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COMBINING MONETARY AND SOCIAL SANCTIONS TO PROMOTE COOPERATION

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We employ an experimental approach to consider the impact of a combination of formal and informal sanctions on contribution levels for a specific type of public good. We find that when both sanctions are available, contributions and overall welfare are higher than when only one of the two sanctioning systems is available. The availability of an array of sanctions of varying severity appears to enhance welfare. (*JEL* C92)

I. INTRODUCTION

When externalities are present, private self-interest and overall group welfare may be at odds, with individuals having incentives to take actions that lower overall group payoff. Examples of situations of interest to economists where tension between individual and group-level incentives arises include cartel agreements, negative externalities from pollution, depletion of a common pool resource, and the private provision of public goods. In such cases, there are potential overall welfare gains from the creation of a social norm[1] and the imposition of a sanctioning system that penalizes behavior that deviates from the norm and imposes costs on the group.[2] The sanctions are intended to lower the return on self-interested behavior and increase the incentive to follow the behavioral norm.

Frequently observed types of sanctions that impose tangible costs of money or time on offenders include fines, incarceration, and economic boycotts. In this article we refer to sanctions where the cost is tangible to the punished actor as *formal* sanctions. Although such formal punishment systems can create strong incentives to behave in the group interest, one of their potential drawbacks is that it costly to apply the sanction to enforce the system. Both sanctioned offenders and those who pay for the process that imposes the sanction bear the cost. If the marginal benefit to the group from the increase in cooperative behavior does not more than offset the deadweight loss of implementing the sanction regime, the sanctioning system is inefficient.

As in Blau (1964), sanctions can also be informal in nature. In this article, we use the term *informal sanctions* to refer to penalties that do not impose tangible costs on the offender, though they may decrease his or her utility. Informal sanctions such as social disapproval, ostracism, gossip, peer pressure, or public embarrassment of offenders are often applied to try to alter behavior and in many cases appear to be effective.[3] These

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1. Coleman (1990) characterizes this situation as the existence of demand for a behavioral norm. See Elster (1989) for a discussion of the origins and benefits of social norms.

2. Several economic models have investigated the consequences of social pressure on economic behavior. See, for example, Akerlof (1980) and Lindbeck et al. (1999). Elster (1989) distinguishes between guilt, an internal type of pressure and shame, an external type of social pressure, as forces promoting prosocial behavior. Labor economists, such as Kandel and Lazear (1992) and Barron and Gjerde (1997), have modeled the effect of peer pressure on team output.

3. See Homans (1961) for a discussion of the role of sanctions in enforcing social norms.

ABBREVIATIONS

BP: Bother Punishments
MP: Monetary Punishment
NP: Nonmonetary Punishment
VCM: Voluntary Contributions Mechanism

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sanctions may originate with a public authority or with private individuals or organizations. They may be well organized or arise spontaneously. Such sanctions are typically not costly to apply. However, to be successful, they require offenders to exhibit changes in behavior in response to the sanction, an assumption that is more questionable with informal than with formal sanctions.

There are many examples in the field where both formal and informal sanctions are used in tandem to attempt to deter behavior that is viewed as antisocial, suggesting that informal sanctions have an additional benefit, even when a formal sanction is in effect. For example, policies against drug abuse, drunk driving, littering, and selling cigarettes to minors include formal official legal restrictions as well as informational campaigns designed to create an informal sanction against those breaking the law. In corporations and academic institutions, failure to perform a level of service activities viewed as appropriate may be penalized financially with lower salary increases or denial of promotion, but may also engender expressions of disapproval and a degree of social ostracism. In organizations such as the military and at some academic institutions, honor codes exist that can coincide with formal policies. One reason that these institutions label cheating and theft as honor code violations may be to create a social prohibition against them in addition to the explicit penalties in force. The publishing of the police crime blotter in local newspapers creates embarrassment for offenders in addition to any legal penalties they face. Tyler (1990) argues that social pressure, rather then the prospect of being penalized for noncompliance, is the major reason that laws are obeyed.

In this article, we report the results from a simple experiment that demonstrates that a sanctioning system combining formal and informal penalties can be more effective than a system where only one type of sanction is available. The context within which we study the power of sanctions is the Voluntary Contributions Mechanism (VCM), a game that experimental economists have extensively used to investigate the conflict between self-interest and group-interest. Each individual simultaneously selects a fraction of his or her endowment to contribute to a group account. At the group optimum, each individual contributes his or her entire endowment to the group account, whereas the dominant strategy for each player is to contribute zero. The allure of the VCM game for our study derives primarily from two of its properties. First, the game provides the researcher with a simple measure of the level of group orientation of individual decisions, the percentage of endowment contributed to the group account. Second, because an extensive literature has studied the effect of various manipulations on the level of contributions, the results can be directly interpreted within the context of a large body of research.

The experiment reported here follows and builds on previous research that studies the effect of sanctioning systems on contribution levels in the VCM game. Yamagishi (1986), Fehr and Gaechter (2000), Falk et al. (2000), Sefton et al. (2000), Masclet et al. (2003), and Bowles et al. (2001) all find that when a structure exists for agents to reduce the monetary payments to low contributors, agents will use the sanctioning system, even when the sanctioner bears some of the cost. Average contribution levels rise sharply when monetary sanctions are available. Gaechter and Fehr (1999), Rege and Telle (2001), and Masclet et al. (2003) have shown that informal sanctions, allowing individuals to display approval and disapproval of other group members' decisions, can also increase contribution levels and earnings.[4]

The question we consider herein is whether the simultaneous availability of *both* monetary and nonmonetary sanctions can generate higher overall welfare than either type on its own. Each type of sanctioning system increases contribution levels and welfare, but formal and informal sanctions each offer some advantages over the other system. The principal advantage of informal mechanisms is that they are of low cost to apply. On the other hand, formal

4. Gaechter and Fehr (1999) report questionnaire data indicating that cooperation and free riding trigger a high degree of approval and disapproval, respectively. Also, in an experiment in which familiarity between subjects is created before they play the VCM game, contributions are revealed publicly, and discussion takes place after the game is played, high contribution levels are observed. Rege and Telle (2001) find that revealing the identity of each group member publicly in a way that allows him or her to be associated with his or her contribution increases average contribution levels. Hollaender (1990) and Bowles and Gintis (2001) have modeled the effect of a disutility of disapproval on contributions and obtain positive contributions as an equilibrium property.

sanctioning systems include direct and tangible penalties for violating recommended behavior and therefore arguably provide more powerful incentives for compliance. If the combined system retains favorable properties of each type of system, it may attain higher welfare than either system on its own. Under a combined system, the monetary sanction need not function both as a communication and as a punishment mechanism. When communication of disapproval is sufficient to increase contributions, informal sanctions can be employed. However, when communication of disapproval alone is insufficient to induce high contributions, the group can resort to monetary sanctions.

Our protocol is based on the experimental design of Fehr and Gaechter (2000) and is described in detail in section II. In our MP (monetary punishment) treatment, subjects may, after observing the amount each member of the group contributes, pay money from their own earnings to reduce the earnings of any group members they wish. We observe that players employ sanctions to punish free-riders even when their application is inconsistent with subgame perfection, and the existence of the sanctioning system results in large increases in contribution levels. Our NP (nonmonetary punishment) treatment is based on the NP treatment of Masclet et al. (2003), who study behavior in a game that is identical to that of Fehr and Gaechter (2000), except that the sanction imposes costs neither on the "punisher" nor on the "punished." The sanction consists of a mechanism to communicate a level of approval or disapproval, which can be thought of as a rating, of other group members' decisions. We replicate the findings of Masclet et al. (2003) that the availability of informal sanctions increases contributions. The informal sanction is fairly effective in generating high contributions, though average contributions and welfare are lower than when monetary sanctions are available.

In our BP (both punishments) treatment, the principal treatment of interest in the article, both types of sanction are available to punish other group members. We find that after several periods of play, the BP treatment generates higher average contribution levels and overall welfare than either the MP or the NP systems. Despite the fact that fewer sanctions are applied and therefore sanctioning costs are lower under BP than under MP, BP results in higher average contributions. Thus, we demonstrate, at least for our particular decision situation and class of sanctioning systems, that a combination of formal and informal sanctions is more effective than either system alone. The next section describes the design and procedures of our experiment, section II presents the results, and section IV provides a brief discussion of our findings.

II. THE EXPERIMENT

The experiment consists of nine sessions conducted at the University of Canterbury, Christchurch, New Zealand. Each treatment, MP, NP, and BP, was in effect in three of the sessions. Subjects were recruited from first-year undergraduate economics and mathematics courses. Some of the subjects had previously participated in economic experiments, but all were inexperienced with the voluntary contributions mechanism. Each subject took part in only a single session of the study. The experiment was computerized and used the z-Tree software package, developed at the Institute for Empirical Research in Economics at the University of Zurich.[5] The currency used for decisions in the experiment was called ECU (Experimental Currency Unit). Subjects' earnings were paid in New Zealand dollars (NZ$1 = US$0.4) at the end of the experiment according to a predetermined and publicly known conversion rate between ECUs and dollars. The conversion rate differed between some of the sessions but was always identical for all subjects within a session. The conversion rate ranged from 17–21 ECU = NZ$1. Sessions took approximately two hours, and subjects earned on average 390 ECU.

Each session included 12 participants that were separated into 3 groups of size 4. Group assignments remained the same for the entire session. That is, "partner" matching conditions were in effect. The computer terminals corresponding to a specific group were dispersed throughout the laboratory and subjects were randomly assigned to a group by their choice of terminal on entering the room for the session.

Each session consisted of 15 plays of the same two-stage game. We refer to each play as a period. The total number of periods in

5. See Fischbacher (1999) for a discussion of the z-Tree software package.

TABLE 1
Levels of Punishment and Associated Costs for the Punishing Subject

Punishment points: P_{ij}	0	1	2	3	4	5	6	7	8	9	10
Cost of punishment: $C(P_{ij})$	0	1	2	4	6	9	12	16	20	25	30

the session and the fact that the rules in each period of the session were identical was common knowledge. In all three treatments, in the first stage of a period, activity proceeded as follows. Each subject was endowed with 20 ECU at the beginning of the stage. Afterward, subjects simultaneously decided how many ECUs from their endowment to contribute to a group account. To do so, they entered a number between 0 and 20 in the appropriate field on their computer screen. For every ECU that a subject contributed, each of the four members of his or her group received a payment of 0.4 ECU. All ECUs from a subject's endowment that were not contributed were also paid to the subject. Contributions of all members of a subject's group were displayed on the screen without a subject identifier and in a random order that changed each period.

The second stage of the period differed between the three treatments. In all treatments, at the beginning of the second stage, the experimenter informed all subjects of the amount each of the other three members of the group contributed. Once informed of the contribution decisions of the other group members, subjects had the opportunity to assign punishment points to each group member. Because the information corresponding to other members appeared on subjects' computer screens without identification and in an order that changed each period, it was impossible to track an individual subject's contribution decision from one period to the next, or to target one specifically for punishment beyond the current period. The point allocation systems for the three treatments are described in detail next.

In MP, subjects had the opportunity to reduce the earnings of any other group members through the assignment of monetary punishment points. They could assign 0 to 10 punishment points to each of the other members of their group. Each monetary point a subject received from any other member of the group reduced his or her earnings from the first stage by 10% with a maximum possible reduction of 100%. Subjects assigning points also incurred monetary costs. Table 1 illustrates the schedule of costs, in terms of ECU, of allocating monetary points to a particular group member. The row titled Punishment points illustrates the possible range of points that subject i could assign to subject j (0–10 points). The Cost of punishment row represents the cost to subject i for the sum of monetary punishment points allocated to subject j. c_j is the contribution of subject j. Letting P_{ij} represent the points that subject i allocates to subject j, and $C(P_{ij})$ the cost of the points that i assigns to j, the total cost of monetary point allocation for subject i for a period is given by $\sum_{j=1}^{3} C(P_{ij})$. The cost schedule is the same as the one that Fehr and Gaechter (2000) and Masclet et al. (2003) employ and was common knowledge to participants.[6] In the MP treatment, subject i's earnings in a period, in terms of ECU, equaled

$$(1)\qquad E_i = \left(20 - c_i + 0.4 \times \sum_{k=1}^{n} c_k\right) \times \left(\max\left\{0, 10 - \sum_{k \neq i} P_{ki}\right\}/10\right) - \sum_{k \neq i} C(P_{ik}).$$

NP was identical to MP except that punishment points did not affect the earnings of subjects assigning or receiving points. Each subject had the opportunity to allocate 0 to 10 nonmonetary punishment points to each other group member. The nonmonetary points were described in the same manner as in Masclet et al. (2003), as representing a level of disapproval of

6. We use the same cost function for punishment that Fehr and Gaechter (2000) and Masclet et al. (2003) employ. The use of the same parametric structure as previous authors have used allows us to verify that our procedures conform sufficiently to those that previous researchers have employed to generate similar results. This allows our results to more easily be interpreted in the context of the previous literature. The willingness to punish and therefore the effect of the availability of punishment may depend on how costly it is to punish other group members.

a subject's contribution decision in the first stage. An allocation of 10 nonmonetary points corresponded to the maximum level of disapproval and 0 nonmonetary points to the minimum level.[7] Subject i's earnings in the NP treatment were equal to

$$E_i = 20 - c_i + 0.4 \times \sum_{k=1}^{4} c_k. \quad (2)$$

In the BP treatment, both the monetary and nonmonetary punishment opportunities were available to all agents. Individual i's earnings were determined by the formula in (1). The opportunity to allocate the two types of points occurred simultaneously. The rules of BP were otherwise identical to NP and MP.

In all treatments, after subjects made their punishment point allocation decisions, each subject was notified of the total number of points he or she received for the period. In all three treatments, a subject learned only the total number of points of each type that he or she had been given, and not the assignment of points from individual group members. At the end of each period in all treatments, the computer displayed a summary of results for both stages to each subject. The display included the subject's own earnings from the first stage, own total points received, own cost of points allocated (for MP), own overall earnings for both stages, own contribution, and total group contribution. Once subjects had recorded their period results on a record sheet, the computer continued to the next period. It was common knowledge that exactly 15 periods would be played. There were no practice periods at the beginning of the sessions.

7. We chose to designate the nonmonetary punishment points as indicating disapproval rather than approval, and to construct a setting where the benchmark of zero points can be expected to be associated with no disapproval, to preserve the analogy with the informal sanctions such as the examples described in the introduction. These informal sanctions are "bads" from the point of view of recipients of the sanctions. However, it may well be the case that nonmonetary "approval" and "disapproval" points would be used differently and have different effects from each other. Sefton et al. (2002) show that when agents are permitted to pay from their own earnings to increase the earnings of others after observing their contributions, the positive effect on contributions is not as strong as when agents can pay to reduce the earnings of others.

The subgame perfect equilibrium in MP is unique. In the second stage, all players assign zero points to all other players. In the first stage, all players contribute zero to the group account. The threat to punish is not credible because it is costly to the punisher, and therefore the best response in the first stage is to contribute zero. The return to an individual for each ECU contributed to the group account is 0.4 ECU, whereas the return on each ECU not contributed is 1 ECU. The equilibrium payoff for each agent is 20 ECU for a total group payoff of 80.[8]

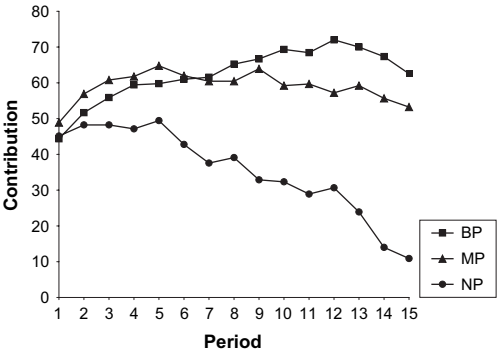
In BP and NP, there are many subgame perfect equilibria, but all of them involve zero contribution to the group account by all players. In NP, any level and distribution of point allocation in the second stage is compatible with subgame perfection because the allocation of points does not change the payoff to any player. In the first stage the best response of each player, regardless of beliefs about the second stage, is to contribute zero to the group account. In BP, any level and distribution of nonmonetary point allocation is compatible with a subgame perfect equilibrium, but only zero allocation of monetary points to each player by each player is consistent with subgame perfection. In all subgame perfect equilibria in BP, all players contribute zero ECU to the group account. Thus in both NP and BP, as in MP, each agent earns 20 ECU in equilibrium. In all three games, the socially optimal outcome can only be attained if each subject contributes the entire endowment of 20 ECU to the group account. In this event, each subject earns 32 ECU for a group payoff of 128 ECU.

III. RESULTS

The presentation of the results is divided into three parts. Section A describes the overall difference in contribution levels and welfare between the three sanctioning systems, whereas sections B and C explore patterns in the BP data. Sections B and C discuss the assignment and the effect of sanctions, respectively.

8. Fehr and Schmidt (1999) show that if some players have disutility for differences in the earnings that they and others receive, there may be subgame perfect equilibria with positive contribution and sanctioning levels in MP. The same argument also applies to BP.

FIGURE 1
Average Group Contribution Levels by Treatment



A. Treatment Effects

Figure 1 illustrates the time series of contribution levels in the MP, NP and BP treatments, averaged over the nine groups that make up each treatment. The complete group contribution data for each group and each period are given in Table A1 in the appendix. Figure 1 indicates that in period 1, before any of the sanctions could be applied, average contribution rates are similar under all three regimes, ranging between 55% and 62% of total endowment. Until period 6, average contributions are greatest in MP, followed by BP and NP. After period 6, contribution rates are highest in the BP treatment, followed by MP, and finally NP. In these later periods, the contribution rate in NP falls consistently, as the nonmonetary sanction appears to lose effectiveness over time when not backed up with a monetary sanction. In MP, the contribution rate is fairly stable over time. The difference between contribution levels in MP and BP suggests that the existence of a nonmonetary sanction increases contribution levels when a monetary sanctioning system already exists.

Table 2 contains the results of pooled variance t-tests of the hypotheses that average contribution rates are equal across treatments for the entire 15 periods, the first 5 periods, the last 5 periods, and the last period of the experiment. The unit of observation is the group, yielding nine observations per treatment, three groups in each of three sessions. In the first five periods, the average contribution is no different between any two of the three sanctioning mechanisms at the 5% level of significance. However, over the entire course of the experiment, in the last five periods alone, or in period 15 alone, average contributions are significantly higher in BP and in MP than in NP at the $p < 0.005$ level. For the same time intervals, average contributions are higher in BP than in MP, though the differences are not significant.

However, higher contribution rates do not necessarily imply higher welfare for the group. In MP and potentially in BP, the sanctioning system is costly to apply, in that punishment reduces the earnings of both the

TABLE 2
Results of Hypothesis Tests of Treatment Effects

Data Used	Treatments Compared	Average Contribution		Average Earnings	
		t-Statistic	*p*-Value	*t*-Statistic	*p*-Value
Periods 1–15	BP = NP	4.43	<0.005	1.56	<0.1
	BP = MP	0.41	Not sig.	1.04	Not sig.
	MP = NP	2.99	<0.005	0.08	Not sig.
Periods 1–5	BP = NP	0.99	Not sig.	1.27	<0.005
	BP = MP	0.51	Not sig.	0.00	Not sig.
	MP = NP	1.35	<0.1	1.25	Not sig.
Period 11–15	BP = NP	6.36	<0.005	3.51	<0.005
	BP = MP	1.23	Not sig	1.96	<0.05
	MP = NP	3.78	<0.005	0.87	Not sig.
Period 15	BP = NP	7.31	<0.005	2.81	<0.01
	BP = MP	1.00	Not sig.	1.65	<0.1
	MP = NP	5.30	<0.005	0.67	Not sig.

FIGURE 2
Average per Period Earnings by Treatment

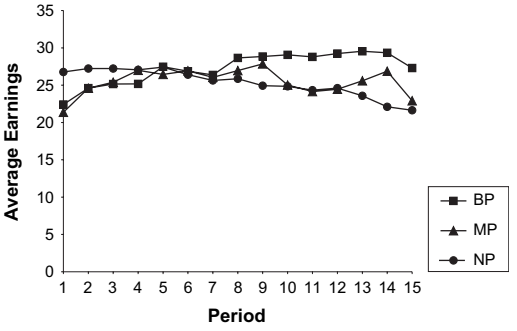
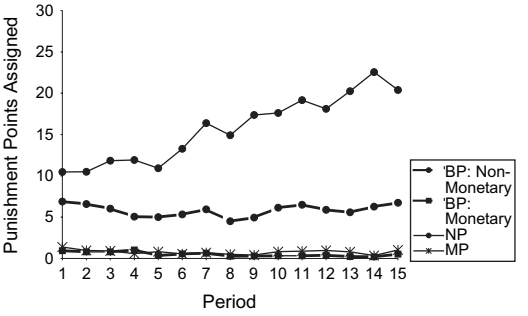


FIGURE 3
Average Punishment Points Assigned per Period in Each Treatment



sanctioner and the sanctioned. Nonmonetary sanctions impose no such costs on either party. Figure 2 shows the average earnings by period in the three treatments. It indicates that during the first five periods, average earnings are highest in NP, in which actual contribution rates are lowest, but in which there are no enforcement costs. In periods 6 and later, BP generates higher earnings than either of the other two systems.

The pooled variance *t*-tests reported in the two rightmost columns of Table 2 reveal the level of significance of the differences in earnings between treatments. In the first 5 periods, as well as over the entire 15-period horizon, the average earnings in no pair of treatments differ significantly. However, for the last five periods, we can reject the hypotheses that average earnings in BP are less than or equal to those in NP at the $p < 0.005$ level and that they are less than or equal to MP at the $p < 0.05$ level. In period 15, average earnings are significantly greater in BP than in NP ($p < 0.01$) and in MP ($p < 0.1$). In both period 15 and the last five periods, earnings are no different in MP than in NP. Thus, after 10 periods the BP system is superior in terms of both average contribution and average welfare levels, although the effect is statistically significant only for welfare.

B. The Assignment of Sanctions

Figure 3 illustrates the behavior over time of the average per-capita number of punishment points assigned in each treatment. It reveals that under NP, ever more nonmonetary sanctions are used even as contribution levels fall over time. However, under MP and BP, there is no overall trend over time in average punishment levels. Under BP, less monetary punishment is used than under MP and less nonmonetary punishment is used than under NP. The lower incidence of monetary punishment in BP than in MP suggests that the deadweight loss from enforcement of the sanction is smaller.[9] The use of monetary punishment in both MP and BP increases in period 15, even though it can have no possible pecuniary benefit to the punisher because it comes too late to influence the behavior of the punished. The use of monetary sanctions in the last period replicates a result reported in Falk et al. (2000) and supports their contention that a main purpose of the sanctions is nonstrategic.

Table 3 displays the number of both types of points that individual agents receive. Each cell indicates the number of instances in which individuals received particular quantity combinations of monetary and nonmonetary points. The data are divided into three groups. The first group consists of high contributors, those who have contributed an amount greater than or equal to the group average in the current period. The second group is

9. The loss from enforcing the sanctioning scheme has two components. The first is the cost of the points to the punisher, which is calculated according to the function given in Table 1. The second is the reduction in earnings of the sanctioned party. Though BP involves a lower expenditure on points than MP, each point is more costly to the punished agent in BP, because average stage 1 earnings are higher in BP. The average per capita cost to sanctioners per period is 0.541 ECU in BP and 0.783 ECU in MP. The average per capita cost from the reduction in earnings of sanctioned individuals equals 1.565 in BP and 2.491 in MP. Therefore, the total deadweight loss from sanctions is lower in BP than in MP.

TABLE 3
Distribution of Sanctions Received, High Contributors, Mild Offenders, and Severe Offenders

		Range of Nonmonetary Points					
		[0, 5]	**[6, 10]**	**[11, 15]**	**[16, 20]**	**[21, 25]**	**[26, 30]**
High contributors							
Range of monetary points	0	304	20	5	2	NA	NA
	1	6	3	4	1	NA	NA
	2	1	4	5	2	NA	1
	3	NA	1	NA	NA	1	NA
	4	NA	1	1	NA	NA	NA
	5	NA	NA	NA	NA	NA	NA
Mild offenders							
Range of monetary points	0	30	15	15	12	3	3
	1	4	7	6	3	5	1
	2	2	7	1	3	2	2
	3	NA	1	3	2	6	1
	4	NA	1	2	NA	2	NA
	5	NA	2	NA	NA	1	NA
Severe offenders							
Range of monetary points	0	NA	NA	3	2	NA	3
	1	NA	1	NA	3	2	1
	2	NA	1	1	3	2	NA
	3	NA	NA	1	1	1	1
	4	NA	NA	1	3	NA	3
	5	NA	NA	1	1	NA	1

the mild offenders, who contribute an amount between $\bar{c} - 5$ and $\bar{c}$, where $\bar{c}$ is the group average in the current period. The severe offenders are those who contribute less than $\bar{c} - 5$.

The table illustrates three main points. The first is that punishment of both types is principally directed at those who contribute less than the group average. The second is that sanctioning of severe offenders, with both types of punishment, is much stronger than for mild offenders.[10] The third is that the application of formal sanctions is more concentrated on severe offenders than the informal sanctions are. The average severe offender received 2.5 points of monetary sanctions, whereas mild offenders received on average 0.944 point, 37.8% as much as the severe offenders. The 7.2% of players who were severe offenders received 32.3% of all formal sanctions. Just 5.6% of all mild offenders but 27.8% of all severe offenders received at least four monetary punishment points. In contrast, severe offenders only received 23.4% of all informal sanctions. Mild offenders were assigned on average 12.07 nonmonetary points, 59% of the 20.47 awarded on average to severe offenders. No agent who received zero nonmonetary points was assigned any monetary points.

10. These first two patterns were noted by Fehr and Gaechter (2000) for monetary sanctions and by Masclet et al. (2003) for nonmonetary sanctions.

C. *The Effect of Sanctions*

Table 4 illustrates the effect of the receipt of the two types of sanctions in BP. Each cell indicates the net change in contributions from period t to $t + 1$ depending on the amount of both monetary and nonmonetary punishment received in period t. Those who receive zero points of both types of sanction on average lower their contribution. Those who receive at least one monetary punishment point typically raise their contribution on average. Players who are assigned zero monetary sanctions

TABLE 4
Change in Average Individual Contribution in Response to the Receipt of Points, BP Treatment

		Range of Nonmonetary Points Received in Period t						
		0	**[1, 5]**	**[6, 10]**	**[11, 15]**	**[16, 20]**	**[21, 25]**	**[26, 30]**
Range of monetary points received in period t	0	−0.47	0.25	−1.15	1.50	0.47	−1	4.25
	1–2	NA	1.66	1.59	−0.43	2.46	2.30	−0.40
	3–4	NA	n/a	0.75	3.75	5.33	4.40	6
	>4	NA	n/a	3.33	NA	5	5	6

TABLE 5
The Relationship between Points and Changes in Contribution Levels in BP

All/High/Low Contributors	**Constant: γ_0**	**Monetary Points: γ_1**	**NonMonetary Points: γ_2**
All	0.325* (0.167)	0.355** (0.155)	−0.007 (0.027)
High	−0.847*** (0.251)	−0.279 (0.488)	−0.069 (0.058)
Low	2.207*** (0.355)	0.414** (0.179)	−0.035 (0.043)

Notes: ***1% significance level, **5% significance level, *10% significance level. Standard errors in parenthesis.

increase their contributions on average if they receive more than 10 nonmonetary points. The impression from the table is that receiving greater monetary sanctions leads to greater increases in contributions.

To evaluate the significance of these effects we estimate regression model (3) for the data in BP. The estimates are shown in Table 5. P_{kt} denotes the number of points k receives in period t. The equations are estimated separately for low contributors (those players k for whom $c_{kt} - \bar{c} < 0$) and high contributors (those for whom $c_{kt} - \bar{c} > 0$). c_{kt} denotes k's contribution in period t.[11] The equations are also estimated for the pooled data (labelled as All in the table) from low and high contributors as well as those for whom $c_{kt} - \bar{c} = 0$.

As we have seen in the previous subsection, the variables P_{kt} and $c_{kt} - \bar{c}$ are correlated. Both P_{kt} and $c_{kt} - \bar{c}$ may have an effect on $c_{kt+1} - c_{kt}$. Players might exhibit more positive net changes in contribution in response to more punishment points as well as in response to contributing a low amount relative to the group average. This means a positive relationship between sanctions and the subsequent net change in contribution might be spurious, when it is in fact the variable $c_{kt} - \bar{c}$ that affects both P_{kt} and $c_{kt+1} - c_{kt}$. The correlation between $c_{kt} - \bar{c}$ and P_{kt} also means that both cannot be used as independent variables in the same equation. Instead we estimate,

$$(3a) \qquad MP_{kt} = \beta_0 + \beta_1(c_{kt} - \bar{c}) + \eta_{kt}$$

$$(3b) \qquad NP_{kt} = \beta_2 + \beta_3(c_{kt} - \bar{c}) + \nu_{kt}$$

$$(3c) \qquad c_{kt+1} - c_{kt} = \gamma_0 + \gamma_1 \sum_k \eta_{kt} + \gamma_2 \sum_k \nu_{kt} + \varepsilon_t.$$

MP_{kt} and NP_{kt} denote the number of monetary and nonmonetary points, respectively, that k receives in period t. The residual η_{kt} is the variation in punishment points that cannot be explained with $c_{kt} - \bar{c}$. Thus, in equation (3c), a significant coefficient γ_1 indicates that the variable MP_{kt} is a determinant of $c_{kt+1} - c_{kt}$, beyond any effect of $c_{kt} - \bar{c}$ on $c_{kt+1} - c_{kt}$.

11. Masclet et al. (2003) argue that the receipt of both monetary and nonmonetary punishment, in settings in which only one of the punishment types was available, increases contribution levels in the following period for low contributors but not for high contributors. They present evidence that high contributors lower their contributions more, the heavier the monetary sanctions they receive.

The estimates suggest that the monetary sanction has a significantly positive effect on average contributions overall and on low contributors specifically. However, its effect on high contributors is negative in sign, though insignificant. Monetary sanctions induce low contributors to increase their subsequent contributions. However, they appear to some extent to trigger lower contributions in the next period as negative reciprocation on the part of high contributors. The level of nonmonetary sanctions assigned had an insignificant effect on contributions in the following period.

IV. DISCUSSION

The aggregate data reveal the following patterns. All of the sanctioning systems are effective in attaining contribution levels higher than would typically be observed in the absence of any system.[12] In the short run, NP, which involves no cost of enforcement, is remarkably effective in achieving high levels of welfare. However, the ability of nonmonetary sanctions alone to enforce cooperative behavior erodes over time, and it is doubtful that in the absence of other incentives or punishment options, nonmonetary sanctions could sustain cooperation indefinitely. In contrast, contributions in MP increase over the first several periods and average about 75% of total endowment after period 3. Earnings in MP exceed the levels attained in NP after period 5. In the long run, when compared to an informal sanctioning system, the higher contributions generated by a formal system more than offset the inefficiencies from the monetary costs of enforcing the sanction regime.[13]

The BP system initially generates contribution levels roughly equal to those in NP and earnings similar to MP. However, both the contribution and earnings measures rise over time, so that after period 7, BP generates higher contributions and earnings than either of the other two systems on its own. In the long run, at least over the time horizons we could observe, the BP system is superior to the other two systems in terms of welfare as well as contribution levels. Furthermore the performance of BP relative to the other two systems improves over time. The deadweight loss of punishment is lower in BP than in MP. Under BP, a smaller quantity of monetary sanctions is applied, and the marginal return from expenditure on sanctions is higher.

Thus in this article we have provided evidence that a system in which formal and informal sanctions are both available can be more effective in generating high earnings than either type separately. We believe that the origin of the superior performance of BP lies in its wider array of sanctions, which provides a greater ability to nuance the disciplinary action taken against free riders. It appears that nonmonetary sanctions can function as a fairly effective substitute for monetary sanctions, at least in some populations and in the short run. However, nonmonetary sanctions can only increase the contributions of those who can be swayed by communication and social pressure.

12. We make this claim based on previous literature. Fehr and Gaechter (2000) and Masclet et al. (2003) use the same parameter values in their VCM games as we do here. Both studies include some data in which there is no sanctioning system and the partner matching protocol is in effect for the first 10 periods of each session, and therefore previous treatments subjects might have participated in do not influence behavior. This data can be meaningfully compared to data from this study. Fehr and Gaechter observe an average contribution of 38% of endowment, and Masclet et al. report an average contribution of 31%. In contrast we obtain average contributions of 74%, 44%, and 78% of endowment in our MP, NP, and BP treatments. Furthermore, both Fehr and Gaechter (2000) and Masclet et al. (2003) report that after several periods average earnings are significantly lower when no sanctions are in effect than in their treatments with (monetary as well as nonmonetary) sanctions.

13. Both monetary and nonmonetary sanctions, when applied in a setting in which the same agents interact repeatedly, can also potentially serve a signaling function concerning future actions. For example, sanctions can be used as a warning that the sanctioner might contribute less in the future unless the sanctioned individual contributes a sufficient amount. Isaac and Walker (1988) have shown that unrestricted communication to increase contribution levels. However, previous research has also established that signaling is not the only motive for sanctioning. Fehr and Gaechter (2000) and Falk et al. (2000) find that monetary sanctions are widely observed in the last period of a multiperiod interaction as well as when agents are matched with new agents in each period. Masclet et al. (2003) observe that nonmonetary sanctions are also applied when agents are grouped with different individuals in each period. In these settings, there is no motive to use punishment as a signal, because the sanctioner does not benefit from any future increase in contribution the sanction induces. Furthermore, in these settings with random rematching, receiving either monetary sanctions or nonmonetary sanctions increases the subsequent contribution level in the next period, indicating that their positive effects are not restricted to environments with repeated interaction, and therefore not only due to the signalling function that the sanctions serve.

On the other hand, a system of monetary sanctions alone is a very blunt tool for inducing cooperation. In MP, the monetary sanction is the only instrument for communication as well as for punishment. Application of monetary punishment can increase the contributions of some individuals whom informal sanctions cannot influence. However, because of its cost, it also is an inefficient manner of raising contributions of those who would need only social sanctions to be induced to cooperate. Monetary penalties also appear to engender negative reciprocation in the form of lower contributions from some sanctioned individuals.

BP allows the use of informal sanctions at no cost to boost the contributions of those they can influence. It also has a system of formal sanctions to punish and change the behavior of those who are insufficiently influenced by informal sanctions. The combination appears to work well in getting high levels of cooperation at minimal cost. It appears that some of the effect of monetary sanctions in BP is immediate, as low contributors respond to sanctions with a net change in contribution in the next period that is increasing in the sanction received. A significant immediate response could not be detected for the nonmonetary sanctions. This does not mean that the nonmonetary sanctions had no effect. Because contribution levels were higher in BP than in MP, and the only difference between the two treatments is the existence of nonmonetary sanctions, they *must* be the cause of the increase in contributions. However, at least some of the effect of the sanctions appears to be either long-term in nature or due to the existence of the sanctioning system and the option of punishment, rather than the actual application of sanctions.[14]

14. One interesting suggestion for future work, suggested to us by an editor, would be to consider the effect of a sanction that is costly to the sanctioning party but not to the sanctioned individuals. This would be an attempt to capture the idea that even informal sanctions may be costly to impose. Such sanctions would be presumably more sparingly applied than our nonmonetary sanctions, and perhaps also used less frequently than our monetary sanctions, which reduce the earnings of the sanctioned party. However, they may have a more powerful effect in increasing contributions of the sanctioned party than the nonmonetary sanction. This is because their application illustrates a willingness to pay from one's earnings to express disapproval and therefore perhaps a greater degree of disapproval than any level of costless nonmonetary sanction expresses. The potentially lower social cost (there is no cost to the recipient) of applying this type of sanction relative to a monetary sanction may also lead to higher welfare than the MP treatment.

APPENDIX: CONTRIBUTION LEVELS IN EACH SESSION

TABLE A1
Group Contribution Levels

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
032002BP															
Group 1	40	42	45	49	44	49	43	50	51	54	55	57	55	55	55
Group 2	52	66	73	78	80	79	78	80	80	80	80	80	80	80	80
Group 3	51	64	69	72	74	71	75	76	77	77	80	79	80	77	72
032102BP															
Group 1	29	30	32	27	38	46	55	60	68	73	53	69	74	59	58
Group 2	42	53	39	48	40	34	41	38	36	43	47	58	40	32	23
Group 3	32	39	40	45	37	40	44	46	50	59	64	66	63	64	56
032602BP															
Group 1	41	47	55	64	67	73	78	80	80	80	80	80	80	80	80
Group 2	70	72	78	80	80	78	80	80	79	80	79	80	79	79	60
Group 3	42	52	72	72	78	79	60	77	79	78	78	79	79	80	79
041002NP															
Group 1	43	51	58	67	55	55	62	65	62	64	68	70	66	49	26
Group 2	47	40	28	8	40	32	35	32	20	32	13	10	2	5	2
Group 3	42	42	39	55	59	52	40	51	35	49	30	48	26	10	25
041102NP															
Group 1	44	64	78	80	75	66	49	29	36	42	39	43	30	5	7
Group 2	45	59	65	71	74	56	42	46	35	6	7	11	24	10	0
Group 3	55	52	59	49	33	28	15	28	26	24	5	2	0	0	5
041202NP															
Group 1	44	40	32	25	22	12	19	26	28	30	17	12	10	10	0
Group 2	41	44	30	49	32	31	41	42	24	39	44	35	7	2	23
Group 3	45	42	45	20	55	53	35	33	30	5	37	45	50	35	10
041602MP															
Group 1	36	49	54	57	65	72	74	78	80	79	61	76	80	80	59
Group 2	23	15	24	25	32	25	22	24	19	26	30	24	28	24	30
Group 3	53	60	63	71	67	66	71	71	71	66	71	70	72	72	66
041902MP															
Group 1	60	75	78	77	76	78	60	79	80	60	79	79	80	80	57
Group 2	47	60	70	74	75	59	57	56	75	57	57	57	57	63	56
Group 3	61	76	80	80	80	80	80	80	80	80	80	80	80	80	80
042203MP															
Group 1	25	27	23	15	33	25	27	22	19	30	25	12	21	18	30
Group 2	60	75	79	77	75	73	73	74	71	74	74	77	75	74	79
Group 3	75	75	76	80	80	80	80	60	80	61	60	40	40	10	22

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