

Learning Dynamics for Mechanism Design: An Experimental Comparison of Public Goods Mechanisms¹

Paul J. Healy²

Abstract

In a repeated-interaction public goods economy, incomplete information and dynamic behavior may affect the realized outcomes of mechanisms known to be efficient in a complete information one-shot game. An experimental test of five public goods mechanisms indicates that subjects with private information appear to best respond to recent observations. This provides predictions about which mechanisms will generate convergence to their efficient equilibrium allocations. These predictions match the experimental result that globally stable efficient mechanisms realize the highest efficiency in practice. The simplicity of the suggested best response model makes it useful in predicting stability of mechanisms not yet tested. *Journal of Economic Literature Classification Numbers: C72, C91, D83, H41.*

Key words: Mechanism design, experiments, best response, public goods, dynamics.

1 Introduction

Many mechanisms have been identified whose equilibria generate efficient allocations in economies with pure public goods. In general, mechanisms that require stronger equilibrium concepts are more restricted in their ability to select desirable outcomes. Theoretical results are unclear about how these trade-offs should be resolved in practice. For example, consider an environment where

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² Division of the Humanities and Social Sciences, California Institute of Technology, Pasadena, CA 91125. Email: pj@hss.caltech.edu. Telephone: (626) 395-4096 Fax: (626) 405-9841

agents have little to no information about each others' preferences and the level of a certain public good is to be re-evaluated at regular intervals. If a social planner were asked to choose a particular mechanism in this setting, which would she prefer? Are dominant strategy equilibria necessary in this environment? Will mechanisms with stable Nash equilibria converge quickly to an efficient outcome, even though preferences are private information?

In the current paper, five public goods mechanisms with various equilibrium properties are experimentally tested in a repeated game setting.¹ Specifically, the Voluntary Contribution, Proportional Tax, Groves-Ledyard, Walker, and Vickrey-Clarke-Groves mechanisms are all compared in an identical laboratory environment.² The goal of this research is to compare behavior across mechanisms and identify a simple learning dynamic that approximates actual behavior and correctly predicts when actions will converge to the efficient equilibria. Armed with this information, the social planner will then be able to select a mechanism whose desirable equilibrium properties should be realized in practice.

Previous experimental studies have concluded that learning dynamics play an important role in the repeated play of a mechanism. Two general observations suggest that behavior may be consistent with a learning model based on some form of best response play. First, convergence is observed only in game forms known to be supermodular, where best response play predicts convergence. Second, tests of dominant strategy mechanisms suggest that agents tend to play weakly dominated strategies that are best responses to previously observed strategy choices.³ Motivated by these observations, the current paper develops a simple model of best response play and finds that its predictions well approximate observed subject behavior.

The key six results of this study are as follows.

- (1) Subject behavior is well approximated by a model in which agents best respond to the average strategy choice over the last few periods. This model is shown to be significantly more accurate than the stage game equilibrium prediction.
- (2) Half of all decisions in the cVCG mechanism are at the demand-revealing dominant strategy point, while the remainder cluster around weakly dom-

¹ This is, to the author's knowledge, the largest set of public goods mechanisms to be tested side-by-side to date.

² The cVCG mechanism refers to the Vickrey-Clarke-Groves mechanism in cases where the level of the public good is selected from a continuum. In contrast, the Pivot mechanism refers to the VCG mechanism when the public project choice is binary. The details of all five mechanisms appear in Section 5.

³ An overview of previous results is provided in the Section 2 of this paper, as well as in a survey by Chen [9].

inated best response strategies that are payoff-equivalent to the dominant strategy prediction.

- (3) Behavior in the Groves-Ledyard and Voluntary Contribution mechanisms converges close to equilibrium.
- (4) Behavior in the Proportional Tax and Walker mechanisms does not systematically converge.
- (5) Because of the stability results, the cVCG mechanism is found to be the most efficient. The instability in the Walker mechanism often leads to payoffs below that of the initial endowment.
- (6) Finally, most strategy profiles observed to be stable or asymptotically stable are approximately equilibrium strategy profiles.

Note that the model presented in result 1 successfully predicts results 2 through 6. This indicates that the model is a reasonable and tractable tool for predicting subject behavior and convergence properties of public goods mechanisms.

A brief overview of the previous experimental literature is given in the next section. The learning model and its testable implications are then introduced in Section 3. Details of the experimental design are outlined in Section 4 and a complete description of each mechanism in use is given in Section 5. Results and data analysis appear in Section 6, and Section 7 offers concluding remarks.

2 Previous Experiments

This section briefly summarizes previous experimental results on public goods mechanisms. One theme spanning these results is that behavior is, at least qualitatively, consistent with a model of best response play. This observation partially motivates the construction of the particular class of best response models in the following section.

The earliest studies of public goods provision have focused on the Voluntary Contribution mechanism. A wide variety of specifications and treatment variables have been examined, and this line of research continues to generate interesting results about preferences and behavior. A comprehensive summary of this literature is provided by Ledyard [23], who concludes that “in the initial stages of finitely repeated trials, subjects generally provide contributions halfway between the Pareto-efficient level and the free riding level,” and that “contributions decline with repetition.” For example, in an early paper by Isaac, McCue & Plott [20], payoffs drop from 50% of the maximum in the first period to 9% by the fifth period. Strategies quickly converge toward the free-riding dominant strategy through repetition.

In the decades since the theoretical development of public goods mechanisms

