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? While extensive research has studied the effects of externally imposed institutions on cooperation, much less is known about how groups select their own governance mechanisms through democratic processes.

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). 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 institutions or multiple imposed institutions; 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 study of institutional solutions to social dilemmas has a rich history in experimental economics. The standard public goods game, developed by Isaac and Walker (1988), 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), 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 Predictions and Hypotheses

4.1 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

4.2   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

5   Methodology

5.1   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.

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

where MPCR = 0.4, Endowment = 10 points per round, and N = 5 participants per group.

5.2   Experimental Procedure

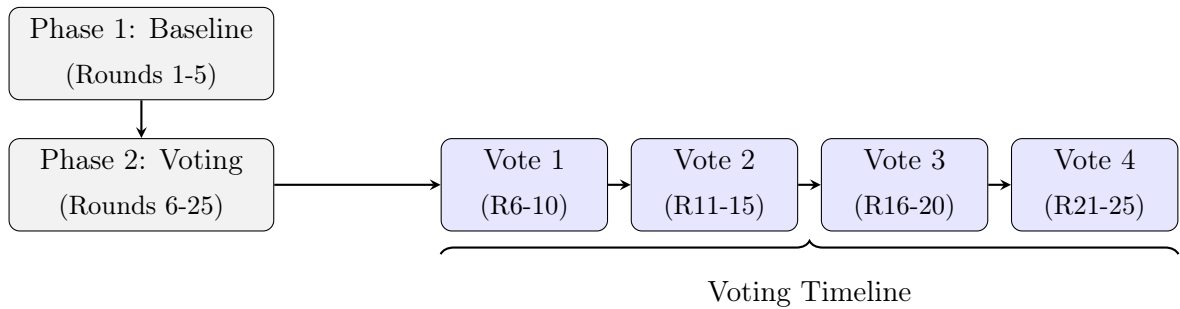The experiment proceeds in two main phases:

Figure 1: Experimental Timeline with Voting Periods

5.3 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)

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

- **Individual Punishment**:

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

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

- **Collective Tax**:

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

where 20% of uncontribued endowment is taxed.

- **Individual Reward**:

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

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

- **Collective Bonus**:

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

where B_i is bonus from pool distributed to top 2 contributors.[1]

5.5 Sample Size and Power Analysis

Based on established experimental economics standards and power calculations:

$$n = \frac{(Z_{\alpha/2} + Z_\beta)^2 \times 2\sigma^2}{\delta^2} \qquad (6)$$

where:

- $\alpha = 0.05$, $\beta = 0.20$ (power = 80%)

- σ = expected standard deviation based on previous studies

- δ = minimum detectable effect size (medium: 0.5)

For our main study: 120 participants (24 groups of 5) provides adequate power for detecting medium effect sizes in within-group comparisons.

5.6 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

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[1]If all contributions are equal, the bonus gets divided equally between all participants.

6 Expected Results and Analysis Strategy

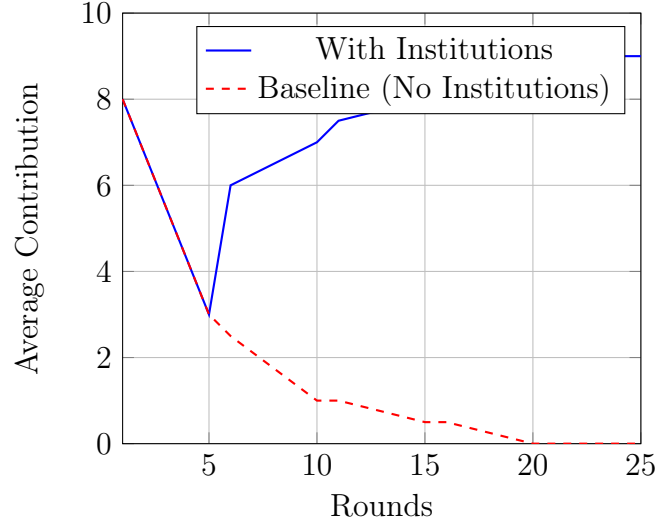## 6.1 Expected Contribution Patterns

Figure 2: Expected Contribution Trajectories

6.2 Analysis Strategy

1. **Descriptive Analysis**: Contribution patterns, voting frequencies, earnings distributions

2. **Hypothesis Testing**:

   - H1: Logistic regression on first voting choice

   - H2: Mixed-effects models comparing efficiency across institutions

   - H3: Transition probability matrices and Markov chain analysis

   - H4: Learning models with experience-weighted attraction

3. **Efficiency Analysis**:

$$\text{Efficiency} = \frac{\text{Actual Total Earnings}}{\text{Maximum Possible Earnings}} \times 100\% \tag{7}$$

4. **Path Dependence Tests**:

$$P(\text{Retention}) = f(\text{Past Performance}, \text{Institution Type}, \text{Group Characteristics}) \tag{8}$$

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7 Limitations and Possible Extentions

7.1 Limitations

- Limited number of voting periods (4 elections)

- Monetary stakes may not reflect real-world consequences

- Potential order effects in institutional presentation

7.2 Future Extensions

- Varying group sizes

- Introducing institutional cost differentials

8 Conclusion

This 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.

References

Fehr, E. and S. Gächter (2000). Cooperation and punishment in public goods experiments. *American Economic Review 90*(4), 980–994.

Isaac, R. M. and J. M. Walker (1988). Group size effects in public goods provision: The voluntary contributions mechanism. *The Quarterly Journal of Economics 103*(1), 179–199.

Sefton, M., R. Shupp, and J. M. Walker (2007). The effect of rewards and sanctions in provision of public goods. *Economic Inquiry 45*(4), 671–690.

Tao, Y., J.-J. Wu, L. Wang, W.-B. Zhang, Y. Sun, M. J. Gelfand, A.-N. Li, B. Li, B. Wang, J. Chen, et al. (2016). The dynamics of human behavior in the public goods game with institutional incentives. *Scientific Reports 6*, 28809.