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Endogenous Institutional Choice in Public Goods Games: A Voting Experiment

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1 Abstract

This study investigates how groups endogenously choose governance institutions to solve social dilemmas in public goods games. Using a novel experimental design, we examine voting behavior and cooperation patterns across 25 rounds where participants repeatedly select among five institutional mechanisms. The experiment begins with 5 rounds of standard public goods game, followed by 20 rounds where groups vote every 5 rounds to implement institutions including punishment and reward options. Our systematic comparison examines individual vs. collective and punishment vs. reward mechanisms within a 2×2 framework. We test hypotheses regarding institutional preferences, path dependence, and efficiency consequences of different institutional choices. A pilot experiment will test the design structure and participant comprehension.

2 Introduction

This experiment examines a fundamental question in experimental economics: how do groups endogenously choose governance institutions to solve social dilemmas, and what are the behavioral and efficiency consequences of these choices?

The classic public goods game demonstrates the tension between individual and collective interests, typically showing a decay in cooperation over time as free-riding behavior dominates (Fehr and Gächter, 2000; Isaac and Walker, 1988). Previous research has established that institutions like punishment (Fehr and Gächter, 2000), rewards (Sefton et al., 2007), and collective mechanisms (Tao et al., 2016) can sustain cooperation when externally imposed. However, the process by which groups choose among these institutions remains underexplored.

2.1 Research Questions

- Which institutional mechanisms do groups prefer when given multiple options?
- How do individual vs. collective institutions affect cooperation?
- What are the efficiency consequences of different institutional choices?
- Do groups show path dependence in institutional selection?

2.2 Research Gap and Novelty

Most studies examine single democratically chosen institutions (Dannenberg and Gallier, 2020; Gürer et al., 2006) or multiple imposed institutions (Tao et al., 2016); we compare multiple endogenously implemented institutional types. Our research provides systematic

comparison of individual vs. collective and punishment vs. reward mechanisms within a unified experimental framework.

3 Literature Review

The standard public goods game, developed by [Isaac and Walker \(1988\)](#) and replicated multiple times, reliably demonstrates the cooperation decay phenomenon where contributions decrease over repeated rounds despite the social optimum requiring full cooperation.

Research on institutional interventions has shown that punishment mechanisms can sustain cooperation ([Fehr and Gächter, 2000](#); [Dannenberg and Gallier, 2020](#)), though they may reduce overall efficiency due to the costs of punishment. Reward systems have also proven effective, though potentially less efficient than punishment ([Tao et al., 2016](#)).

3.1 Theoretical Framework

Our study builds on several key theoretical perspectives:

- **Behavioral Game Theory:** Considers how psychological factors affect strategic decision-making
- **Social Preference Models:** Incorporates fairness, reciprocity, and inequality aversion
- **Path Dependence Theory:** Suggests that initial institutional choices constrain future options

4 Methodology

4.1 Experimental Design

We employ a within-subjects design with 25 total rounds conducted using oTree software. Each group consists of 5 participants (24 groups in main study, 120 total participants), with group composition remaining stable throughout the experiment. The participants will be Vilnius university students, no economics students.

$$\text{Earnings}_i = \text{Endowment} - \text{Contribution}_i + \text{MPCR} \times \sum_{j=1}^N \text{Contribution}_j \quad (1)$$

where $\text{MPCR} = 0.4$, $\text{Endowment} = 10$ points per round, and $N = 5$ participants per group.

4.2 Experimental Procedure

The experiment proceeds in two main phases:

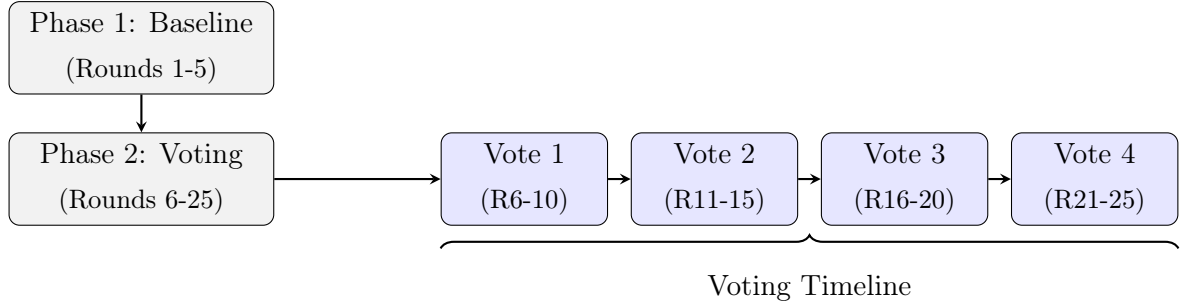


Figure 1: Experimental Timeline with Voting Periods

After each round participants are shown their contribution, profit and the group averages; every 5 rounds they are shown 2 informative graphs.¹

4.3 Institutional Options

Participants select from five institutional options every 5 rounds:

Table 1: 2×2 Institutional Framework

	Punishment	Reward
Individual	Individual Punishment	Individual Reward
Collective	Collective Tax	Collective Bonus

1. **No Institution:** Standard public goods game (baseline)
2. **Individual Punishment:** Players can punish free-riders at personal cost ([Fehr and Gächter, 2000](#))
3. **Collective Tax:** Automatic 20% tax on uncontributed endowment
4. **Individual Reward:** Players can reward cooperators at personal cost ([Sefton et al., 2007](#))
5. **Collective Bonus:** Automatic rewards for top contributors ([Tao et al., 2016](#))

4.4 Mathematical Representation of Institutions

Important design feature: All institutions maintain identical total endowment (10 points per player per round). Punishment and reward points are deducted from parti-

¹These graphs display the average profit and average contribution of all participants, calculated specifically for the preceding 5-round period, this is shown before voting begins.

participants' own earnings; no institution provides additional spending capacity that would create endowment disparities.

Variable definitions: Endowment $e = 10$, contribution $c_i \in [0, 10]$, MPCR $m = 0.4$, group size $N = 5$.

- **Individual Punishment:**

$$\pi_i = e - c_i + m \sum_{j=1}^N c_j - \sum_{j \neq i} p_{ij} - 2 \sum_{j \neq i} p_{ji} \quad (2)$$

where p_{ij} is punishment points assigned by i to j .

- **Collective Tax:**

$$\pi_i = 0.8(e - c_i) - c_i + m \sum_{j=1}^N c_j \quad (3)$$

where 20% of uncontributed endowment is taxed.

- **Individual Reward:**

$$\pi_i = e - c_i + m \sum_{j=1}^N c_j + 2 \sum_{j \neq i} r_{ji} - \sum_{j \neq i} r_{ij} \quad (4)$$

where r_{ij} is reward points assigned by i to j .

- **Collective Bonus:**

$$\pi_i = 0.8e - c_i + m \sum_{j=1}^N c_j + B_i \quad (5)$$

where B_i is bonus from pool distributed to top 2 contributors.²

4.5 Sample Size and Power Analysis

Assumptions: $\alpha = 0.05$, $\beta = 0.20$, $\rho = 0.5$, $\sigma = 4.0$.

1. Group-level analysis (voting outcomes):

- With 24 independent group observations
- 80% power to detect: $d \approx 0.82$ (large effect) in between-group comparisons

2. Individual-level analysis (contributions):

- With 120 participants in within-subjects design ($\rho = 0.5$)
- 80% power to detect: $d \approx 0.26$ (small-to-medium effect)

²If all contributions are equal, the bonus gets divided equally between all participants.

- For medium effects ($d = 0.5$): Power > 98%

3. Mixed-effects model considerations: With 24 groups and 120 individuals:

- Adequate for estimating group-level random intercepts
- May be limited for group-by-treatment interactions
- Sufficient for main effects of institutions on contributions

Summary: Our sample provides:

- High power for *within-individual* comparison of contributions across institutions
- Adequate power for detecting *large effects* in group-level voting patterns

4.6 Data Collection

We will collect:

- Contribution decisions (0-10 points each round)
- Voting choices (4 voting periods)
- Punishment/reward allocations when applicable
- Earnings data
- Demographic information and post-experiment questionnaires

5 Predictions and Hypotheses

5.1 Theoretical Predictions

- **Institutional Preferences:** Groups prefer individual control over automatic systems initially, but may shift toward collective mechanisms as they learn about relative efficiency
- **Punishment vs. Reward:** Punishment favored initially due to salience of free-riding
- **Status Quo Bias:** Groups tend to retain institutions that appear successful
- **Efficiency Trade-offs:** Automatic systems avoid costly sanctioning

5.2 Hypotheses

- **H1:** Individual punishment will be most popular initially among institutional options

- **H2:** Collective institutions will yield highest efficiency in the long run
- **H3:** Groups will show path dependence in institutional choice (retention rates > 60%)
- **H4:** Voting patterns will reflect learning from institutional performance

6 Expected Results and Analysis Strategy

6.1 Expected Contribution Patterns

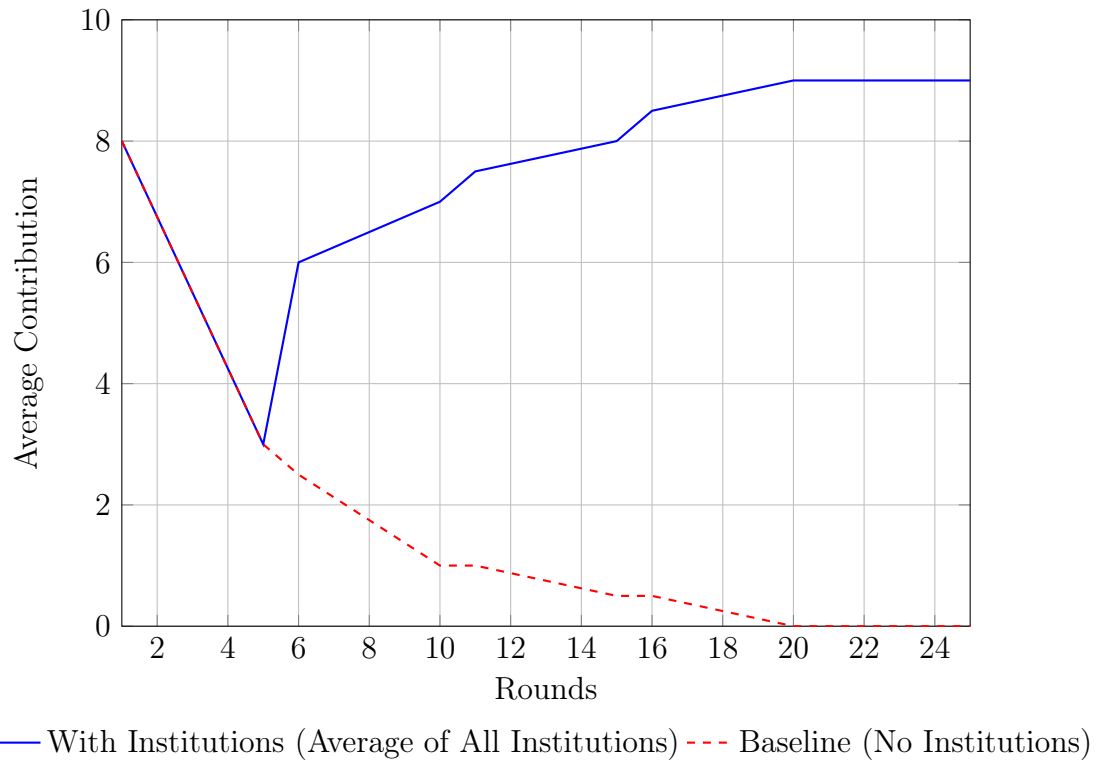


Figure 2: Expected Contribution Trajectories

6.2 Analysis Strategy

1. **Descriptive Analysis:** Contribution patterns, voting frequencies, earnings distributions
2. **Hypothesis Testing:**
 - H1: Regression on first voting choice
 - H2: Mixed-effects models comparing efficiency across institutions

3. Efficiency Analysis:

$$\text{Efficiency} = \frac{\text{Actual Total Earnings}}{\text{Maximum Possible Earnings}} \times 100\% \quad (6)$$

4. Path Dependence Tests:

$$P(\text{Retention}) = f(\text{Past Performance, Institution Type, Group Characteristics}) \quad (7)$$

7 Limitations and Possible Extentions

7.1 Limitations

- Limited number of voting periods (4 elections)
- Interval between voting might be too short
- Monetary stakes may not reflect real-world consequences

7.2 Future Extensions

- Different group sizes
- Additional treatments with different starting points
- Longer periods between voting

8 Conclusion

Our study provides a novel experimental framework for examining endogenous institutional choice in social dilemmas. By allowing groups to repeatedly select among multiple governance mechanisms, we capture the dynamic nature of institutional evolution that characterizes many real-world collective action problems. Our systematic comparison of individual vs. collective and punishment vs. reward mechanisms within a 2×2 framework advances beyond previous research that typically examines single institutions or imposed rules.

The findings will contribute to several literatures: experimental economics on institutional design, political economy on democratic decision-making, and organizational theory on self-governance. Practical applications include designing voting systems for environmental governance, corporate compliance mechanisms, and community resource management.

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