Journal of Economic Behavior & Organization 126 (2016) 102–119

Contents lists available at ScienceDirect

Journal of Economic Behavior & Organization

journal homepage: www.elsevier.com/locate/jebo

Voluntary participation in public goods provision with Coasian bargaining☆

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ARTICLE INFO

Article history:
Received 16 April 2014
Received in revised form 16 August 2015
Accepted 24 February 2016
Available online 10 March 2016

JEL classification:
C91
D71
D83
H41

Keywords:
Coase Theorem
Voluntary participation
Public goods
Laboratory experiments

ABSTRACT

This paper reports findings from an experimental study of voluntary participation games, as considered by Dixit and Olson (2000). The voluntary participation game consists of two stages: a non-cooperative participation decision followed by Coasian bargaining on public goods provision only among those who choose to participate. Our experimental findings show that, consistent with the theoretical findings of Dixit and Olson, the outcome of this game falls short of full efficiency. However, we find that voluntary participation undermines the Coase Theorem to a lesser extent than predicted by Dixit and Olson, particularly with larger numbers of players. We also investigate the effect of pre-play communication on the public goods provision and find little evidence that cheap talk helps subjects coordinate on the efficient outcome of coalition formation in the laboratory.

1. Introduction

Does voluntary participation undermine the efficient provision of public goods? In this paper, we investigate voluntary participation in a public goods provision game and report findings from a series of laboratory experiments. The international arena of climate negotiation showcases the importance of voluntary participation in public goods provision. In the absence of an international government, the world has to rely on countries' voluntary participation in climate treaties to resolve the climate problem. For instance, the Kyoto Protocol may be an effective mechanism to provide a global public good – the abatement in greenhouse gas emissions – if all of the main emitters opt to commit to it. To successfully enact the Protocol, two conditions must be met: (1) at least 55 parties must ratify it and (2) those parties that are listed in Annex I of the

☆ We would like to thank Hanghui Zhang for helpful discussions and inputs on data analysis, and Timothy Cason, Qu Feng, Wei-Torng Juang, Junjian Yi and conference and seminar participants in CEANA-TEA Joint Sessions of 2012 TEA Annual Meeting and Kochi University of Technology for helpful comments. We are also grateful to the Co-editor Dirk Engelmann, the Associate Editor Ananish Chaudhuri and an anonymous referee for their insightful comments and suggestions that greatly improve the paper. We gratefully acknowledge financial support provided by Shanghai University of Finance and Economics and a start up grant of Nanyang Technological University.

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http://dx.doi.org/10.1016/j.jebo.2016.02.009
0167-2681/

Protocol and have ratified it must account for at least 55% of the total carbon dioxide emissions at the 1990 level for the Annex I countries. The "55 parties" clause was satisfied when Iceland ratified the Protocol, and the ratification by Russia satisfied the "55%" clause. The United States, the largest emitter of greenhouse gases in Annex I, however, did not ratify the Kyoto Protocol. Without the participation of the United States, the climate treaty had little chance of successfully addressing the climate problem.

Several recent papers conduct theoretical investigations into voluntary participation in public goods provision. Saijo and Yamato (1999) consider a two-stage game in which a first stage voluntary participation is followed by a mechanism in the second stage satisfying several desirable properties such as non-emptiness, feasibility, symmetry, and Pareto efficiency for participants. They show that the most efficient outcome with the participation of all agents is often not supported by an equilibrium. Saijo and Yamato (2010) extend the model and show an impossibility theorem of full participation. In their influential paper, Dixit and Olson (2000) look at the mixed strategy participation equilibrium of a similar game with a lumpy public good.[1] In the second stage of their model, participants engage in Coasian bargaining to determine whether or not to provide the public good. Dixit and Olson primarily rely on simulations to support the claim that voluntary participation undermines the Coase Theorem (Coase, 1960): public goods are unlikely to be provided if the provision of public goods relies solely on the voluntary participation choices of individuals. Shinohara (2009) uses a similar model to demonstrate the existence of refined pure strategy Nash Equilibria with an efficient allocation.

The main purpose of this paper is to study experimentally the role of voluntary participation in a public good game. Although Saijo and Yamato (1999, 2010) mainly provide results on the impossibility of full participation, we aim to provide a quantitative insight on the participation level. In particular, we make heavy use of Dixit and Olson (2000).[2] Starting from the model considered by Dixit and Olson (2000), we first obtain some additional analytical results with new findings regarding the mixed strategy participation equilibrium. We then propose and conduct laboratory experiments to test the results from both Dixit and Olson (2000) as well as our own additional analysis, and investigate whether voluntary participation really undermines the Coase Theorem.

Our baseline treatment consists of two games with different group sizes ($N = 4$ and $N = 8$). This choice allows us to investigate how the group size affects participation. Controlling for the group size is of importance since Dixit and Olson (2000) are particularly pessimistic about the outcome when the group size is large. Olson (1965) argues that a public good would be provided more easily for a smaller group than for a larger one. Several papers (e.g., Harrington, 2001; Heijnen, 2009) follow up by theoretically examining the possibility that a failure in public goods provision occurs more often when the number of players involved increases. In reality, likewise, it was argued that a smaller group of countries might have a better chance of achieving a successful climate agreement, before the Copenhagen negotiations took place in 2009. However, the experimental economics literature on voluntary contribution mechanisms (VCM) provides different insights about the effect of group size on public goods provision. For instances, Isaac and Walker (1988a) find that allocative efficiency decreases in group size when marginal per capita return (MPCR) also declines, while there is no a pure numbers-in-the-group effect when MPCR is kept constant; Isaac et al. (1994) find that larger groups may even provide public goods more efficiently. Different from these VCM games where contribution is a dominated strategy as in a prisoner's dilemma, participation is not a dominated strategy in our coalition game with Coasian bargaining, which is essentially a coordination game.

The experimental data from our baseline games show that the average frequency of participation decreases with the number of players, as predicted by Dixit and Olson (2000). Furthermore, consistent with the theoretical predictions, the observed outcomes of the baseline games fall short of full efficiency. However, we find that the voluntary participation undermines the Coase Theorem to a lesser extent than that predicted by Dixit and Olson (2000), particularly for the larger group size ($N = 8$). The "over-participation" of individual subjects is stronger in larger groups; the frequency of coalition formation (or equivalently, frequency of public goods provision) is significantly higher when $N = 8$ compared to the frequency of coalition formation when $N = 4$.

We demonstrate that risk-aversion increases the probability of the successful provision of public goods in the mixed strategy participation equilibrium characterized by Dixit and Olson (2000).[3] Our finding is in line with several experimental studies showing that individuals are typically risk averse in the laboratory. Using the maximum likelihood method, we estimate the degree of risk-aversion in each treatment and find that a reasonable degree of risk-aversion is able to explain the pattern of "over-participation" observed in the lab. This result highlights that the pessimistic point of view by Dixit and Olson (2000) might be due to the fact that they assume risk-neutrality. Meanwhile, *conditional participation*, that is, subjects' higher likelihood of participation if they believe more others will participate, seems to contribute to the higher frequency of coalition formation when $N = 8$.

[1] A public good is said to be lumpy if no amount of the public good can be provided until the total contributions exceed some threshold (Taylor, 1987).

[2] We focus on the one-shot version of the game in Dixit and Olson (2000). They also characterize infinitely repeated plays of the game, which lies beyond the interest of the current paper.

[3] In contrast to this result, Teyssier (2012) shows that risk-aversion reduces contributions in a public good game with strategic uncertainty. The strategic uncertainty in Teyssier (2012) comes from the fact that first movers are unaware of second movers' actions in sequential contributions. In Dixit and Olson (2000), strategic uncertainty is created by mixed strategies of simultaneous participation decisions.