instability indices constructed in this way allow us to do paired difference test on the stability of institutions across treatments while keeping other things constant.

The results of these exercises provide strong evidence showing that institutional choices produced by rotating dictatorship are significantly less stable than by fixed dictatorship (Wilcoxon signed-rank test, p<0.01, $n = 39$) and significantly less stable than by majority voting (Wilcoxon signed-rank test, p<0.01, $n = 13$). But there is no evidence suggesting any difference in stability between majority voting and fixed dictatorship (Wilcoxon signed-rank test, p=0.844, $n = 39$).

Result 4. *Institutional choices generated by rotating dictators are significantly less stable*

than those generated via majority voting or fixed dictatorship. The stability of institutional choices does not differ between majority voting and fixed dictatorship.

Next, we explore the relationship between instability and cooperation (Hypothesis 2b). We estimate the following specification for all groups using a linear model[7] and using data from all rounds

$$\begin{aligned} X_{jt} =& \alpha + \lambda instability_{jt} + \gamma X_{j,t-1} + \theta_t + \delta_1 COM_{jt} + \delta_2 PUN_{jt} + \delta_3 REP_{jt} \\ &+ \beta_1 MV + \beta_2 RD + \epsilon_{jt} \end{aligned} \tag{4}$$

where X_{jt} is the per round contributions of group j averaged over the three rounds in term t. $instability_{jt}$ is the instability index which measures how much the institutional choice(s) of group j change from term $t-1$ to term t, as defined previously. COM_{jt}, PUN_{jt}, and REP_{jt} stand for the establishment of the three institutions in group j, term t. θ_t is term fixed effects, capturing the trend of cooperation over time. And MV and RD are dummy variables indicating the collective-choice rule group j is using.

Table 3 presents the results. The instability of institutional choice has a negative effect on group contributions. The magnitude of this effect is relatively small but significant. The establishment of punishment significantly increases group contributions by 21.6 points, and reputation decreases group contributions by 6.2 points. The results combined with the group institutional choices presented in the previous section justify our argument that institutional design can be seen as a problem-solving process: Groups try to find out which institutions work best in terms of promoting cooperation. Institutions that work (punishment) are chosen more frequently, while institutions that don't work lose their places. The results also show that group contributions are highly correlated with contributions in the last term, with a coefficient of about 0.66.[8]

Result 5. *The instability of institutional choice decreases subsequent group contributions.*

Our second hypothesis is thus partially supported. Rotating dictatorship produces unstable institutional choices, compared with majority voting and fixed dictatorship. Instability is associated with a lower cooperation level.

5 Discussions: What drives the direct effect

Result 3 offers no support for Hypothesis 1, which stated that democratic participation right would increase compliance with the selected institutions and results in higher contributions. In this section, we try to explore why this may be the case. Among the many potential explanations we focus on two, namely communication and leadership. The first conjecture points to the use and in particular the *content* of communication. The messages subjects exchange in the communication phase may cause the difference between FD and

[7]The dependent variable here is group contributions, which are never censored. Therefore, we use a linear model instead of a censored tobit model.

[8]The results do not depend on the specifications; the signs and significance of variables are very similar if group contributions in the last term are not included.

Table 3: Instability and contributions

	Dependent variable:
	Group Contributions
Instability	-3.876**
	(1.963)
Group contributions in the last term	0.657***
	(0.051)
Term	-2.175***
	(0.785)
Communication	2.014
	(2.814)
Punishment	21.623***
	(2.414)
Reputation	-6.159*
	(3.418)
MV	-4.826*
	(2.588)
RD	-0.773
	(2.781)
Constant	20.510***
	(4.938)
Observations	190
Adjusted R^2	0.601
Note:	*p<0.1; **p<0.05; ***p<0.01

RD groups. A second conjecture is that the dictators in the FD treatment act (more) as true "leaders". They might take their responsibilities in promoting group cooperation by sending messages and making larger contributions than non-dictators. As a result, the whole group benefits from having a leading figure, even though they cannot identify which member is the leader. We find some evidence supporting the first conjecture and evidence against the second.

5.1 The usage and the content of communication

In section 4, we have shown that in the first round communication increases contributions to the public good. Now we consider in more detail the usage and the content of the messages in this round.

The first three rows of Table 4 give a summary of the usage of communication across treatments: the percentage of groups that have established communication, the percentage of individuals who send any message at all, and the number of messages sent sorted by content. Fixed dictators choose to establish communication more frequently and send more messages than groups in the MV and RD treatments. Remember that the content of a messages is semi-specified. It can be a proposal for certain amount of contribution to the public good, a proposal for the establishment of certain institution combinations, or a proposal for a certain cost-sharing rule. Table 4 also shows that the types of messages sent are similar across treatments.

Table 4: Usage of communication in round 1

	MV	FD	RD
% groups using communication	61.5	75	61.5
% individuals sending any message	51.3	58.3	51.3
NO. messages sent	39	38	33
message about contribution	18	19	20
message about institution	13	10	7
message about sharing-rule	8	9	6

What might matter more than the number of messages sent is the specific content of the message, and the proposals for contribution in particular. Table 5 presents the frequency of the proposed amount of contribution in round 1. We immediately notice that in the RD treatment less people propose to contribute the full endowment to the public good. Results from Fisher's exact tests confirm that the proposals for contribution are significantly different between MV and RD groups (p=0.08, n=38), and between FD and RD groups (p=0.04, n=39).

Previous findings from economic experiments demonstrate that a large fraction of the population can be categorized as conditional cooperator (Fischbacher et al., 2001): they cooperate only if they expect others to cooperate. Seeing selfish signals, group members

Table 5: Frequency of individual proposed contribution in round 1

proposed amount	MV	FD	RD
0	0	0	1
3	0	1	0
5	0	0	1
8	0	1	0
10	1	0	5
15	0	1	1
20	17	16	12
N	18	19	20

may lower their expectations of how much others would contribute, and this may result in a lower group cooperation level. Results of a regression of actual contributions on the minimal proposed amount of contribution in a group (not reported here) suggest that a one point decrease in the minimal proposed amount of contribution decreases actual contributions significantly, by 1.07 point on average ($p<0.01$). The fact that group members in the RD treatment observe less (very) positive signals may explain, at least partly, why RD groups cooperate at a lower level.

5.2 The leadership effect

To examine whether some sort of leadership effect exists and whether it is stronger in the FD treatment than in the RD treatment, we compare the behaviors of dictators and non-dictators in all rounds with communication.

First, dictators are more willing to send messages to their group members than non-dictators when communication is possible. This finding also holds for both FD and RD sub-samples separately. But the dictators in the FD treatment are not more willing to communicate than those in the RD treatment. Second, dictators in both FD and RD treatments propose a higher amount of contribution than non-dictators do, but the contribution proposals by the dictators in the FD treatment and in the RD treatment are indistinguishable. Finally, dictators behave similarly as non-dictators in terms of actual contributions to the public good in treatments FD and RD. Taken together, this implies that there indeed seems to be a "leadership" effect in both treatments with dictatorship, albeit weak. The dictators are more willing to communicate and propose larger amount of contributions but are not actually contributing more than non-dictators. More importantly, we find no evidence that this leadership effect is stronger in the FD treatment than in the RD treatment. Therefore, the higher cooperation level observed in the FD treatment compared with the RD treatment cannot be attributed to a (stronger) leadership effect in the first treatment.

6 Conclusion

This paper studies the role of collective-choice rules in a problem-solving decision environment where groups can exploit the possibility of institutional design to achieve self-governance. We test if collective-choice rules directly affect cooperation after controlling for institutions and if collective-choice rules indirectly affect cooperation through the stability of institutional choices. Specifically, we study majority voting, dictatorship, and rotating dictatorship. The Institutional Design Game we use is based on a standard public goods game. Groups repeatedly select institutions they would like to implement via a given collective-choice rule and play the self-tailored public goods game with the chosen institutions. Institutions are costly.

Our main findings are: (1) Cooperation level is not higher when the institutions are chosen via a democratic rule than when the same institutions are chosen via a non-democratic rule. On the contrary, groups with a fixed dictator cooperate at a higher level than those with rotating dictators, conditional on institutions. (2) Institutional choices chosen by majority voting or by a fixed dictator are more stable over time than those chosen by rotating dictators. (3) The instability of institutions is associated with lower cooperation level.

Previous literature has established an "endogeneity premium" (Bó et al., 2010), namely that institutions chosen by the subjects themselves are more effective than the same institutions when imposed on them. The "endogeneity premium" is widely interpreted as the merit of democratic participation in group decision-making. But it could also be that endogenous institutions work better because they are chosen by someone at stake. We exclude this possibility by comparing institutions that are all chosen by subjects themselves but through democratic or non-democratic rules. We do not find evidence of a "democracy premium" (institutions chosen via democratic rules are more effective than chosen via non-democratic rules). Our results do not refute the findings of an "endogeneity premium", but suggest further investigation into the underlying mechanisms through which democratic participation right is transmitted to higher cooperation.

Our second finding concerns the stability of collective decisions in a complex problem-solving setting where the consequences of these decisions are uncertain and individual preferences are not necessarily fixed. In the presence of this complexity, one does not expect widespread agreement on the optimal collective choice. Therefore, collective choice is likely exposed to greater variance when the decision rights are more dispersed. We show that indeed decisions are most unstable when they are made by individuals on a rotating basis. Yet we detect no significant difference in the stability of institutional choices between majority voting and fixed dictatorship. Future work could look at whether the difference in stability persists as the size of group grows and as the complexity of decision environment increases. Finally, in our environment, unstable institutions is not constructive to cooperation.

Taken together, our results indicate that certain collective-choice rules may matter for the effectiveness of collective decisions. It helps to think about the value of democratic participation right, the cost of instability, and the possible tradeoff between the two before

a group sets the collective-choice rule for making collective decisions.

Of course, there are several questions remaining to be answered. For example, concerning the direct effect, it is a bit surprising that individuals in the treatment of rotating dictatorship send more selfish signals than those in other treatments. It could be a coincidence given the relatively small sample. Alternatively, one may suspect that subjects with rotating dictators anticipate the instability of their institutional environment and that the anticipation of instability already hurts their willingness to fully cooperate. As to the indirect effect, our setting suffers from endogeneity issue as many empirical studies do. If we want to learn more about the causal relationship between stability and cooperation, we need an experimental design which is more tailored to this purpose. Finally, the direct and indirect effects observed here may serve as starting points for studying and better understanding the role of collective-choice rules. It is not clear, for example, whether the impact of collective-choice rules will be stronger or weaker, as the decision environment becomes more complex. All these aspects may be examined in further research.

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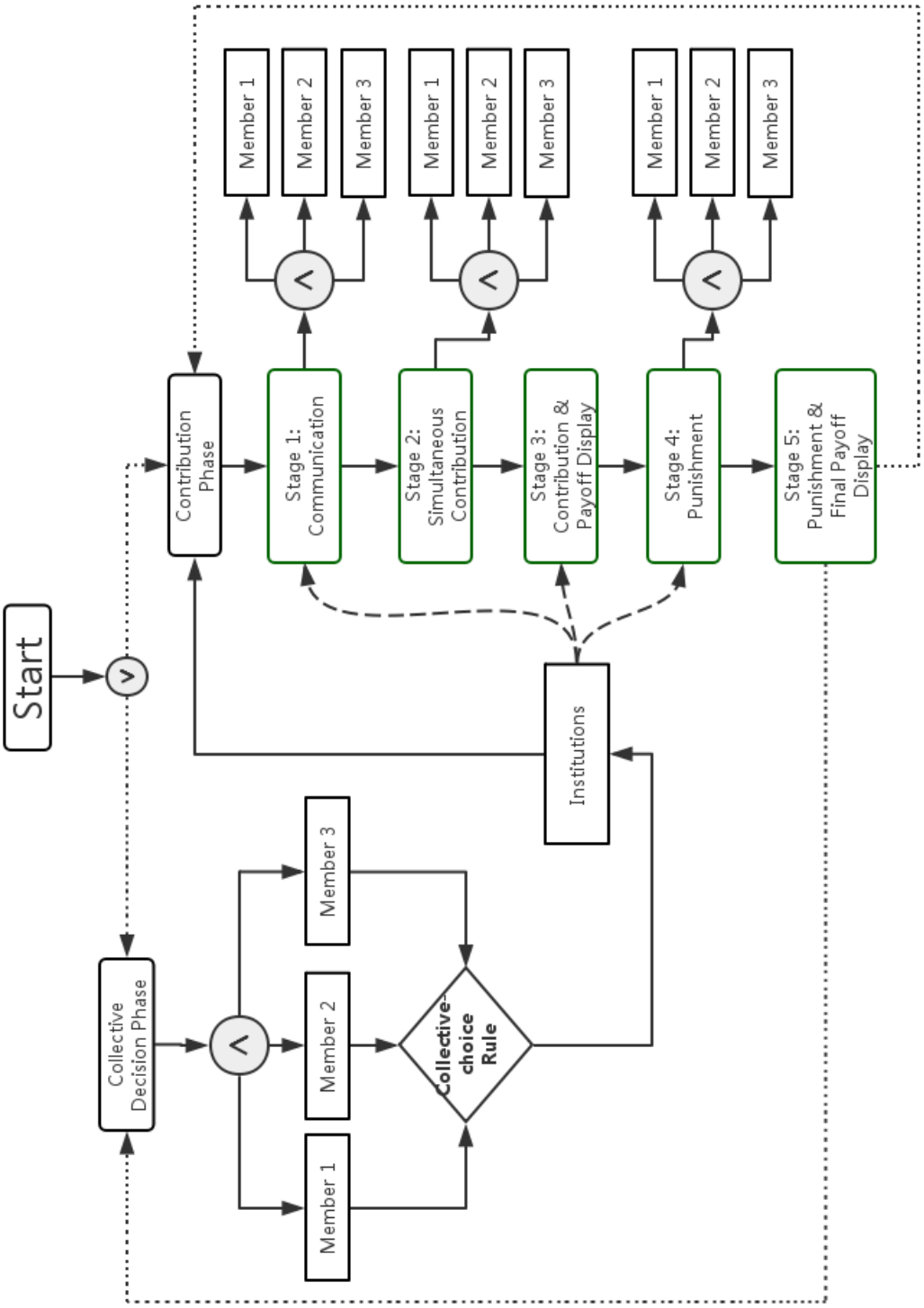
A Experiment Procedure



B Instructions

Welcome and thanks for your participation. You receive €3 for having shown up on time. If you read these instructions carefully, you can earn more. Your earnings will be paid out to you in cash immediately after the experiment.

It is strictly forbidden to communicate with the other participants during the experiment. If you have any questions or concerns, please raise your hand. We will answer your questions individually.

The experiment consists of 18 rounds. It is divided into 6 terms. Each consists of 3 rounds. You will interact with two other participants. The three of you form a group that will remain the same in all 18 rounds. You will never know which of the other participants are in your group.

The sum of the 18 round payoffs will determine your final earnings. 100 points in the experiment are converted to 3 Euros: 100 points = €3.

Basic Game

This is the game that you play every round. Each participant will be (re)assigned as either Member 1, Member 2, or Member 3. This identity changes every round.

In each round, each of you receive 20 points. In the following, we shall refer to this amount as your endowment. **Your task is to decide how much of your endowment you want to invest in a project.** After investment, the rest of your endowment is kept for yourself.

One POINT, no matter invested by whom, in the project gives 0.5 POINT to each member in your group. Therefore how much you earn from the project depends on both your own investment and your group members' investment. To calculate how much you earn from the project:

1. Investments into the project from the three group members are added up as the total group investment.

2. Each member in this group receives half amount of the total group investment.

The amount that you keep for yourself remains the same. Your profit is therefore the sum of the following two parts:

Profit = 0.5 * total group investment + the amount that you keep for yourself

You and your group members make this decision at the same time without knowing others' choices. The individual investments and profits of all group members will be shown to you at the end of each round.

Now please look at the screen and answer a few questions. These questions aim at making sure that you understand the game. They do not influence your earnings. If you have any questions, please raise your hand.

Possible Extensions

As mentioned, the experiment will consist of 6 terms of 3 rounds. At the beginning of each term, you are able to change the rules of the basic game by using one or more of the following three Mechanisms:

Mechanism A: It is used before investment. You are able to exchange messages with your group members before making your investment. There are at most three pieces of message you can send, which will be listed below.

Mechanism B: It is used after investment, when investments and profits are shown to you. You are able to see not only the investments and profits in the current round, but also the history of investments and profits of your group members in the previous rounds starting from this term. Your identity (Member 1, Member 2, or Member 3) will not change during this term.

Mechanism C: It is used after seeing your investments and profits. You are able to assign points to other group members to reduce their earnings. Each point assigned to a group member will reduce the earnings of this group member by 3 points. You can only assign points to those who invest less than you.

To be able to use these Mechanisms, you will have to pay for the fixed costs as a group. Each Mechanism costs each member of the group 3 points in this term. That is, each of you pay 1 point per round in the term in which the Mechanism is used.

Additionally, Mechanism A and C might incur variable costs, which depend on your actual usage. Within Mechanism A, the variable cost of each piece of message is 1 point. Within Mechanism C, the variable cost of each assigned point is 1 point. For example, if Member 1 assigns 1 point to Member 2, the variable cost of such action is 1 point, whereas the earnings of Member 2 will be reduced by 3 points.

Your group can choose to share the variable costs of the Mechanism A and C equally among all group members or not. If your group chooses to share the variables costs, then no matter who sends a message or who assigns points to others, the variable costs of such actions will be shared equally by all group members. Otherwise the costs of sending a message or assigning points to others will only be burdened by the member who takes the action.

The following table gives you a summary of the costs of each Mechanism.

	Fixed costs	Variable costs
Mechanism A	3 POINTS per person	1 POINT every message
Mechanism B	3 POINTS per person	-
Mechanism C	3 POINTS per person	1 POINT every point assigned

Your task is to decide:

At the beginning of each term

1. With regard to each of the three Mechanisms, would you like it to be used in your group? (Yes/No)

2. With regard to Mechanism A and Mechanism C, would you like the variable costs to be shared equally by all group members? (Yes/No)

In each round

3. (If applicable) Do you have any messages to send? If yes, what would you send?

There are three pieces of message to choose from. You need to fill in the blank before sending. You can choose more than one of them:

- "I propose that we invest ___(integer number from 0 to 20) points in the project."
- "I propose that we later use Mechanism ___ (A/B/C/none)."
- "I propose that we later share the variable cost of Mechanism ___(A/C/none)."

4. (If applicable) How many points you want to assign to those who invest less than you?

[*FOR MV ONLY*] Whether a Mechanism will be actually used depends on whether a majority in your group agree to use it. That is, if two or more group members vote yes for a Mechanism, it will be used in the following term (three rounds) and all group members will pay for its fixed costs.

For Mechanism A and C, whether the variable costs would be shared equally by all group members depends on whether a majority in your group agree to it.

[*FOR FD ONLY*] One of the group members will be randomly assigned the role of decision maker throughout the 6 terms. Whether a Mechanism will be actually used and whether the variable costs will be shared equally totally depend on the decision maker's choice. You are informed of your role after all group members have made their choices regarding the Mechanisms in term 1.

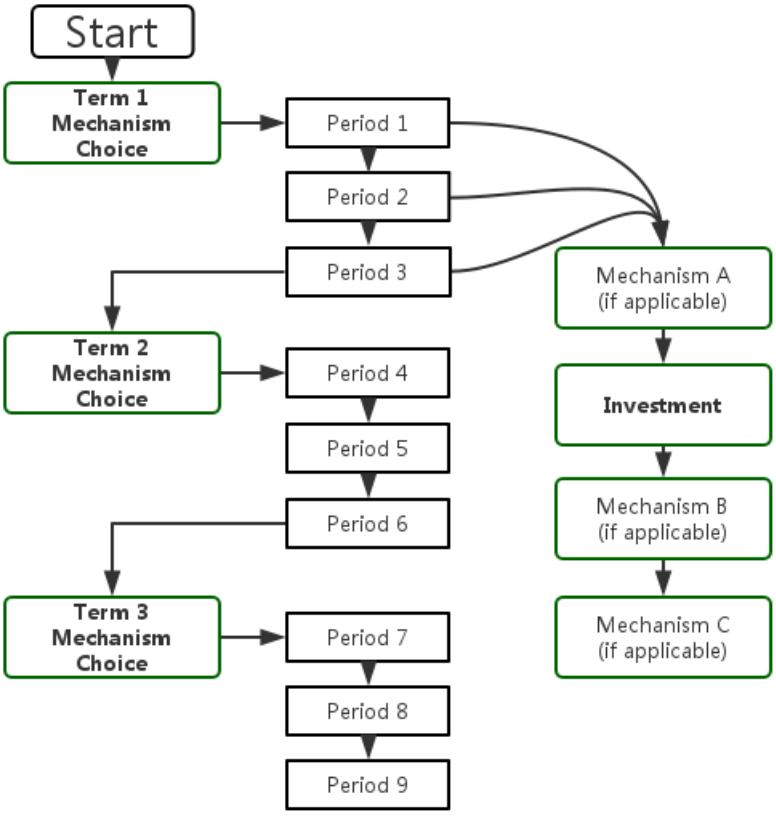
If you are not the decision maker, you are still able to indicate your preferences although your choices will not affect the outcome.

[*FOR RD ONLY*] In each term, one group member will be randomly assigned the role of decision maker. Whether a Mechanism will be actually used and whether the variable costs will be shared equally totally depend on the decision maker's choice. Each of the group members will become the decision maker exactly twice in the six terms. You are informed of your role only after all group members have made their choices regarding the Mechanisms.

If you are not the decision maker, you are still able to indicate your preferences although your choices will not influence the outcome.

How is the game played?

The procedure of the game is shown in the following picture. (Only the first three terms are presented).


Start
Term 1 Mechanism Choice
Period 1
Period 2
Period 3
Term 2 Mechanism Choice
Period 4
Period 5
Period 6
Term 3 Mechanism Choice
Period 7
Period 8
Period 9
Mechanism A (if applicable)
Investment
Mechanism B (if applicable)
Mechanism C (if applicable)

C Additional results

Performance over time

We present the average group performance over time of different treatments in Figure 9. The benchmark group earnings are 60 points per round. Figure 9 shows that on average, groups in all treatments manage to earn more than the benchmark in all rounds. In FD, the average group performance follows a hump-shape pattern. In MV and RD, there are ups and downs over time with no obvious trend. Groups in FD on average outperform those in MV and RD most of the time.

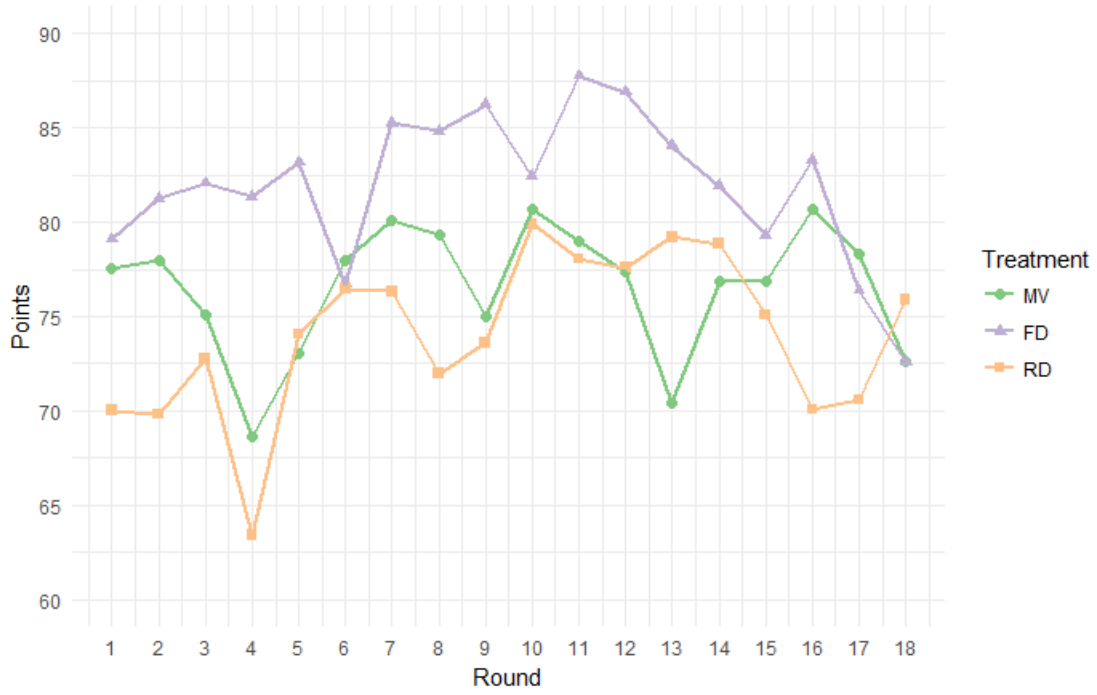


Figure 9: Group earnings over rounds

Decomposition of group performance

Table 6 shows that FD groups on average earn 7.83 more points than RD groups, of which 4.19 points come from the profit side and 3.64 come from the cost side.

Average per term group contributions

Table 7 shows the average per term group contributions. Subjects in FD contribute more than those in RD in earlier terms. The contributions of FD groups are also consistently higher than those in MV, but the differences are not statistically significant (all p-values > 0.1).

Table 6: Decomposition of group performance

	Earnings			Costs			Profits		
	MV	FD	RD	MV	FD	RD	MV	FD	RD
Term 1	81.28	86.36	79.65	4.41	5.55	8.78	76.88	80.81	70.87
Term 2	82.14	85.57	81.88	8.92	5.14	10.57	73.23	80.43	71.32
Term 3	83.29	86.39	78.18	5.18	0.94	4.20	78.12	85.45	73.98
Term 4	80.86	88.69	80.73	1.85	2.99	2.21	79.01	85.70	78.52
Term 5	78.87	82.33	81.88	4.18	0.58	4.15	74.69	81.76	77.73
Term 6	79.49	79.71	81.56	2.26	2.28	9.38	77.23	77.44	72.18
Avg.	80.99	84.84	80.65	4.46	2.91	6.55	76.53	81.93	74.10

Table 7: Group contributions over terms

	Group contributions		
	MV	FD	RD
Term 1	42.56	52.72‡	39.31‡
Term 2	44.28	51.14	43.77
Term 3	46.59	52.78†	36.36†
Term 4	41.72	57.39†	41.46†
Term 5	37.74	44.67	43.77
Term 6	38.97	39.42	43.13
Avg.	41.98	49.69‡	41.30‡

Notes. Two-sided Mann-Whitney U tests. † Significant difference ($p<0.1$) between FD and RD. ‡ Significant difference ($p<0.05$) between FD and RD.

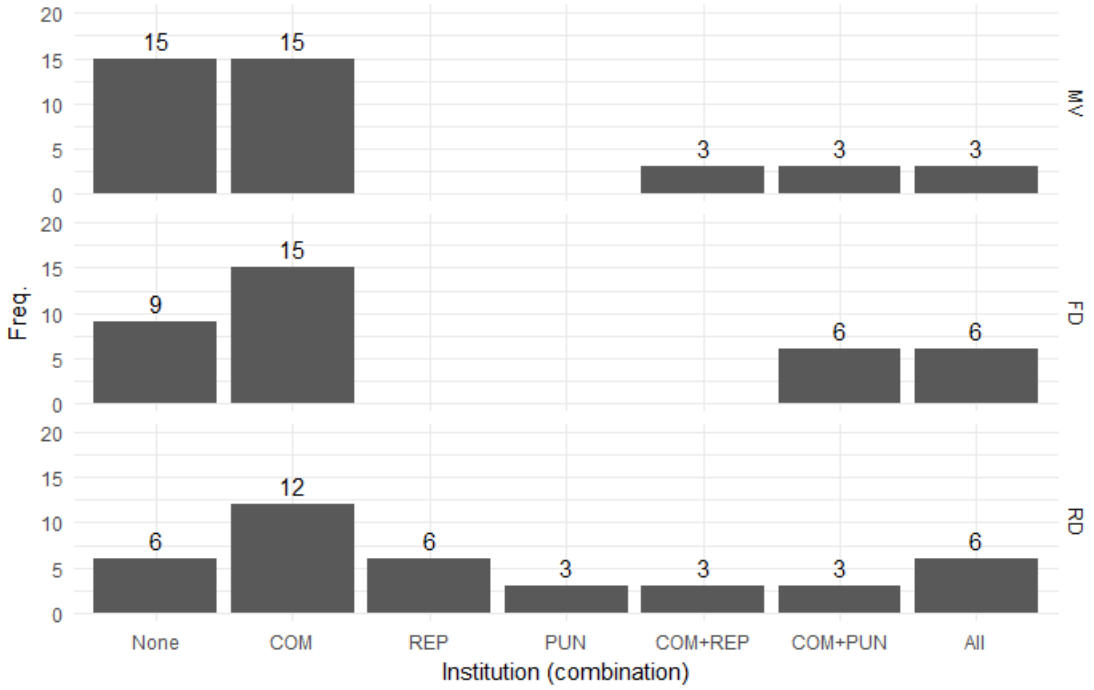


Figure 10: First round individual institutional choices

First round individual institutional choices

As shown in Figure 10, the initial preference of individuals over institutions does not differ across treatments (p=0.412, n=114). It suggests that collective-choice rules do not affect the type of institutions people choose to use.