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Analysis

Improving Environmental Quality Through Aid: An Experimental Analysis of Aid Structures With Heterogeneous Agents[☆]

Paul E. Chambers[a,*], E. Glenn Dutcher[b], R. Mark Isaac[c]

[a] Department of Economics, University of Central Missouri, Warrensburg, MO 64093, United States
[b] Ohio University, United States
[c] Florida State University, United States

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ABSTRACT

Environmental aid has grown significantly over the past decade with aid allocation mechanisms varying greatly and little guidance as to which should be preferred. To increase aid effectiveness, some have argued that potential recipients should compete for aid. We experimentally test this proposition against a baseline treatment where groups of heterogeneous agents receive aid by improving environmental quality. With the first mechanism, aid is allocated based on the improvement of environmental quality by each group with the potential of multiple groups receiving aid. In the second mechanism, aid is competitively allocated only to the single group that has initiated the greatest improvement of environmental quality. Surprisingly, the average level of environmental progress is lower in a competitive setting than in the setting with the potential for multiple recipients. Underscoring this result is our finding that environmental progress is stable in the baseline but begins high and falls quickly with repetitions in the competition. Although the initial level of progress is higher on average in the competitive setting, this mechanism generates the highest variance which could be catastrophic to sensitive ecosystems. These findings have direct implications on which mechanism the granting agency should use dependent upon their specific objectives.

1. Introduction

Environmental aid increased from $10 billion per year in the early 2000s to approximately $15 billion per year in the late 2000s (Marcoux et al., 2013). Although there has been sizable growth in environmental aid expenditures, significant gaps still exist in the literature on how aid allocation structures can improve the effectiveness of environmental aid (Hicks et al., 2008). Multiple studies have shown that ex-ante designation of the recipient can lead to unintended consequences and/or greatly reduce the effectiveness of the aid (e.g. Kanbur et al., 1999; Chambers and Jensen, 2002; Svensson, 2003; Clark et al., 2005). To circumvent this issue, Svensson (2003) and Epstein and Gang (2009) have proposed aid tournaments as a way to increase incentive compatibility of the allocation process.[1] In lieu of distributing aid to ex-ante designated recipients, aid tournaments are meant to increase the efficiency of disbursement by rewarding actual reforms. In these aid tournaments, potential recipients compete for aid where the criterion for aid distributions is based on a positive performance variable such as pollution abatement, reforestation, energy efficiency or sustainable fishery practices.

Zinnes (2009) evaluates numerous performance based aid allocation mechanisms, which are referred to as prospective inter-jurisdictional competition (PIJC). Contrasting with inter-jurisdictional competition which may yield a race to the bottom, the structure of PIJC is specifically designed to yield a race to the top. Kunce and Shogren (2005) provide an example of an inter-jurisdictional competition which yields an environmental race to the bottom. Within the PIJC framework, competitive and non-competitive mechanisms are compared.[2] Zinnes notes that no mechanism clearly dominates; however, in the field settings examined, many confounds could exist disallowing a simple

[☆] This work was funded by the University of Central Missouri.
[*] Corresponding author.
E-mail address: pchambers@ucmo.edu (P.E. Chambers).
[1] See also Gardner and Waller (2005) who argue that aid tournaments can prevent the worst effects of the principal-agent problem associated with the Samaritan's dilemma.
[2] Various mechanisms are evaluated: pure tournaments with N multiple winners where the number of winners is preannounced, benchmark certification which acts as a signaling device for potential donors, pecuniary certification which in addition to the benchmark certification includes a tangible reward and mixed tournaments that have N winners with pecuniary certification for the weaker performers.

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comparison of the allocation mechanisms.[3] Also, absent from the work of Zinnes is the analysis of the possibilities of negative aspects from the tournament approach. Thus, it is still unclear how the suggested competitive structure affects behavior of recipient groups enacting the environmental reforms. Our paper provides insight into this issue by isolating outcomes of competitive versus non-competitive aid structures. We focus on aid meant to foster the provision of global and regional collective environmental goods (non-rivalrous and non-excludable) such as ecosystems and how the aid structure affects these provisions. The aid structure may have significant and distinct impacts on ecosystem health depending on resilience of the ecosystem. Resilience of an ecosystem may be defined as the capacity to absorb disturbances and reorganize while still maintaining the same functionality (see Holling, 1973; Gunderson and Holling, 2002; Walker et al., 2004). Ecosystems with low resilience are subject to catastrophic shifts and large losses of ecological resources (Scheffer et al., 2001).

At the core of the arguments outlining the benefits for the different allocation mechanisms is a simple theoretical framework. To get a clean first estimate of how human actors behave in such a simple setting, we rely on laboratory experiments. We believe our incentivized experiments provide a first estimation on such behavior where our results are obviously limited to the theory we are testing. More complex environments will dictate how the theory must be adjusted, but our goal is to provide the basis for such adjustments to be made. Our focus is on how potential recipients respond to the two allocation mechanisms along three dimensions: the average effect, the evolution of behavior over time and the variance in behavior. All three of these dimensions are important for the aid agency, depending on their goals, which implies we are not trying to determine which is absolutely better, but rather providing a richer context into *when* one may be preferred over the other. In constructing the experimental design, we take advantage of the simplicity of the conditions allowed in an experimental setting. This simplicity is an important component for causation to be established. We rely on a group setting because aid is typically given to groups based on their coordinated efforts toward reform actions; i.e., an individual decision maker is less likely to be the relevant agent to enact environmental reforms given the broad scope of the problem. Thus, the experimental setting can be summarized as follows: groups, comprised of heterogeneous individuals, provide a common good (e.g., the protection of biodiversity, pollution abatement) through collective group effort. This collective group effort can be rewarded by the aid agency to the group either through a competitive or non-competitive process.

Because of the nature of the problem, there is an obvious incentive to free-ride given that the reward is given to the entire group. But, since we are using groups comprised of (more realistic) heterogeneous agents, free-riding behavior in our setting is much different than in the classical examples (e.g., Isaac and Walker, 1988).[4] With this setting, we are able to explore whether weak players rely more heavily on strong players for the bulk of the group effort. If so, we can understand the reaction by the strong player; do they get fatigued from being taken advantage of or do they accept their role and shoulder the majority of the burden? Likewise, we can also study whether the same behavioral results carry over once a competition is introduced.[5]

In our experimental design, subjects, who are heterogeneous with respect to their opportunity costs of contributions, are assigned into groups of four to play a collective good game using the Voluntary Contribution Mechanism (or VCM as outlined in Isaac and Walker, 1988). In a within subjects design, the reward for allocations to the collective good is either given in a direct manner – contributions to the collective good were directly tied to the aid given with multiple groups receiving aid – or a winner-take-all contest – the group with the highest joint contributions receiving all of the aid.

We find that average contributions to the collective good (interpreted as levels of the improvement to environmental quality) are lower in the winner-take-all contest than in the baseline. Underlying this result is the fact that the levels of environmental progress in the multiple recipient method are stable over time whereas in the winner-take-all contest, the levels of the progress starts very high but fall rapidly through repetitions. This implies that aid agencies which aim to give aid only once would do best to choose the winner-take-all contest mechanism while agencies that look to give aid on a continuous basis should consider the multiple recipient method framework keeping in mind the initial poor performance of such a mechanism. We also show that the variance is higher in the winner-take-all contest than in the multiple recipient mechanism – a finding that is especially important to regions where ecosystems have a loss of resilience and are therefore vulnerable to catastrophic shocks.

2. Experimental Design

We will first outline our procedures followed by the predictions generated by a simple model.

2.1. Procedures

The experiments were conducted at the Florida State University xs/fs lab using z-Tree (Fischbacher, 2007). During the fall semester of 2012, 112 Florida State University student subjects were recruited via the online system ORSEE (Greiner, 2004) to participate in one of 5 sessions. Including the $10 participation fee, average subject earnings were $19.72 for an experiment that lasted about an hour.

In each of the five sessions, subjects were paired with three others to make groups of four members. We utilized a within subjects design where each session consisted of alternating a baseline collective goods game (BCGG) with a winner-take-all contest (WTA). The order of play for all sessions was the same: 5 periods of the BCGG, 5 periods of the WTA contest, 5 periods of the BCGG and 5 periods of the WTA contest for a total of 20 periods. The groups were fixed within the 5 periods but subjects were randomly rematched after each treatment. Our overall design was implemented for robustness - with this design, we can make certain that if an observed effect truly exists, it is observed multiple times under varying conditions with different group members.

In the BCGG, a VCM was used where groups were comprised of heterogeneous agents who vary in their opportunity cost of contributions. In the experiment, all subjects within a group had a different optimal contribution level,[6] but the number and types of heterogeneous agents within each group was the same. Thus, each period, a subject simply had to decide how much to contribute to the group and private accounts where an in-program calculator was provided to facilitate in their decisions.[7] As is typical, contributions to the private account generated earning to only that subject while contributions to the group account benefited all in the group equally. We interpret the allocations to the group account as costly environmental reforms in order to obtain aid which is equally distributed amongst all members of the group.

The WTA contest treatment is identical to the baseline except the contributions to the group account of all groups in a session are compared and the entire prize is given to the group with the highest combined contributions. This means that tokens contributed to the group account of the non-winning groups generated no earnings. The prize

[3] See Roe and Just (2009) for a discussion on the limitations of research methodologies.

[4] Note that heterogeneity in our setting is different than in Hammond and Zheng (2013). In our setting, the average ability within the group is the same making the group composition identical.

[5] See Dechenaux et al. (2014) for a review of experimental contests.

[6] This design differs from other interior solution public goods games (see Laury and Holt, 2008) in that it addresses our research question by having the optimal allocations of members in each group vary.

[7] Due to the complexity involved in figuring out an optimal interior solution, including a calculator assuages concerns of numeracy as an explanation for the results that we observe.