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Endogenous and costly institutional deterrence in a public good experiment

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ABSTRACT

Modern societies rely on formal, central authority institutions that regulate the behavior of all members of society. This paper investigates the formation of a central authority regime within a linear public good experiment. The institution is funded by a fixed cost that increases with the level of deterrence, which is specified as the number of group members who are likely to be monitored. The level of deterrence is both exogenously and endogenously determined, allowing investigation of the effect of endogenous selection. The results indicate no significant positive endogenous selection effect. Indeed, in contrast to the existing literature, when a non-deterrent central authority is endogenously determined contributions tend to decrease.

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1. Introduction

Modern societies rely on central authority institutions to regulate behavior, enhance cooperation, and improve welfare. Such institutions are self-funded and regulate the behavior of all members of society. The rules, established through a political process, specify which behavior warrants sanction, the level of the sanction (i.e., the punishment), and the process used to detect violators. Whether individuals have an incentive to alter their behavior depends on the level of deterrence. Central authority regimes can manipulate the level of deterrence by altering the probability that a violation is observed and by altering the level of punishment. The theoretical aspects of deterrence are well understood. When the expected cost of violating the rule is greater than the benefit, the institution is deterrent, in which case it is in the self-interest of individuals to conform to the imposed rule (Becker, 1968; Stigler, 1970; Polinsky and Shavell, 1979; Ehrlich, 1996). In the case of speed limits, for example, where a fine is imposed on people caught speeding, deterrence depends on the likelihood that the police will observe someone who is speeding and the cost of the resulting ticket. A recent experiment using a roadway speeding frame suggests that the rate of speeding falls when the expected cost of doing so increases (DeAngelo and Charness, 2012).[1]

In public good experiments it is in the self-interest of subjects to avoid contributing (i.e., to free-ride). Deterrence can be introduced so that it is in subject's self-interest to contribute, by manipulating the probability that a subject's contribution is observed and the sanction that is imposed if the subject's contribution is found to be below some threshold. Research has shown that when free-riding is sanctioned with certainty, contributions rise with the level of the sanction; that is, they rise with the expected cost of free-riding (Tyran and Feld, 2006; Markussen, Putterman, and Tyran, 2013; Kamei, Putterman, and Tyran, 2015).[2]

Of particular interest is research that examines the effect of allowing self-determination (i.e., endogenous selection) of the

[1] DeAngelo and Charness (2012) also observe that speeding rates decrease when subjects are uncertain which regime is in force and that when the non-deterrent regime one voted for (against) is implemented speeding rates increase (decrease) so that the overall rate of speeding is unchanged with endogenous selection.

[2] More broadly, as discussed below, the expected cost of free-riding can be manipulated by altering the minimum level of contribution required to avoid being sanctioned or by altering who among the free-riders (all or only the worst) are subject to being sanctioned (Galbiati and Vertova, 2008; Andreoni and Gee, 2012; Kamijo et al., 2014).

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central authority within which subjects operate.[3] Results suggest that endogenous selection of a *non-deterrent* central authority institution enhances cooperation in linear public good experiments (Tyran and Feld, 2006; Markussen, Putterman, and Tyran, 2013). In both Tyran and Feld (2006) and Markussen, Putterman, and Tyran (2013) the contributions of groups that selected the given institution were compared to those that had the equivalent institution exogenously imposed; after controlling for selection effects, contributions were higher when the institution was endogenously selected. Given the ubiquity and scale of central authority institutions in modern economies, understanding the determinants of cooperation within them is an important empirical question.

The design implemented here allows another look at the effect of endogenous selection of central authority on cooperation within a linear public good experiment. The novelty of this experiment is that deterrence is costly and potentially imperfect. The level of deterrence is implemented as the probability that a subject's contribution is observed by the central authority. In contrast to the literature above, the level of the sanction is held constant and the expected cost of free-riding is altered only through the probability of being monitored. Similar to the real world, the central authority may monitor imperfectly, sometimes failing to observe the contributions of those who free-ride.

Further, in our design the fixed cost of the institution rises with the level of deterrence. In the related public goods literature there is no relationship between the level of deterrence and the fixed cost of the institution. Here, subjects must accept a lower level of deterrence in order to lower the fixed cost of the institution. This provides all subjects, or groups, with an incentive to maintain cooperation at lower levels of deterrence, and is realistic because in the real world additional monitoring is costly. This is important because the fixed costs of central authority institutions impose costs on society. In the speed limit case, for example, the cost of monitoring drivers' speed and maintaining related judicial system capabilities must be covered regardless of driver behavior.

Our experiment includes three treatments that differ in the per-subject monitoring cost. Within each treatment the level of deterrence is first exogenously and then endogenously determined. Thus we are able to observe the effect of deterrence on contributions and the effect of endogenous selection on contributions within subject. Two main results are presented. First, contributions rise, at a decreasing rate, as the expected cost of free-riding increases. There is no significant increase in contributions beyond a weakly deterrent level of monitoring. Second, there is no indication that the endogenous selection of non-deterrent levels of monitoring increases contributions relative to when the monitoring is exogenously imposed.

2. Background and literature

Individuals within groups are often faced with social dilemmas, where behavior consistent with their self-interest contrasts with the group's interest. For example, public goods are non-excludable and non-rival; it is not feasible to restrict anyone from using the good once it is provided and one person's use does not detract from another's use. Economic theory predicts that when faced with the social dilemma that public goods present, individuals will attempt to free-ride and enjoy the benefits of the public good without contributing to its provision.

To investigate this prediction, public good experiments often employ a linear Voluntary Contributions Mechanism (VCM). In a standard VCM game each subject in a group is given a fixed endowment of experimental currency (herein referred to as experimental dollars, EDs) which can be allocated between a private account and a group account. Individual allocations to the group account are referred to as contributions. The return from the private account accrues only to the individual, while the return from the group account depends on the group's aggregate allocation and is equally distributed across the individuals in the group. The payoff (π) to group member i can be described as follows:

$$\pi_i = (e - x_i) + \alpha \sum x_j$$

where x_i is the member's contribution to the group account, e is the endowment (constant across all group members), α is the marginal per capita return (MPCR) from the public good, and Σx_j represents the sum of contributions to the group account from all group members. With n players, $(\frac{1}{n}) < \alpha < 1$ and a known last period, there is a unique Nash equilibrium such that each individual contributes nothing to the group account, that is, free-rides. On the other hand, the social optimum requires that each subject contribute their entire endowment to the group account. The literature on public goods has established that initial contributions tend to be roughly half of one's endowment and decline with repetition (Ledyard, 1995; Davis and Holt, 1992).

2.1. Central authority institutions

To investigate behavior within central authority institutions, consider the following payoff function:

$$\pi_i = (e - x_i) + \alpha \sum x_j - c - ps(e - x_i)$$

where the first two terms repeat the linear public good formulation presented earlier, c is the fixed cost of implementing the formal institution for each group member, s is the level of the sanction, and p is the probability of being monitored. The sanction is often proportional to the deviation from the social optimum contribution $(e - x_i)$, although this need not be the case. Regardless of the exact functional form, the intuition of this literature is that a deterrent institution will alter incentives such that it is in an individual's self-interest to contribute to the public good. For example, in the above payoff function if $ps > 1 - \alpha$ the expected cost of free-riding is strictly greater than the benefit and the institution is deterrent.[4]

Beyond this basic intuition there are many ways to implement a central authority mechanism. For example, Galbiati and Vertova (2008) investigated the impact of an exogenously imposed minimum contribution (x_o) required to avoid being sanctioned. Across treatments, x_o was either 2/5 or 4/5 of the endowment. Contributions were monitored with low probability ($p = 1/12$) and the sanction ($s = 1.2$) was a function of one's deviation from the minimum obligation ($x_o - x_i$). The institution at either level of x_o was non-deterrent, but for any given contribution the expected sanction was greater in the high x_o treatment. Relative to a no minimum VCM baseline, the low x_o had no effect on contributions and the high x_o increased contributions (Galbiati and Vertova, 2008).

[3] Dal Bo, Foster, and Putterman (2010) consider the adoption of an institution that transforms a standard prisoner's dilemma game into acoordination game. Results suggest that endogenous selection increases cooperation, an effect referred to as an *Endogeneity Premium* (Dal Bo, Foster, and Putterman, 2010). Sutter, Haigner, and Kocher (2010) allow groups to supplement a public good experiment with either a peer punishment or reward mechanism. Relative to an exogenously imposed baseline, contributions are higher if either the punishment or reward mechanisms are endogenously selected and is referred to as a *Democratic Participation Rights Premium* (Sutter, Haigner, and Kocher, 2010).

[4] These characteristics of a central authority are in contrast to peer punishment mechanisms which include no fixed costs and are only costly when subjects employ the punishment. Public good experiments with peer punishment allow each subject to observe the contributions of their group members and to pay a fee in order to sanction them. Peer punishment has been shown to enhance cooperation and earnings (Fehr and Gächter, 2000; Fehr, Fishbacher, and Gachter, 2002). However, this is not universally observed (Chaudhuri, 2011).

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