Monetary and Nonmonetary Punishment in the Voluntary Contributions Mechanism

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A demand for behavioral norms arises when members of a group have individual incentives to take actions that reduce the group's overall welfare (James S. Coleman, 1990). Norms require enforcement with a system of sanctions that penalize deviations from acceptable behavior (George C. Homans, 1961). Formal sanctions include fines or restrictions implemented by a legal system or private individuals that impose costs of money and time on the offender. However, informal sanctions such as peer pressure, gossip, or social ostracism might in some cases also be effective deterrents, and expressions of social acceptance might be effective in encouraging group-oriented behavior (Peter M. Blau, 1964). Indeed, the fact that expressions of approval and disapproval are commonly observed in human interaction suggests that they must influence the behavior of at least some individuals. In recognition of the importance of informal sanctions, economists have integrated phenomena such as peer pressure (Eugene Kandel and Edward P. Lazear, 1992; John M. Barron and Kathy Paulson-Gjerde, 1997), and the avoidance of social disapproval (George A. Akerlof, 1980; Heinz Hollander, 1990; Assar Lindbeck et al., 1999) into theoretical models. Social pressures are thought to be a major factor behind high voter participation (Carol-Jean Uhlaner, 1989; Stephen Knack, 1992) and compliance with the law (Tom R. Tyler, 1990).

In this study, we use experimental methods to study the power of informal sanctions. The context is a simple game called the Voluntary Contributions Mechanism (VCM). The VCM is appealing because it starkly isolates the conflict between self-interest and group interest and allows a simple measure of the extent of group-interested behavior. It has also been widely studied in the laboratory, facilitating the interpretation of our results within a large literature. In the version of the game that we consider, each player receives an identical initial endowment of money. Players simultaneously select a fraction of the endowment to contribute to a group account, while keeping the remainder. All funds in the group account pay a positive return to each member of the group. The parameters are chosen so that each agent has a dominant strategy to contribute zero to the group account, but at the group optimum, every agent contributes all of his endowment to the group account.

Experiments have documented that there is initially a positive level of contribution to the group account.[1] The level of contribution de-

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[1] This cooperation has been attributed to other-regarding behavior as well as to decision error. The presence of conditional cooperators, players who reciprocate high (low) contributions by others with high (low) contributions of their own (see, for example, Claudia Keser and Frans van Winden, 2000), has been identified. Thomas R. Palfrey and Jeffrey E. Prisbrey (1997) identify a warm glow effect, in which agents receive utility from the act of contributing. Simon P. Anderson et al. (1998) find that pure altruism, a preference for others to have a higher payoff, is one of the factors that account for contributions. Gary E. Bolton et al. (2000) interpret their data as indicating the presence of nonlinear distributive preferences.

The decrease in contributions is consistent with a reduction in the incidence of errors over time. With an optimal decision at zero contribution, the only way confusion and errors can appear in the data is in the form of higher-thanclines with repetition (R. Mark Isaac et al., 1985; Andreoni, 1988; Isaac and James M. Walker, 1988b; Joachim Weimann, 1994; Keser, 1996) and readily responds to changes in treatment variables. For example, contribution rates increase if communication between the parties is allowed before each play (see, for example, Isaac and Walker, 1988a; Elinor Ostrom et al., 1992). See John O. Ledyard (1995) for a survey of previous studies.

It is known that a formal sanctioning system increases contributions. In a recent paper, Ernst Fehr and Simon Gächter (2000), hereafter FG, study the following two-stage game. In the first stage, four subjects play the VCM game described above. In the second stage, each subject, after observing each other group member's contribution, has an opportunity to reduce the earnings of any of the other players in his group, at a cost to himself. In the unique subgame-perfect equilibrium to the two-stage game, agents never punish because it lowers their own payoff, and because the punishment is not credible, there are no contributions in the first stage. In their experiment, however, FG observe that agents do exhibit a willingness to punish other members of their group, and that the availability of the punishment opportunity increases contributions markedly. The result is obtained under both Partner (in which the same players interact repeatedly) or under Stranger (in which players interact with different players each period)[2] matching protocols.

An obvious possible conclusion to draw is that the availability of monetary fines is the cause of the increase in contributions. We will refer to this interpretation, stated more precisely below, as the *Direct Punishment Hypothesis* (DPH).[3] DPH will be supported, for example, if agents believe that a failure to contribute an amount others view as sufficient will result in punishment that will make lower contributions unprofitable.

Hypothesis 1 (Direct Punishment Hypothesis): The opportunity for agents to reduce the monetary payoff of others after observing their decisions increases contribution levels.

However, in addition to a formal system of monetary fines, the sanctioning system is a vehicle to express *disapproval* of others' decisions. This suggests a second possible explanation for FG's result: that the opportunity to express disapproval of other agents' decisions *in itself* increases the level of contribution. We refer to this explanation as the *Indirect Punishment Hypothesis* (IPH). There is reason to believe that this might be the case. In a repeated game, punishment serves as a form of pre-play communication for future periods, and even unstructured communication is known to increase contributions. Punishment may be a particularly powerful form of communication because it can serve as a warning that the sanctioner will lower his future contribution if the sanctioned player does not increase his own contribution. Additionally, whether or not the

predicted contribution levels. Palfrey and Prisbrey (1996) argue that decision error is the main cause of positive contributions. James Andreoni (1996) finds that both confusion and intentional contributions are present. The contribution rate is also higher than the Nash equilibrium level when the equilibrium specifies a positive level of contribution (Keser, 1996; Martin Sefton and Richard Steinberg, 1996).

[2] Samuel Bowles et al. (2001) and Jeffrey Carpenter (2002) obtain similar results as Fehr and Gächter, and find that when a sanctioning system is available, large groups make higher per capita contributions than small groups. Toshio Yamagishi (1986) studied the effect of an exogenous sanctioning mechanism that was funded with voluntary contributions by group members and observed that the sanctioning system was indeed funded, and served to increase contribution levels. Sefton et al. (2000) replicated FG's experiment with different parameters and added two treatments. In their Reward treatment, agents could, at a cost to themselves, give bonus payments to other agents after observing their contributions. In their Combined treatment, agents could both reward and punish other agents. They found that the Combined treatment was the most effective in promoting contributions.

[3] Fehr and Klaus M. Schmidt (1999) provide a theoretical model that is consistent with DPH. They demonstrate that Nash equilibria with positive contribution levels can exist when the utility functions of agents include an aversion for inequity. However, the assumptions of the model do not necessarily imply DPH, since equilibria with positive contributions occur only for certain ranges of preference parameters. Likewise DPH can be supported for reasons other than those underlying the model. Therefore, our experiment does not represent a test of the Fehr-Schmidt model.

game is repeated, if players incur a disutility from receiving an expression of disapproval, they may make higher contributions in order to avoid or in response to an informal sanction.[4]

Hypothesis 2 (Indirect Punishment Hypothesis): The opportunity for agents to express disapproval of others' decisions increases contribution levels.

If the IPH is correct, informal sanctions that communicate disapproval but do not reduce pecuniary payoffs can also be effective in increasing contribution levels. The experiment reported here isolates the role of the IPH in increasing contributions in FG's experiment. Our *Monetary Punishment* (MP) treatment, replicates the experiment of FG. Our *Nonmonetary Punishment Treatment* (NP) is identical to MP, except for one difference. Instead of having an opportunity to reduce the payoff of others, each player has an opportunity to communicate a level of disapproval of each other player's contribution. This creates a system of informal sanctions. We study the system under both Partner and Stranger matching protocols. Higher contributions in NP than in a treatment where no sanctions are available would provide support for the IPH. Higher contributions in MP than in NP would indicate support for the DPH, since the only difference between MP and NP is the monetary dimension of the sanction. Higher contributions under Partner than under Stranger matching would suggest that the effectiveness of informal sanctions depends, at least in part, on repeated interaction.

I. The Experiment

The experiment consisted of 11 sessions of 30 periods,[5] divided into three segments of 10 periods. Seven of the sessions were conducted at Purdue University, in the United States, and the other four at the Groupe d'Analyse et de Theorie Economique (GATE), at the Universite Lumiere Lyon II, in France.[6] The subjects were recruited from undergraduate courses in business and economics at both universities. Some of the subjects had participated in previous experiments, but all of the subjects were inexperienced in this particular type of experiment. No subject participated in more than one session of the study. On average, a session lasted 90 minutes, including initial instruction and payment of subjects. The experiment was computerized using the REGATE program developed at GATE.

Some information about the sessions is presented in Table 1. The first four columns indicate the session number, the number of subjects that took part in the session, the location, and the treatment in effect in the session, MP, NP, or NS. The *Matching Protocol* columns indicate whether Partner or Stranger matching was in effect during each of the three 10-period segments that made up a session. The Partner matching protocol was in effect for the first 10 periods of every session, and for the entirety of the four MP and the four NP sessions. Under the Partner matching protocol, the computer network separated the subjects into groups of four. Group assignments remained constant for the entire session. Under the Stranger matching protocol,[7] which was in effect from period 11

[4] Gächter and Fehr (1999) provide two pieces of evidence that approval incentives can increase contribution levels. The first is questionnaire data indicating that cooperation and free-riding trigger a high degree of approval and disapproval respectively. The second is data from an experiment in which interaction between subjects that creates familiarity before they play the VCM game, in conjunction with public revelation of contributions and discussion after the game is played, increases contribution levels. Mari S. Rege and Kjetil Telle (2001) also find that revealing the identity of each group member publicly in a way that allows him to be associated with his contribution increases average contribution levels. They also observe that framing the experiment using terms such as cooperation, free-riding, and community, that emphasize the pro-social nature of contributions, serves to increase average contribution levels.

[5] There was one exception. Session number 10 was terminated due to a software crash after period 15. In that session, the data from 8 of 16 subjects for period 15 were also lost. Also, the data from period 15 for group 3 in session 2 was lost because of a computer problem and is not included in the data analysis.

[6] The data from the two locations, which do not reveal large differences, are analyzed separately in Masclet et al. (2000).

[7] Several previous studies have explored whether contribution rates are different between Partners or Strangers (when no punishment is available) but have not reached a clear consensus. Andreoni (1988) and Palfrey and Prisbrey (1996) find that Strangers contribute more than Partners, while Rachel T. A. Croson (1996), Keser (1996), and Keser and van Winden (2000) find that Partners contribute more

TABLE 1—CHARACTERISTICS OF THE EXPERIMENTAL SESSIONS

Session number	Number of subjects	Location	Treatment	Matching Protocol		
				Periods 1–10	Periods 11–20	Periods 21–30
1	12	Purdue	MP	Partner	Partner	Partner
2	12	Purdue	MP	Partner	Partner	Partner
3	12	GATE	MP	Partner	Partner	Partner
4	12	GATE	MP	Partner	Partner	Partner
5	16	Purdue	NP	Partner	Partner	Partner
6	8	Purdue	NP	Partner	Partner	Partner
7	12	GATE	NP	Partner	Partner	Partner
8	8	GATE	NP	Partner	Partner	Partner
9	16	Purdue	NS	Partner	Stranger	Stranger
10	16	Purdue	NS	Partner	Stranger	N/A
					Periods 11–15	
11	16	Purdue	NS	Partner	Stranger	Stranger

on in the three NS sessions, participants were rematched each period into new groups of four. It was common information that each subject had a zero probability of being matched with any given other individual for two consecutive periods as well as ever being grouped again with the same three people.[8]

During each 10-period segment subjects did not know whether or not the experiment would extend beyond the current segment. However, they knew the segment length and that each period in the segment would be identical. Thus, each 10-period segment in MP or NP is most appropriately viewed as a 10-period finitely repeated game. In periods 1–10 and periods 21–30 of each session, there was no punishment available. Activity in these periods proceeded as follows. At the beginning of each period, each agent was endowed with 20 Experimental Currency Units (ECUs), with each ECU convertible to U.S. dollars at 30 ECU = 1 dollar or to French francs at 5 ECU = 1 franc. Subjects simultaneously chose the portion of their endowment to contribute to a group account. They made this contribution decision by using a scroll bar on their computer screen. Each ECU contributed to the group account yielded a payoff of 0.4 ECU to each of the four members of the group. Each ECU not contributed by the subject was credited to the subject's private account.[9] Therefore, the earnings, in ECU, of individual i in a period equaled

$$E = 20 - c_i + 0.4 \times \sum_{k=1}^{4} c_k \tag{1}$$

where c_i is the contribution of player i. It is easily seen from (1) that individual i's earnings are maximized at $c_i = 0$. If the game is played once, there is a dominant strategy to contribute zero. If the game is finitely repeated, the only subgame-perfect equilibrium of the game is for all players to contribute zero in each period.

In periods 11–20 of the four *Monetary Punishment* (MP) sessions, each period consisted of

than Strangers, and Weimann (1994) finds no difference. See Andreoni and Croson (forthcoming) for a review and survey of previous work in the area. As discussed previously, some of the rationale for the hypothesized effect of the disapproval points on contributions requires repeated interaction, which would suggest that Partner matching would yield higher contributions. On the other hand, Armin Falk et al. (2000), who study the same game as FG, find that the sanctioning pattern is similar under Partner and Stranger matching, and conclude that the main purpose of the sanctions is nonstrategic.

[8] Notice that our Stranger matching differs from random matching by assuring that two players are never in the same group for two consecutive rounds. While the Stranger matching protocol did not eliminate the possibility for preplay communication completely, it forced such communication to be much more indirect.

[9] The same parameters were used in the FG study. At the group optimum, each member of the group contributes all 20 ECU, yielding a payoff of 32 ECU per person for the period. If every player follows his dominant strategy, each player receives a payoff of 20 ECU.

TABLE 2—LEVELS OF PUNISHMENT AND ASSOCIATED COSTS FOR THE PUNISHING SUBJECT

Punishment points	0	1	2	3	4	5	6	7	8	9	10
Cost of punishment	0	1	2	4	6	9	12	16	20	25	30

a two-stage game in which the first stage followed exactly the same rules as in periods 1–10. At the beginning of the second stage, subjects were informed of the contribution levels of each of the other members of their group. They could then assign zero to ten punishment points to each of the three other group members. Each point received by a subject from any other agent reduced the first-stage earnings of the subject by 10 percent, with a maximum reduction of 100 percent. A subject observed the total number of points he received, but not how many each individual assigned to him. There was a cost to the agent assigning the points associated with each point allocated. The schedule of costs, denominated in ECU, is given in Table 2.[10] Subject i's earnings in a period equaled

$$(2)\quad \left(20 - c_i + 0.4 \times \sum_{k=1}^{n} c_k\right) \times \frac{\max\left\{0,\ 10 - \sum_{k\neq i} P_{ki}\right\}}{10} - \sum_{k\neq i} K(P_{ik})$$

where P_{ik} is the number of points assigned by i to k, and $K(P_{ik})$ is the cost to i of assigning the points to k. Contributions were listed in random order and without a running identification number on the screen each period so that it was impossible to target another player for punishment for more than one period. As indicated previously, in the only subgame-perfect equilibrium of the game, whether it is played once or finitely repeated, all players always contribute zero and never punish.

Periods 11–20 of the four *Nonmonetary Punishment* (NP) and the three *Nonmonetary Punishment Stranger* (NS) sessions followed identical rules to periods 11–20 of MP, except that under NP and NS, each point awarded to an agent had no effect on her final earnings and was costless to assign. As in MP, each agent had the opportunity to assign between zero and ten points to each other group member. The points represented the level of disapproval of a subject's contribution in the first stage. An allocation of ten points was to be assigned for the highest level of disapproval and zero points for the lowest level of disapproval. The points and their purpose were described to the subjects in the following language:

> In this stage you have the opportunity to register your **approval** or **disapproval** of each other group member's decision by **distributing points.** <u>**You can award a large number of points to any member of your group if you disapprove of his or her decision (10 points for the most disapproval, 0 points for the least disapproval).**</u>[11]

Under nonmonetary sanctions, the unique subgame-perfect equilibrium in either the one-shot or the finitely repeated version of the game requires a level of contribution of zero, though any profile of point assignment is compatible with a subgame-perfect equilibrium.

At the end of each period in all treatments,

[10] The cost for agent i indicated in the table represented the cost to i of points assigned by i to any individual agent k. That is, letting P_{ik} equal the points that i assigns to k, the table indicates $K(P_{ik})$, the cost to player i of assigning the points to player k. The cost to i of assigning points to k and q, $K(P_{ik} + P_{iq}) = K(P_{ik}) + K(P_{iq})$.

[11] The bold print and underlining provides a strong framing emphasizing that points indicate disapproval. We chose the emphasis to make sure that subjects were aware that the points could potentially be used as a sanctioning system. The question that interested us was whether the sanctioning system, if employed, would promote higher contributions, rather than whether or not it would be employed at all. The same bold print was used in the instructions describing the punishment points in the MP treatment.

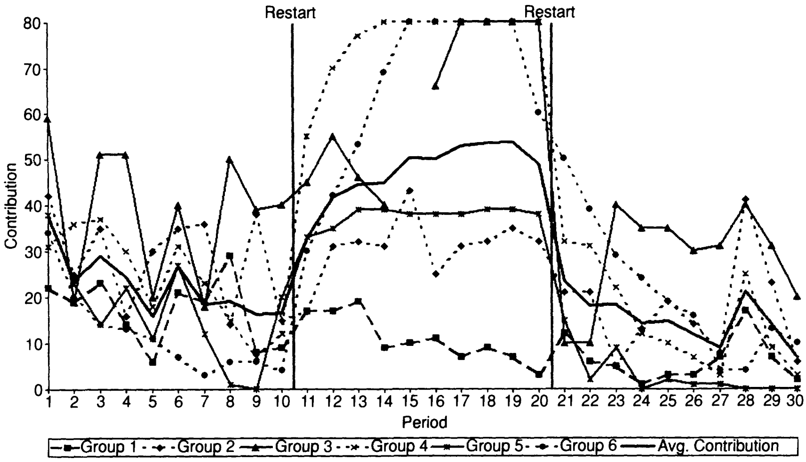

FIGURE 1. GROUP CONTRIBUTION LEVELS IN MP (PURDUE)

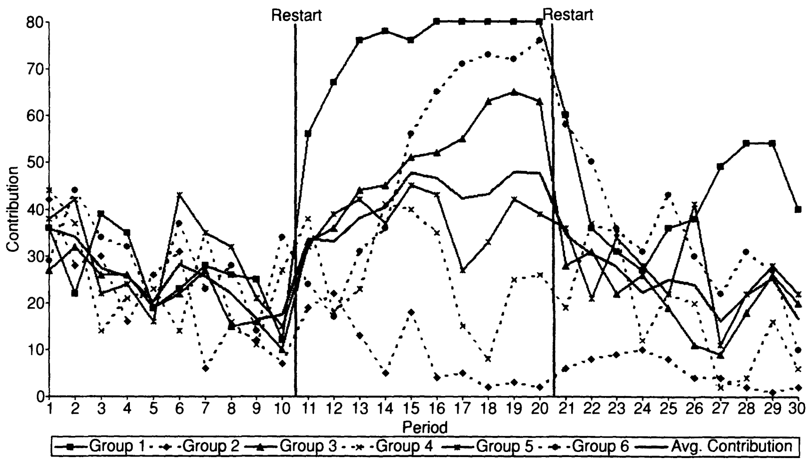

FIGURE 2. GROUP CONTRIBUTION LEVELS IN MP (GATE)

the computer displayed the subject's own initial endowment, own earnings from the first stage, own points received, own cost of points allocated (for MP), own overall earnings for both stages, each group member's contribution, and the total group contribution. The computer program then continued to the next period.

II. Results

Figures 1 and 2 show the time series of group contributions by period for each of the six groups that participated in MP at Purdue and at GATE, respectively. Figures 3 and 4 display the corresponding data for NP. The bold lines indicate the average group contribution over all sessions. As described in Result 1 below, both the MP and NP data show the same patterns reported by FG: an increase in contributions when punishment is available in periods 11–20 and a fall in contributions when punishment in no longer available in periods 21–30.

RESULT 1: *The Direct and Indirect Punishment Hypotheses are both supported. Monetary and nonmonetary sanctions initially increase contributions by a similar amount. Over time, however, monetary sanctions lead to higher*

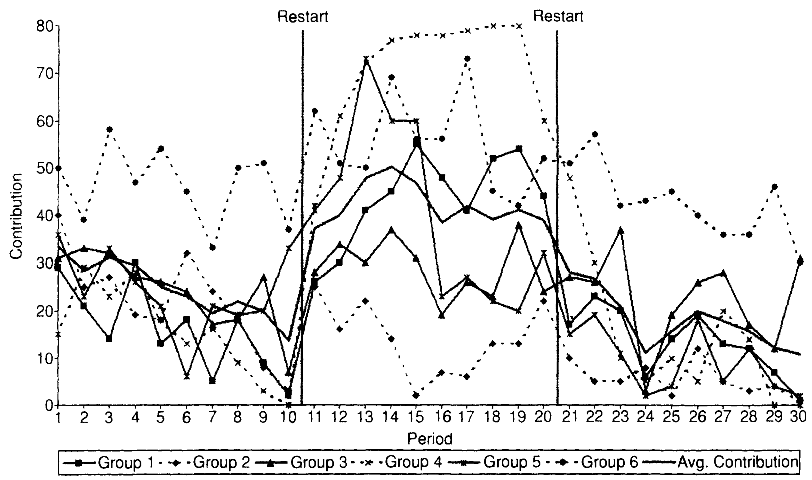

FIGURE 3. GROUP CONTRIBUTION LEVELS IN NP (PURDUE)

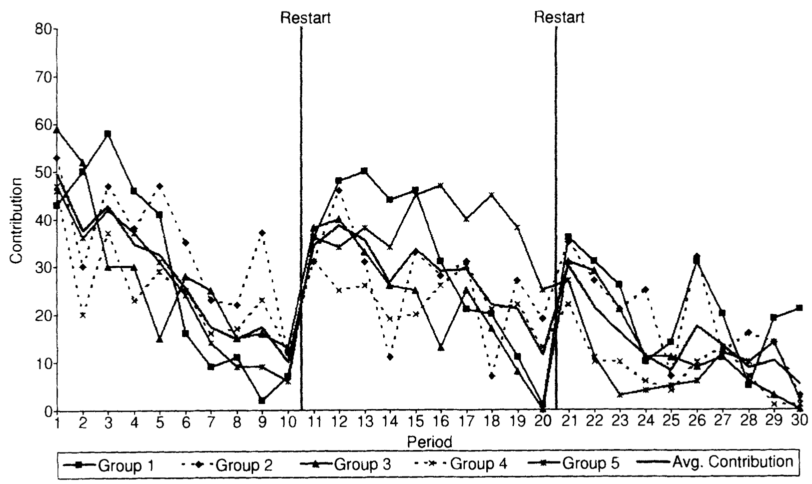

FIGURE 4. GROUP CONTRIBUTION LEVELS IN NP (GATE)

contributions than nonmonetary sanctions. After the opportunity to impose sanctions is lifted, contributions fall to similar levels in both treatments.

SUPPORT FOR RESULT 1:

A Mann-Whitney rank-sum test[12] of the difference between MP and NP in periods 1–10, before sanctions become available, yields $z = 0.246$, not significant at conventional levels. The mean individual contribution in periods 1–10 is 6.03 for MP and 6.55 for NP. Contribution rates are higher in periods 11–20, when sanctions are available, than in the pooled data from periods 1–10 and 21–30 for 10 of 12 groups in MP (significant at $p < 0.05$) and 10 of 11 groups in NP ($p < 0.01$). Contribution rates are higher in periods 11–20 than in periods 1–10 for 10 of 12 groups in MP and 7 of 11 groups in NP, despite the tendency for contributions to decline over time in the absence of

[12] In all statistical tests reported in this paper, the unit of observation is the group for the MP and NP data, and the session for the NS data.

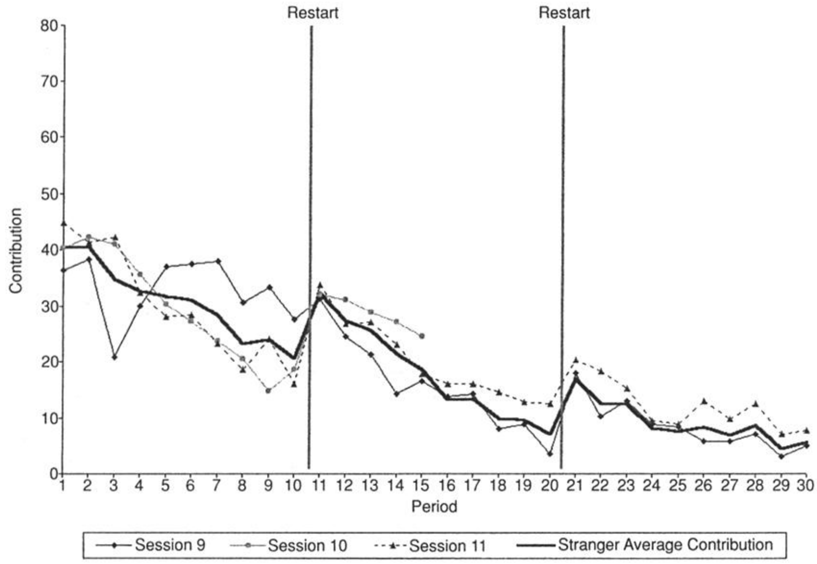

FIGURE 5. GROUP CONTRIBUTION LEVELS FOR EACH NS SESSION

punishment. The mean individual contribution in periods 11–20 is 11.14 in MP and 8.97 in NP. In periods 11–15 a rank-sum test of the difference between MP and NP yields an insignificant value of $z = 0.09$. However, for the data from period 20, we reject the hypothesis that NP has a median contribution greater than or equal to that in MP at the $p < 0.025$ level ($z = 2.093$). The contribution level is not different between MP and NP in periods 21–30, when sanctions are no longer available ($z = 1.16$). Average contributions are lower in periods 21–30 than in periods 11–20 for all 23 groups.

Figure 5 illustrates the mean contribution by period in each of the three NS sessions. Comparison of Figures 3, 4, and 5 suggests that at least some of the effectiveness of the nonmonetary sanctions requires repeated interaction. This is stated more precisely in Result 2.

RESULT 2: *When nonmonetary sanctions are available, contribution levels are greater under Partner than under Stranger matching.*

SUPPORT FOR RESULT 2:
The mean individual contribution rates in periods 11–20 of NP and NS are 8.97 and 4.97, respectively. A rank-sum test of the differences yields ($z = 1.776$, $p < 0.05$). Since the average contribution level is not higher in periods 1–10 in NP than in NS, the increase in contributions resulting from the availability of sanctions is greater in NP than in NS.

The time series of average earnings by period in MP and NP are shown in Figure 6. In both MP and NP, average earnings increase when the punishment opportunity becomes available. The increase is immediate in NP, as contributions rise, and no costs of punishment are incurred. In MP, there is an initial decrease in earnings, due to costs paid by both punishers and the punished, which more than offsets the increase from higher contributions. After several periods, earnings are similar in MP and NP, as contribution rates rise in MP relative to NP, and the amount of sanctioning in MP declines. Result 3 summarizes our findings on earnings.

RESULT 3: *Both types of sanctions increase average earnings. Average earnings in the first five periods after the introduction of punishment are greater in NP than in MP. However, in periods 16–20, MP and NP generate similar earnings.*

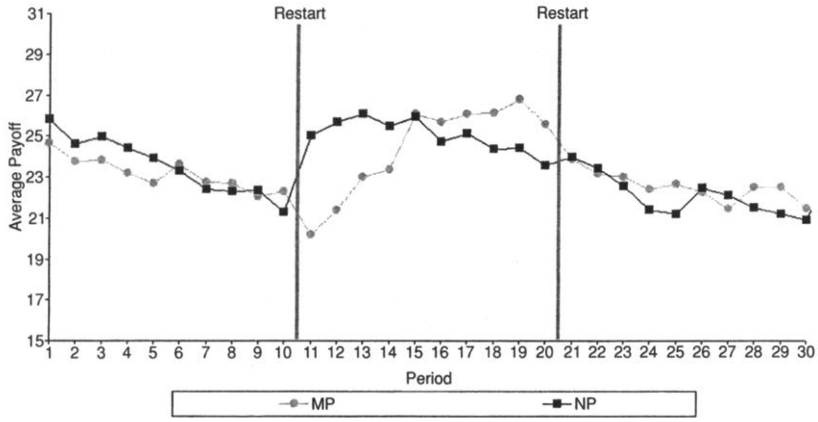

FIGURE 6. AVERAGE PER PERIOD EARNINGS IN MP AND NP

SUPPORT FOR RESULT 3:

Mean earnings in periods 11–15 are greater than the mean over periods 1–5 and 21–25 for all 11 groups in the NP treatment (significant at $p < 0.001$) but only 6 of 12 groups in MP. Mean earnings in periods 16–20 are greater than the mean over periods 6–10 and 26–30 for all 11 groups in NP ($p < 0.001$) and 9 of 12 groups in MP (significant at $p < 0.1$). NP yields significantly higher average earnings than MP in periods 11–15 ($z = 1.416$, $p < 0.1$). MP generates higher average earnings than NP in periods 16–20 ($z = 0.923$), and in period 20 ($z = 1.14$), but the differences are not significant.

Results 4 and 5 concern the relationship between sanctions and contributions at the level of the individual subject. In their study, FG document a positive relationship between $\max\{0, \bar{c} - c_k\}$, the negative difference between k's contribution and the average contribution, and the number of points i assigns to k. Falk et al. (2000), who study the same game as FG, find that i assigns k more points the greater the value of $\max\{0, c_i - c_k\}$, the negative difference between k's contribution and i's. In both studies, the sanctioning patterns were similar under Partner and Stranger matching. As indicated in Result 4, we replicate both of these earlier findings, and find that they carry over to nonmonetary sanctions.

RESULT 4: *The level of both monetary and nonmonetary sanctions assigned by one individual to another is increasing in (i) the negative difference of the contribution of the punished subject from the average level, and (ii) the negative difference of the contribution of the punished subject from the contribution of the punishing subject.*

SUPPORT FOR RESULT 4:

Table 3 contains the estimates from the following regression model:

$$\begin{aligned}(4)\qquad P_{ik}^t = \beta_0 &+ \beta_1(\max\{0, c_i^t - c_k^t\}) \\ &+ \beta_2(\max\{0, c_k^t - c_i^t\}) \\ &+ \beta_3(\max\{0, \overline{c^t} - c_k^t\}) \\ &+ \beta_4(\max\{0, c_k^t - \overline{c^t}\}).\end{aligned}$$

The first three columns in the table contain the estimates for periods 11–20, and the last three columns include only the data from period 20, the final period of the segment.[13] Both β_1

[13] Because of the large number of zero values for the dependent variable in the MP treatment, Tobit estimation was used for the MP data. For NP, there were very few zero values of P_{ik}^t, and therefore OLS estimation was used.

TABLE 3—DETERMINANTS OF SANCTIONING BEHAVIOR

	MP[a] periods 11–20	NP periods 11–20	NS periods 11–20	MP[a] period 20	NP period 20	NS period 20
Constant	−2.677***	2.267***	4.99***	−4.071***	2.453***	4.528***
	(0.192)	(0.145)	(0.179)	(1.057)	(0.459)	(1.627)
Negative deviation from i's own contribution ($\max\{0, c_i - c_k\}$)	0.142***	0.209***	0.144***	0.219*	0.196	3.147**
	(0.027)	(0.034)	(0.032)	(0.120)	(0.129)	(1.521)
Positive deviation from i's own contribution ($\max\{0, c_k - c_i\}$)	0.241***	0.002	−0.066	0.762***	−0.031	0.395
	(0.040)	(0.022)	(0.053)	(0.226)	(0.096)	(1.483)
Negative deviation from average ($\max\{0, \bar{c} - c_k\}$)	0.321***	0.507***	0.318***	0.248	0.629***	0.528
	(0.045)	(0.053)	(0.067)	(0.258)	(0.168)	(0.518)
Positive deviation from average ($\max\{0, c_k - \bar{c}\}$)	−0.291***	−0.000	−0.231***	−1.012***	0.209	0.131
	(0.074)	(0.002)	(0.076)	(0.388)	(0.130)	(1.404)
R^2	—	0.349	0.210	—	0.998	0.215
Observations	1,437	1,320	1,176	144	132	96

Notes: Standard errors are in parentheses.
[a] Tobit estimation used; other four regressions are OLS estimates.
* Significant at the 10-percent level.
** Significant at the 5-percent level.
*** Significant at the 1-percent level.

and β_3 are highly significant for the period 11–20 data in MP. As in Falk et al. (2000), player i sanctions k more the greater the negative deviation of k's contribution is from i's. However, there is an additional effect that i sanctions k more, the further below the group average is k's contribution, as observed by FG. Both of these effects also carry over to the NP treatment, where the two coefficients are also highly significant. All of the β_1 and β_3 coefficients have the same sign in period 20 as in 11–20 (though some are not significant due to fewer observations), indicating that the effects do not require repeated play.

In MP, the effect of a greater positive difference of k's contribution from i's, indicated by the positive estimate of β_2, is to increase the amount that i punishes k. However, the negative estimated β_4, means that i punishes k less, the more that k deviates positively from the group average. The signs of β_2 and β_4 indicate that agents who contributed low amounts are more likely than other players to punish those who made high contributions. A similar pattern is documented by Falk et al. (2000), who interpret it as evidence of spiteful preferences on the part of some players. Agents with spiteful preferences receive lower utility as other agents' earnings increase. A spiteful player in the MP treatment would both contribute a low amount and punish other agents. The fact that seven of the eight β_2 and β_4 estimates are not significantly different from zero in NP and NS is also consistent with the presence of players with spiteful preferences. Since earnings cannot be changed during the sanctioning phase of NP nor of NS, spiteful preferences would not necessarily lead to sanctioning.

Figure 7 illustrates the relationship between the number of points an agent receives and the change in his contribution in the next period. The horizontal axis is the range of possible punishment points that could be received in period t, from 0 to 30 inclusive, and the vertical axis is the average change in contribution from period t to $t + 1$, (the average over all i and t of $c_i^{t+1} - c_i^t$, where c_i^t is individual i's contribution in period t). The numbers above and below the bars in the graph correspond to the number of observations within that range of points received. In MP, agents who receive one or more points tend to increase their contribution,

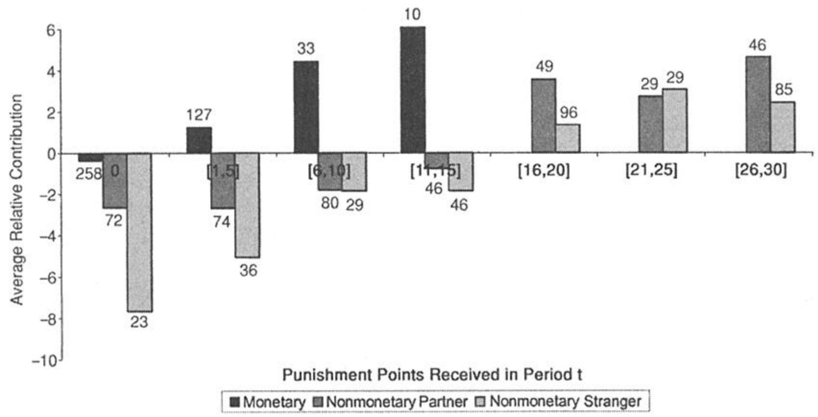

FIGURE 7. THE EFFECT OF SANCTIONS ON THE CHANGE IN CONTRIBUTION BETWEEN ONE PERIOD AND THE NEXT

while those who receive zero tend to lower it. In NP and NS, agents who receive more than 15 points, 50 percent of the maximum possible, on average raise their contribution in the next period, while those who receive less than 15 points tend to lower it. Conjecture 1 asserts that even after taking into account an overall tendency for those who contribute less (more) than average to raise (lower) their contribution in the next period, the receipt of sanctions increases contributions of those who previously contributed less than the group average. We characterize the relationship as a conjecture because we cannot be certain that the points themselves, rather than some other variable correlated with the number of points received, cause the increase in contribution.

CONJECTURE 1: *In each of the three treatments, individuals who contributed less than the group average in period t increase their contributions more in period t + 1 the more points they receive.*

SUPPORT FOR CONJECTURE 1:

The estimates from the following regression model, shown in Tables 4A and 4B, suggest that sanctions boost contributions, but only for those who contribute less than the group average:

(5)

$$c_i^{t+1} - c_i^t = \beta_0 + \beta_1\left(\sum_k P_{ki}\right) + \beta_2(c_i^t - \bar{c}^t).$$

TABLE 4A—DETERMINANTS OF CHANGES IN CONTRIBUTION: LOW CONTRIBUTORS

Dependent variable: $c_i^{t+1} - c_i^t$ for $(c_i^t - \bar{c}^t < 0)$

	Monetary Partner	Nonmonetary Partner	Nonmonetary Stranger
Constant	0.783**	−1.948**	−0.953
	(0.360)	(0.951)	(0.928)
Points received	0.123*	0.1417***	0.104**
in period t	(0.068)	(0.054)	(0.047)
Deviation from	−0.421***	−0.496***	−0.312**
the average	(0.087)	(0.152)	(0.166)
$(c_i^t - \bar{c}^t)$			
R^2	0.175	0.168	0.064
Observations	160	178	189

Notes: Standard errors are in parentheses.
* Significant at the 10-percent level.
** Significant at the 5-percent level.
*** Significant at the 1-percent level.

β_1 measures the effect of the total number of points player i receives on his change in contribution from one period to the next, and β_2 is the effect of the difference between individual i's contribution and the mean contribution level of his group in period t. The model is estimated separately for players who contributed more and less than the mean in period t. The β_2 estimates in Tables 4A and 4B show a significantly negative relation between the deviation from the average and the subsequent change in contribution in all six estimated equations. However, the β_1 estimates in Table 4A suggest that even after this effect is accounted for,

TABLE 4B—DETERMINANTS OF CHANGES IN CONTRIBUTION: HIGH CONTRIBUTORS
Dependent variable: $c_i^{t+1} - c_i^t$ for $(c_i^t - \bar{c}^t > 0)$

	Monetary Partner	Nonmonetary Partner	Nonmonetary Stranger
Constant	1.397***	0.172	0.290
	(0.336)	(0.697)	(1.120)
Points received	−0.300***	0.007	−0.049
in period t	(0.066)	(0.065)	(0.060)
Deviation from	−0.770***	−0.835***	−0.901***
the average $(c_i^t - \bar{c}^t)$	(0.096)	(0.131)	(0.136)
R^2	0.262	0.168	0.241
Observations	191	207	145

Notes: Standard errors are in parentheses.
*** Significant at the 1-percent level.

both formal and informal sanctions raised contributions for individuals who contributed less than the average.

Thus a correlation exists between the receipt of punishment points and the subsequent net change in contribution for those who contributed less than the group average. The estimates in Table 4B suggest that greater monetary sanctions actually lowered the contributions of those who contributed more than average, perhaps because they reciprocated the punishment inflicted on them. Under NP and NS this pattern was not observed.

III. Discussion

Our experiment provides an example of how cooperation can be enhanced purely by informal sanctions. Nonmonetary sanctions initially raise contributions by as much as monetary sanctions. In later periods monetary sanctions are more effective than nonmonetary sanctions in generating high contribution levels. However, because of the cost of enforcing monetary sanctions, overall earnings are similar under the two systems. Both the Direct and Indirect Punishment Hypotheses are supported, as the increase in contributions caused by informal sanctions supports the IPH, while the greater long-term increase observed under monetary sanctions supports the DPH.

Positive contributions, the use of costly punishment, and changes in behavior in response to informal sanctions are all phenomena that are inconsistent with a subgame-perfect equilibrium in which agents noncooperatively maximize their monetary payoff. However, there are several models, which when taken together, begin to point to a coherent explanation of the behavior we observe. Fehr and Schmidt (1999) show that if some players are averse to inequities in payoffs, the availability of costly sanctions can increase contribution levels. The ERC model of Bolton and Axel Ockenfels (2000), which assumes that players are willing to sacrifice some absolute earnings to increase their earnings relative to other players, can also explain the application of costly punishment. However, these models, and indeed any approach that assumes that players' decisions consider only the pecuniary payoffs to themselves and others, cannot explain the increase in contribution from nonmonetary sanctions.

Hollander (1990) shows that equilibria with positive contributions can exist in the VCM game if agents value the approval of others. Though the Hollander model is consistent with the data from NP, it cannot account for differences between NP and MP, nor between NP and NS. In Hollander's interpretation of his model, approval and disapproval take the form of emotional reactions to observed contributions. Fehr and Gächter (1998) also raise the potential role of emotions and conjecture that in MP, emotions make noncredible threats of monetary sanctions become credible and cause contributions to increase. Though it is unclear whether there can ever be a consensus on how to model emotions analytically, the NS data do indicate that contributions increase in response to the receipt of points for reasons that are not strategic.

It appears that individuals tend to make higher contributions relative to the preceding period the more points they have received and the lower their contribution was relative to the group average. The presence of these patterns in NP and NS invites an analogy with the work of Kandel and Lazear (1992), Jon Elster (1998), and Bowles and Gintis (2001), who distinguish between internal peer pressure, called *guilt*, and external peer pressure, called *shame*. Guilt causes an individual to incur disutility from causing harm to others, and might be a factor in leading those who contribute less than the average to increase their contribution levels more than others. Shame, a disutility that occurs when others identify the individual as an offender, may be a factor that leads those who receive nonmonetary sanctions to contribute more. One difference between a treatment with no punishment and with nonmonetary punishment is that external peer pressure can be brought to bear, and our experiment suggests that external peer pressure can be a powerful force promoting cooperation.

Bowles and Gintis (2001) model the VCM game with monetary punishment including both guilt and shame in the utility function of agents, in addition to own and others' pecuniary payoffs, and a preference for reciprocating others' contribution levels. If the receipt of points is assumed to induce shame, their framework explains the increase in contributions in response to the introduction of the sanctioning system in NP. The model is also consistent with higher contributions in MP than in NP, since MP has the avoidance of both shame and pecuniary penalties to promote contributions.

In the NP and NS treatments, players who received more than 50 percent of the maximum possible number of points tended to increase their contributions, while those who received less did not. Furthermore, the relationship between the informal sanctions and the change in contribution was nuanced in that more points received corresponded to a greater increase in contribution. The number of points associated with an increase in contributions was greater than any one sanctioner, even assigning the maximum number of points, could impose. This is a sharp contrast to MP, where the receipt of merely one point was associated with an increase in the average individual's contribution. It may be that for informal sanctions to be effective in altering an individual's behavior, he must recognize that there is a degree of consensus among the other players that his contribution is inadequate. On the other hand, when a formal sanctioning system exists, one dedicated enforcer can keep contributions high.

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