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Sustaining cooperation in social dilemmas: Comparison of centralized punishment institutions

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ABSTRACT

This study investigates two centralized punishment institutions for a linear public goods game. These institutions require a certain contribution level and sanction under-contributing players. The two differ in who, among those who do not meet this requirement, receive sanctions. In one institution, all violators are sanctioned, and in the other, only the worst violator(s) is sanctioned. Theoretically, the public goods game of the latter institution yields contributions equal to or greater than that of the former institution with the same requirement and sanction level. The results of an experiment support this theoretical prediction. However, there is a discrepancy between the theory and laboratory observations in that the institution with the theoretically optimal requirement did not yield the highest profit.

1. Introduction

To solve social dilemma situations in which individuals' and society's interests conflict, legislators often regulate individuals' and firms' behavior using legal sanctions. Legal sanctions are intended to ensure the compliance of individuals and firms through appropriate incentives. Therefore, in designing a public policy to sustain cooperation in social dilemma situations, it is important to understand how people react to legal sanctions and how effective different legal sanctions are in achieving social interests.

In the standard model of legal sanctions proposed by Becker (1968), a potential offender compares the benefit of a criminal act with the expected loss, multiplying the conviction probability by the punishment disutility (fine, imprisonment, exclusion, etc.). If the former dominates the latter, he or she commits the crime. Becker's model has been applied to tax evasion and the public goods game in a wide variety of studies on legal sanctions. For example, studies have analyzed the severity and probability of punishment, both of which directly influence the effectiveness of legal sanctions (e.g., Alm and McKee, 2006; Anderson and Stafford, 2003; Friedland et al., 1978; Grogger, 1991); social norms and social interactions, which indirectly influence the effectiveness of legal sanctions (e.g., Cooper, 1998; Fortin et al., 2007; Kahan, 1997; Lopez et

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al., 2012); and non-deterrent sanctions (e.g., Galbiati and Vertova, 2008a, 2008b; Kube and Traxler, 2011; Tyran and Feld, 2006).

Following the convention of the institutional analysis of economic regulations, centralized institutions impose two factors: a required level of performance and a fine. Ideally, all individuals who violate the rule will be punished. However, in reality, this does not hold in many cases. For example, enforcement agencies' resources are often constrained, causing congestion in law enforcement. The result is that law enforcement is restricted if there are too many people violating laws, and only some offenders can be apprehended and punished. For example, a police officer faced with several speeding cars cannot punish all of them, and will probably have to settle for pulling over only the worst offenders.

In this study, we examine the effectiveness of two types of centralized institutions. The first type represents the ideal of total enforcement, and is characterized as an *absolute punishment institution*. The second type exhibits limited enforcement, and is characterized as a *relative punishment institution*. In an absolute punishment institution, all individuals whose contribution is less than the required threshold pay a fine. The same is true in a relative punishment institution, except that only the lowest contributors are punished. In the latter case, whether one is punished depends on the degree of violation, as compared to others who have violated the laws. Thus, relative punishment institutions can be viewed both as absolute institutions with limited enforcement, and as institutions intentionally structured to use the strategic interdependence among violators (e.g., cartel leniency policy). In addition, enforcement is easier for a relative punishment institution than it is for an absolute punishment institution.

Much of the literature on centralized punishment in public goods games has focused on proportional penalties, in which the severity of the punishment increases with the degree of the violation (e.g., Galbiati and Vertova, 2008a, 2008b; Putterman et al., 2011). However, this study investigates fixed penalties, in which the severity of the punishment is constant and does not depend on the degree of the violation. There are three reasons for our focus on fixed penalties. First, legal sanctions with a fixed penalty are used in practice. For example, in Japan, the fines for parking offenses, smoking in the street, and cheating on train fares are all fixed penalties. Second, a fixed penalty has the advantage of reducing law enforcement congestion, as enforcement agencies do not have to spend time identifying the degree of the offense. Finally, using fixed penalties shifts the focus of the research from marginal incentives to comparing required levels of performance and fines. This provides us with a simpler framework for comparing different punishment schemes.

A limited number of experimental studies have considered centralized punishment institutions that are strategically interdependent in terms of whether a violator is punished. For example, Yamagishi (1986) and Andreoni and Gee (2011, 2012) analyzed centralized punishment institutions in which the lowest contributor is punished.[1] In Yamagishi's institution, the lowest contributor is penalized by an amount equal to all players' voluntary investments to the punishment fund. In the two studies by Andreoni and Gee, the institution punishes the lowest contributor in such a way that their profit is slightly lower than that of the second lowest contributor. In these three studies, institutions have strategic interdependencies, not only on whether players are punished, but also on the severity of the punishment. However, our relative punishment institutions are only strategically interdependent in terms of whether players are punished. This is because, in reality, the level of punishment is often predetermined.[2]

In this study, we control for the level of the requirement. Here, we theoretically and experimentally analyze two punishment institutions that differ in how they determine who is punished in a social dilemma situation. Theoretically, we find that, when the sanction is deterrent, it is a Nash equilibrium strategy to contribute what is required in both institutions. In contrast, when the sanction is non-deterrent, it is a dominant strategy to not contribute in absolute punishment institutions, but there is a mixed-strategy Nash equilibrium to contribute a positive amount in relative punishment institutions. In addition, we obtain the optimal requirement for both institutions.[3] Experimentally, we find that the average contributions and profits are similar in the two punishment institutions when the sanction is deterrent, but are higher in the relative punishment institution when the sanction is non-deterrent. Thus, the observations from the laboratory experiments supported the theoretical results. However, there is a discrepancy between the theory and laboratory observations in that the institution with the theoretically optimal requirement did not yield the highest profit. Taken together, we conclude that the relative punishment institutions yield the same or higher level of performance in the associated public goods game as the absolute punishment institutions.

Our results have two useful implications. First, they imply that switching from an absolute punishment institution to a relative punishment institution may make non-deterrent sanctions more effective. Second, our results for relative punishment institutions may explain why people obey laws backed by non-deterrent sanctions. Kube and Traxler (2011) explained this point by claiming that centralized sanctioning is often supported by decentralized sanctioning,

[1] Qin and Wang (2013) studied an institution similar to a relative punishment institution, in which the lowest contributor is punished with some probability. Their experiment manipulated apprehension probabilities. When the probability is 100%, their institution is equivalent to a relative punishment institution with a requirement of a whole endowment. The exception is the tie-breaking rule: in their institution, when there is more than one lowest contributor, the tie is broken randomly, whereas in our mechanism, all lowest contributors are punished. Their experimental results were in line with our observations for relative punishment institutions.

[2] Generally, in the established law of a modern nation, the content and level of punishment for a criminal act are determined in advance (principle of legality).

[3] The two institutions share the same optimal requirement, which is determined by the marginal value such that, if the required contribution is beyond this value, individuals have no incentive to comply with the regulation.