Negotiation in the Commons: Incorporating Field and Experimental Evidence into a Theory of Local Collective Action

by

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This paper develops a model of community level collective action to explain the evolution of institutional solutions to social dilemmas. The assumptions of the model are based on evidence from ethnographic and experimental studies that show that the degree of excludability of a common pool resource affects agent behavior by forming the basis for an ingroup. The major predictions of the model are that members of a community will develop institutional rules to protect cooperation and that the level of cooperation will be determined endogenously by the community's rule choice. The results of a new experiment support these predictions. (JEL: C 78, C 91, H 41, Z 13)

I. *Introduction*

Ever since HARDIN [1968], theoreticians have doubted that community-level collective action can be an effective means of local conservation. However, countless field and experimental studies have consistently found cooperation where conventional theory predicts it will not occur. This paper seeks to develop a positive theory of local institutional development that exploits a link between ethnographic and experimental research. In cultivating this link, the model developed herein and the experiment designed to test one aspect of the model attempts to account for and predict when communities are able to solve social dilemmas such as the maintenance of a common pool resource.

Until recently, economic theory has not drawn from ethnographic or experimental research to provide foundations for assumptions it makes about behavior. This is unfortunate because these two types of empirical research compliment each other and can assist theoreticians in developing better models. Anthropological studies are very effective at identifying human universals that

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tend to arise under similar conditions and experimental labs are adept in reducing this behavior to its core determinants. As a result, much that has been learned in the lab about how people react to economic incentives has been given external validity by field studies that identify similar behavior under analogous incentive structures. The next logical step is to base assumptions about the behavior of agents in economic models on these findings and to develop theory that better describes reality.

One topic of research that is ripe for such a synthesis is the area of social dilemmas. Social dilemmas are situations where individuals have incentives to try to exploit the cooperative efforts of each other while not incurring the costs associated with cooperation. The dilemma is that if everyone acts based on these incentives, then no one cooperates and the gains to interaction are not realized. OSTROM [1992] identifies eight factors that tend to be present when communities overcome social dilemmas. In this paper we concentrate on the behavioral implications of one of these factors – the ability to draw clear boundaries between those with rights to access a commonly held resource and those that can be excluded. Using ethnographic and laboratory evidence, we posit and defend the hypothesis that excluding outsiders from the local commons implicitly defines a salient ingroup among the members of the local community which, in turn, provides an impetus to institute rules to govern the use of the commons.

In the remainder of the paper we first develop the connection between exclusion and ingroup formation in the context of field and lab studies. Once this connection has been established, we formulate a model of collective action that incorporates the idea of an ingroup bias. Finally, we develop an experiment to test our main hypothesis that cooperation can be achieved at high levels when an ingroup is given the opportunity to choose rules that protect cooperators. The last section discusses the implications of the model for policies that can foster and enhance the efficiency of community-based solutions to social dilemmas.

2. *Lessons from the Field and the Lab*

Surveying the ecological and ethnographic literature on local solutions to common pool resource problems reveals that the resource in question is often characterized by some degree of excludability. The studies of local fishery management conducted by ACHESON [1987], [1989], [1993]; MILLER [1989]; OSTROM [1990], [1992]; and ENSMINGER AND RUTTEN [1993] in the United States, Mexico, Japan, and Kenya, respectively, demonstrate how local communities, the size of which is often determined by the carrying capacity of the local commons, are able to exclude outsiders from exploiting the resource. To a lesser degree, exclusion is cited as one of a number of factors leading to local collective action that BERKES [1986], CRUZ [1989], and LUECK [1993] attribute to fisheries in Turkey, water rights in tail-end farming communities in the Philippines, and the hunting territories of the Cree Indians, respectively. These field studies beget questions of how outsider exclusion changes the predicted behavior of community members and how these behavioral changes account for successful conservation of the commons.

On the surface, exclusion of outsiders creates local domains and promotes territoriality in community members (ACHESON [1987]). Territoriality is important because it restricts use to a closely linked network of individuals and, therefore, makes monitoring easier and more effective. Monitoring is more effective because being shunned by a fellow member of the community is more powerful than by a stranger (LEVINE AND CAMBELL [1972]). Further, the act of excluding outsiders is likely to act as a symbolic first step towards collective action. Exclusion is symbolic because local community members implicitly create a bond by attributing part or all of the blame to outsiders. As quoted in MCCAY AND ACHESON [1987], "[i]f we can keep others out, it makes sense for us to do something about our own behavior." As a result, restricted access fosters communication among local users who are then able to develop institutions that focus on the viability of the community.

Although field studies identify the links between outsider exclusion and the conservation of the local commons, an intermediate step cannot be deduced from field work. For example, how are the characteristics of social dilemmas responsible for cooperation at the level of the individual? More particularly, why does the exclusion of outsiders motivate community members to develop rules to regulate the commons? The details of this mechanism are best studied in the experimental lab.

The first section of table 1 summarizes the results of ingroup experiments and identifies some of the major findings that are relevant for a behavioral explanation

Table 1

Experimental Research on Ingroup Behavior and Endogenous Rule Change

Experiment	Area of study	Major finding
BREWER [1979], [1981]	Ingroup behavior	In group bias, reciprocity
BREWER AND KRAMER [1986]	Ingroup behavior	Payoff matrix transformed
HORNSTEIN [1976]	Ingroup behavior	Empathy
WILDER AND COOPER [1981]	Ingroup behavior	Empathy
KRAMER AND GOLDMAN [1995]	Ingroup behavior	Value orientation amplified
BOLLE AND OCKENFELS [1990]	Prisoner's dilemma	Payoff matrix transformed
BORNSTEIN, WINTER, AND GOREN [1996]	Ingroup behavior	Cooperation
KOLLOCK [1998]	Ingroup behavior	Payoff matrix transformed
SAMUELSON et al. [1984]	Rule changes	Rule changes
SAMUELSON AND MESSICK [1986]	Rule changes	Subjects choose a representative
SATO [1987]	Rule changes	Subjects choose enforcement

of local collective action.[1] In particular, we focus on how communities, by excluding outsiders, are able to see past individual motivations and cooperate or agree to institute more restrictive rules to protect cooperation.

BREWER [1979], [1981] has experimentally identified the notion of an ingroup bias. In support of the congruence theory, experimental subjects demonstrate an ingroup bias by disproportionately attributing favorable traits to members of their group compared to other non-group subjects. More particularly, people exhibit a positive bias toward members of their own group regarding trustworthiness, honesty, and cooperativeness, resulting in a depersonalized or group-based trust. This intragroup trust is, in turn, responsible for expectations of reciprocity between group members. Additionally, HORNSTEIN [1976] and WILDER AND COOPER [1981] attribute ingroup cooperation to the ability of members of even weakly defined groups to empathize with each other because of attributes perceived to be held in common. Further, it has been demonstrated that subjects' social value orientations are amplified by group membership (KRAMER AND GOLDMAN [1995]).[2] Two patterns stand out in the KRAMER AND GOLDMAN [1995] study. First, people who are predisposed to cooperative acts, as measured by a value orientation instrument, showed amplified levels of cooperation in response to salient social cues associated with group membership. Second, group membership was also shown to affect subjects classified as being more egoistic. Egoistic members of groups (who are most interested in maximizing their own payoff), on average, cooperated more strongly than their counterparts who were not members of groups.

Overall, these aspects of ingroup cognition can be understood to affect the subjective interpretation of social dilemma payoff matrices in experimental studies. BORNSTEIN, WINTER, AND GOREN [1996] and KOLLOCK [1998] have demonstrated that subjects use normal form game payoffs as a baseline, but subjectively revalue the different outcomes based on the strength of group cohesion. A standard 2 by 2 prisoner's dilemma is transformed either into an assurance game (two symmetric pure strategy Nash equilibria) or an invisible hand game (cooperation as the

[1] Psychologists offer three theories to account for the link between a salient ingroup and cooperation. First, social categorization states that individuals structure their perception of themselves and others by means of abstract social categories that they internalize. These social categories are responsible for cohesive group behavior (TURNER [1982]). Second, the theory of congruence states that group membership affects a person's baseline for judging others. This is due to the fact that one person assesses another by summing their perceived trait ratings and then adding or subtracting the person in question's group membership base rating (OSGOOD AND TANNENBAUM [1955]). As a third alternative, the theory of cognitive dissonance predicts that failing to take advantage of the gains to cooperation causes discord among the members of a community. Excluding outsiders allows dissonance to be reduced by using outsiders as a necessary scapegoat. Also in an effort to further reduce dissonance, community members seek to discuss the dilemma they face (see LEVINE AND CAMBELL [1972] for details).

[2] The value orientation instrument is developed in GRIESINGER AND LIVINGSTON [1973] and SHURE AND MEEKER [1967] and has been used to explain cooperative behavior by MCCLINTOCK AND LIEBRAND [1988] and OFFERMAN, SONNEMANS, AND SCHRAM [1996].

dominant strategy) depending on the salience of the group manipulation. This phenomenon is also a likely cause of cooperative play found in the experiments of BOLLE AND OCKENFELS [1990] and BREWER AND KRAMER [1986].

These characteristics of ingroup processes (favorable bias in evaluating other group members, expectations of reciprocity, empathy toward others and the amplification of cooperative predispositions) allow local communities to solve social dilemmas, not only by putting the long term goals of the community before individual wants, but primarily because they allow communities to collectively seek taylor-made institutions that change the rules regarding the use of the commons. In brief, exclusion provides an incentive for the resulting ingroup to build "rules in use" that contribute to the community's stock of social capital.[3]

The second section of table 1 lists experimental research asking whether groups will change the rules regulating the use of the commons when given the chance. The study by SAMUELSON et al. [1984] demonstrates the basic point that members of a group will vote to change the rule governing the commons if they feel that the commons is being over-exploited. The experiments of SAMUELSON AND MESSICK [1986] and SATO [1987] focus on the type of rule that will be chosen by unsatisfied group members. Samuelson and Messick offer three alternative rules and find that subjects most often vote to elect a group leader to make extraction decisions. The second most voted for rule was to allocate the maximum sustainable amount in proportion to the pre-rule change level of extraction. Sato allowed subjects to choose a rule that provided the opportunity to punish other group members who were over-extracting from the experimental commons. The major result of this study was that subjects chose the punishment rule and the threat of punishment improved profits for the group. These studies provide evidence that ingroups (made salient by conversation and the vote) will seek rules to alleviate the dissonance associated with social dilemmas.

In summary, the insights, given by the field studies mentioned above, demonstrate that a first step towards averting a tragedy in the local commons is to exclude outsiders. The results of laboratory experiments have shown that exclusion provides the benefits associated with the ingroup bias. This phenomenon fosters feelings of reciprocity and empathy that give subjects an incentive to discuss alternative rules governing the use of the commons. At the same time, groups have been shown to solve social dilemmas by fostering group-based trust. This trust translates into positive prior expectations on the probability that other group members will cooperate. The end result is a sequence starting with a small but positive probability that other group members will cooperate and, if the prior is reaffirmed by cooperation, it grows to the point where groups can support collective action. Experimental work corroborates this theory in suggesting that, given the opportunity to discuss the current rule structure and given the social dilemma is extreme

[3] The term "rules in use" is borrowed from OSTROM [1992] who also describes locally developed institutions as social capital. Social capital is meant to describe both explicit and implicit institutional structures that contribute to social welfare.

(one that highlights extraction externalities), participants will develop institutions. The next section develops a model of this process.

3. *Bargaining in the Commons*

Accounting for the behavioral implications of group formation, the model developed in this section differs from standard models in two distinct ways. To begin with, the model incorporates a small but positive prior that one agent holds about the cooperation of another group member. This prior is set in proportion to the severity of the dilemma and the strength of group cohesion and is updated endogenously by agent behavior. Secondly, we assume that exclusion of outsiders is sufficient to support good-faith discussion among group members to resolve the dilemma. This assumption is derived from the basic ingroup bias which gives foundations for empathy and reciprocity between group members. It is also supported by the increased ability of group members to monitor and credibly sanction each other.

Consider a forest used by the local community for various sources of timber (e.g., firewood, lumber, etc.). Further, suppose that facing the destruction of the forest, the community has successfully excluded outsiders from extracting resources and is now considering the implementation of an institutional rule to regulate the use of the commons. For simplicity, let the community consist of two lumberjacks who can each cooperate and replant trees after cutting them down or defect and not replant harvested trees. Assume that when the community harvests without replanting, the forest's yield falls to zero.

The four possible outcomes of this situation describe a standard social dilemma. If both lumberjacks cooperate to conserve the commons, they will split its carrying capacity. If the lumberjacks mutually defect, they will ruin the commons by over-harvesting and end up with nothing. Lastly, if one lumberjack cooperates and the other defects, then the defector will benefit from the re-planter and not incur the cost of replanting. Let the cost of replanting be c and the gains to the cooperative act of replanting in terms of future harvests be G_C for each cooperative act. This means that the carrying capacity of the commons, net of replanting costs, is $2(G_C - c)$. Figure 1 represents the structure of this interaction as a normal form game. Call the two lumberjacks Row and Column and assume they must choose to either cooperate (C) or defect (D). The condition $1/2\, G_C < c$ assures that the dominant strategy for each lumberjack is to cut and not replant because any unilateral cooperator's share of the harvest of replanted trees will not be enough to cover the costs associated with replanting. Hence, in the absence of an institution to govern the forest, the two lumberjacks have the incentive to cut and not replant. Therefore, the Nash prediction is the destruction of the forest.

As stressed above, by excluding outsiders from the forest, the lumberjacks are likely to be influenced by an ingroup bias and find it in their interest to discuss a solution to the dilemma that they face. At the foundation of the dilemma is an uncompensated transfer in the form of the act of replanting from any unilateral cooperator

Figure 1

The Forest Conservation Problem

Row \ Column	*C*	*D*
C	$G_c - c$, $G_c - c$	$1/2\ G_c - c$, $1/2\ G_c$
D	$1/2\ G_c$, $1/2\ G_c - c$	0, 0

to his/her free-riding counterpart. Designed properly, an institution can change the structure of the situation by providing a rule that compensates unilateral cooperators and forces defectors to bear some of the cost of conserving the commons. Here, the term *institution* is meant to describe a rule that assures unilateral cooperators a set portion of the gains their cooperation generates and also dictates a fixed portion of the costs associated with cooperation that defectors must pay.

To formulate the development of an institution as the outcome of two-person bargaining, first allow the two lumberjacks to have preferences over any convex combination of the possible outcomes of the interaction. For this to be the case, we assume that the lumberjacks have preferences over all the possible lotteries constructed using the unilateral defect, the asymmetric, and the cooperative outcomes as endpoints (VON NEUMANN AND MORGENSTERN [1944]). The resulting bargaining set contains all the outcomes that lie on or in the parallelogram with the four outcomes of the game represented in figure 1 as vertices. This set is drawn as figure 2.[4] The rationale for representing the game this way is to allow all possible allocations of the costs and benefits of cooperation (as represented by different values of γ) to potentially obtain. In this case the disagreement point is the outcome that occurs when the community cannot settle on an institution, (0, 0), the Nash prediction.

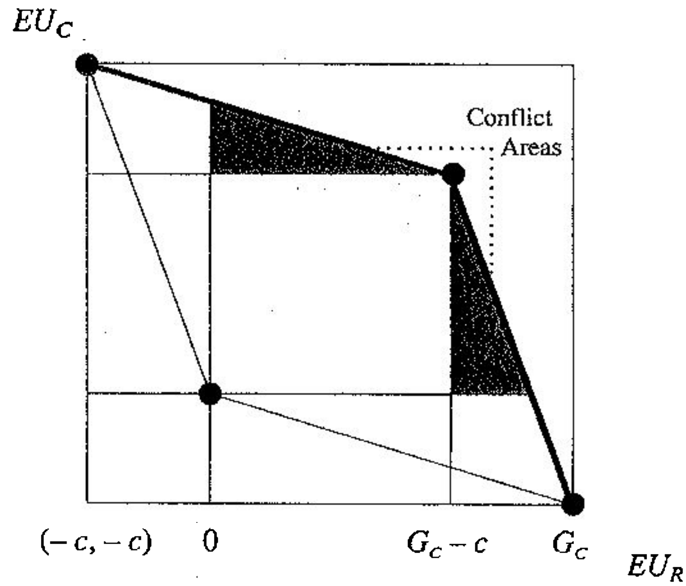
Now that the community has preferences over all the outcomes in figure 2, define $\gamma \in [0,1]$ as an institution that determines the amount of the benefits from any solitary cooperative act that the producer keeps and, at the same time, a measure of the amount of the cost of cooperation that a free-rider must incur. Choosing γ in this way will make possible all the outcomes under the convex hull connecting the two egoistic payoff-maximizing outcomes (Row cooperates/Column defects and Column cooperates/Row defects) to the cooperative outcome.[5] The Pareto frontier of this set coincides with the convex hull created by the institution γ.

[4] Here $1/2\ G_c$ is replaced by G_c to undo the implicit rule that unilateral cooperators must share the benefits of their contribution equally.

[5] Points strictly under the convex hull, are characterized by not fully taking advantage of the gains to cooperation. We assume that no such inefficiency exists for the purposes of this discussion.

Figure 2

Utility Representation of the Forest Conservation Game



Institutions to coordinate or regulate behavior are rarely costless. Let $e(\gamma)$ be the cost associated with enforcing the institution γ, where $e(\gamma) < G_C - c$ and $e'(\gamma) > 0$.[6] Think of $e(\gamma)$ as a cost imposed on unilateral cooperators who look to the institution for compensation.[7] When cost-effective, the lumberjack who becomes the "sucker" (i.e., is cheated on) has an incentive to enforce the rules agreed upon in an attempt to recover some of the cooperative gains they create. When both lumberjacks cooperate, there is no need to enforce the rule. When they both defect pointing fingers at each other only adds to the dilemma.

Figure 3 illustrates the normal form of the game that the lumberjacks play after deciding to implement some rule, γ, and the cost, $e(\gamma)$, is imposed on unilateral cooperators.[8] The major difference between the game in figure 3 and the game in figure 1 is the way that exploitative behavior is treated. By creating an institution to regulate the benefits of defecting, the community can allow any outcome that permits the payoff to cooperating unilaterally to vary between not receiving any of

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6 The condition $e(\gamma) < G_c - c$ assures that it is potentially worthwhile to enforce γ, and the condition $e'(\gamma) > 0$ implies that the cost of enforcing a rule is increasing in how restrictive it is.

7 There is strong evidence from voluntary contribution experiments that subjects will undertake costly punishment when they feel other members of the group are exploiting their cooperation. For examples see SATO [1987], OSTROM, WALKER, AND GARDNER [1992], FEHR AND GAECHTER [1998], or CARPENTER [1999].

8 The payoffs of this game can be related to figure 2 by assuming that the community is able to take full advantage of the gains to cooperation (assuming $e(\gamma) = 0$) and by allowing the returns to the *de facto* altruist to range from $-c$ to $G_c - c$ as $\gamma \to 1$ and the returns to unilaterally defecting to range from G_c to $G_c - c$ as $\gamma \to 1$.

Figure 3
Designing an Institution, γ

Row \ Column	C	D
C	$G_c - c,\ G_c - c$	$\gamma G_c - c - e(\gamma),\ G_c - \gamma c$
D	$G_c - \gamma c,\ \gamma G_c - c - e(\gamma)$	0, 0

the benefits of cooperation and being able to internalize them all (adjusting for any enforcement costs). Also, the payoff to exploiting the cooperation of the other player now varies from paying none of the cost and receiving all of the benefits to having to pay the full cost of cooperation. The importance of designing γ in this way is to assure that all the possible lotteries of the space spanned by the outcomes of the original social dilemma are incorporated into the analysis. Now the question arises: If γ is determined endogenously, which value will the community choose?

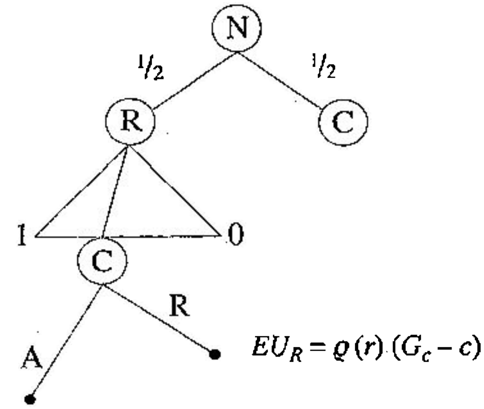
To incorporate group-based trust, suppose the lumberjacks initially formulate subjective priors about what strategy their partner will choose in an unregulated commons. Further, based on the above discussion of experimental studies we assume that these priors are a function of the salience of group membership which is determined by the severity of the dilemma facing the community and the degree of reciprocity implied by the level of group cohesion.

Formally, let $r \in [0, 1]$ be the prior probability a lumberjack assigns to the likelihood that her partner will cooperate and replant after cutting trees (i.e., her assessment of the cooperativeness of her partner).[9] In this case, each agent expects the other to cooperate with probability r. Therefore, because each agent reciprocates by also cooperating with propensity $\varrho(r) \in [0, 1]$, where $\varrho'(r) > 0$, the expected level of cooperation – from the agents point of view – is $\varrho(r)^2$, the expected probability of mutual defection is $[1 - \varrho(r)]^2$, and the probability of one lum-

[9] Here, we assume (again for simplicity) that the lumberjacks have identical priors that are based on a subjective measure of the severity of the dilemma and the reciprocity that comes with the establishment of an ingroup. More specifically, assume that this prior is increasing in the severity of the dilemma, increasing in the degree to which reciprocity becomes the culture of a group, and increasing in the belief that the rules regulating the commons are responsible for the dilemma and not individual behavior. This assumption is based on the study mentioned above by SAMUELSON et al. [1984] and by numerous experiments that show that reciprocity influences the outcome of experimental games (see FEHR, GAETCHER, AND KIRCHSTEIGER [1997], for example). Also, we do not assume that this prior is decreasing in group size. Although there is theoretical support for this position (e.g., OLSON [1965]), experimental research continually refutes it. See LEDYARD [1995] for a discussion of this topic.

Figure 4

Bargaining Over γ with Endogenous Risk of Breakdown



$$EU_A = [\varrho(r)]^2 (G_c - c) + [\varrho(r) - \varrho(r)^2](1+\gamma)(G_c - c) - [\varrho(r) - \varrho(r)^2]\, e(\gamma)$$

berjack being the sucker is $\varrho(r)[1-\varrho(r)]$.[10] Notice, the level of cooperation in the commons is a function of the beliefs of the agents about the behavior of their partner and their own level of reciprocity. Hence, the level of cooperation increases as the environment (i.e., the severity of the dilemma) calls for and as groups form and stir feelings of reciprocity.

To find the equilibrium value of the institution, γ^*, suppose that one lumberjack is randomly assigned the role of making a proposition and the other is given the right to accept the proposition, in which case the rule will be imposed, or reject the proposal, in which case no institution will be implemented. The extensive form of this bargaining game is illustrated in figure 4. Here, nature moves first and with probability 1/2 Row makes the proposal and with probability 1/2 Column is the proposer. Suppose Row becomes the proposer, chooses a value of γ between 0 and 1, and offers it to Column. If Column rejects this proposal, no institution is implemented and the players each believe they will yield an expected utility of

$$EU_R = [\varrho(r)]^2 (G_c - c) + \varrho(r)[1-\varrho(r)](1/2\, G_c - c) + [1-\varrho(r)]\varrho(r)(1/2\, G_c) + [1-\varrho(r)^2](0),$$

which simplifies to

$$EU_R = \varrho(r)(G_c - c).$$

If the proposal is accepted, then each player's expected utility depends on the level of γ chosen,

[10] One important detail to notice is that the risk of ending up in the breakdown state (0, 0) in an unregulated world is determined by the priors that the players hold over the likelihood of a cooperative partner. Further, as will be demonstrated below, this probability changes endogenously in relationship to the community's choice of an institution.

$$EU_A = [\varrho(r)]^2 (G_c - c) + \varrho(r)[1 - \varrho(r)][\gamma G_c - c - e(\gamma)] \\ + [1 - \varrho(r)]\varrho(r)(G_c - \gamma c) + [1 - \varrho(r)]^2 (0),$$

which simplifies to

$$EU_A = [\varrho(r)]^2 (G_c - c) + [\varrho(r) - \varrho(r)^2](1 + \gamma)(G_c - c) - [\varrho(r) - \varrho(r)^2]\, e(\gamma).$$

After some algebra, the value of γ, which makes EU_R just equal to EU_A, can be shown to be $e(\gamma)/(G_c - c)$. Therefore, Column will accept any value of γ greater than $e(\gamma)/(G_c - c)$ because rules having this characteristic strictly increase expected utility.[11]

Now that we have characterized responder behavior, we can turn to the proposer. The proposer will pick γ to maximize expected utility, which occurs where

$$\frac{\partial EU_A}{\partial \gamma} = [\varrho(r) - \varrho(r)^2](G_c - c) - [\varrho(r) - \varrho(r)^2]\, e'(\gamma) = 0$$

or where the marginal benefit of enforcing the rule if cheated on, $G_c - c$, equals the marginal cost of enforcing, $e'(\gamma)$. Notice that enforcement acts to deter potential defectors. The marginal benefit of enforcing the rule is the benefit associated with turning a defector into a cooperator or $G_c - c$. Therefore, if sanctioning fellow community members is cheap relative to the gains of mutual cooperation (as is typically the case), then communities will find it in their interests to institute strong rules to protect cooperation.

By returning to figure 2, the logic of this result can be clarified. For the moment, disregard the cost of enforcing the rule which implies that γ equals one in equilibrium. In this case, as the value of γ increases, the two asymmetric outcomes where one lumberjack cooperates and the other defects are drawn along the convex hull representing the Pareto frontier inward towards the cooperative outcome. As this happens, the variance in the potential outcomes falls because the payoff to defecting on a cooperator decreases and the sucker's payoff increases. For any level of γ that moves these outcomes somewhere into the unshaded areas of figure 2, defection is still a dominant strategy and, therefore, the institution is unable to support mutual cooperation.[12] However, the interaction becomes a game of chicken and defection loses dominance when the value of γ withdraws the asymmetric outcomes past the border of the lightly shaded regions. This value is $\gamma_{\text{critical}} = c/G_c$. Institutions in this region ($c/G_c < \gamma < 1$) are actually likely to foster antagonism because of the asymmetry of the resulting off-diagonal payoffs. While each player would prefer to bully his or her partner into capitulating (i.e., to be convinced to unilaterally cooperate),

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[11] Notice, we do not write $\varrho(r, \gamma)$ because in this case it is obvious that choosing to create a more restrictive institution will increase cooperation - we would basically be assuming the outcome we are interested in. Instead, we choose to make ϱ independent of γ and then we will show how beliefs, through ϱ depend on the institutional choice, in equilibrium.

[12] Again, any outcome strictly below the convex hull is characterized by an agreement that does not take full advantage of the gains to cooperation. See footnote 5.

they cannot be certain that the partner will not show strength at the last moment. This type of conflict does not arise in the institution-less community (when $\gamma < c/G_c$) because each player can rationalize defection as simply pursuing one's interests. Where γ drags the asymmetric outcomes into the areas designated by conflict in figure 2, bullies exhibit greed because defection is no longer defensible on the grounds of fearing to be a sucker.[13] As the value of γ increases, the incentive to elbow one's partner into an asymmetric outcome diminishes until it finally vanishes, where $\gamma = 1$. At $\gamma = 1$ cooperation becomes a weakly dominant strategy and there is no longer any incentive (first fear of being the sucker, then greed) to not cooperate.

Reintroduce the cost of enforcing into the analysis. As defined in YOUNG [1997], the institution developed here can be thought of as a conventional contract that develops because it is the only solution that is mutually acceptable to all community members. For any value of γ less than where $G_c - c = e'(\gamma)$, some community members will be taken advantage of by free-riders and will seek to change the convention to protect themselves.

It is important to stress the endogenous nature of these results because they highlight the ability of communities to regulate themselves effectively and also demonstrate the self-sustaining nature of the institutional rules developed. To demonstrate this, we will show that the risk of breakdown (i.e., not being able to create an acceptable rule) is endogenously determined by the choice of γ. First, derive the equilibrium beliefs of each agent, r, by noticing that in equilibrium the payoff to cooperating based on these beliefs must equal the payoff to defecting, otherwise the community would continuously be changing rules. Therefore, in equilibrium $\varrho(r)$ must solve

$$\varrho(r)(G_c - c) + [1 - \varrho(r)][\gamma G_c - c - e(\gamma)] = \varrho(r)(G_c - \gamma c),$$

which yields

$$\varrho(r)^* = \frac{\gamma G_c - c - e(\gamma)}{\gamma G_c - \gamma c - e(\gamma)}.$$

Notice that $\varrho(r)^*$ approaches 1 as γ approaches 1. This result demonstrates that beliefs change from defection to cooperation as players internalize more of the cooperative gains they generate. More formally,

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13 Here, greed is quantifiable. For any value of $\gamma \in [c/G_c, 1]$, the social efficiency of the two asymmetric Nash equilibria are always less than the efficiency of the mutual cooperation outcome. Therefore, aggressive players who try to coerce their partner into a situation that favors them are sacrificing total social production for a greater share of a smaller pie.

It is well established in the ethnographic literature that situations in which one group member becomes stronger than the rest are unsustainable and often lead to the banishment or death of the ambitious leader. BOEHM [1993] develops the theory of reverse dominance hierarchy to account for this regularity in small scale (including hunter-gatherer, sedentary, and pastoral) societies. Also, KNAUFT [1991] develops a U-shaped evolutionary trajectory of hierarchy through monkeys, apes, small-scale human, and large-scale human societies, the minimum of which coincides with small-scale human society.

$$\frac{\partial \varrho(r)^*}{\partial \gamma} = \frac{c\,[(\gamma-1)\,e'(\gamma)+G_c-c-e(\gamma)]}{[\gamma G_c-\gamma c-e(\gamma)]^2},$$

which is greater than zero for $(G_c - c - e(\gamma)) > e'(\gamma)$. This illustrates that, as long as enforcement does not become too costly when the community "bargains up" the value of γ, agents are likely to increase the likelihood they assign to the cooperation of others and are less likely themselves to defect, given the institution.

4. *The Results of a New Experiment*

This section reports the results of an experiment designed to test one particular aspect of the model developed in section 3. While it is important to understand how ingroups form and affect outcomes in social dilemma situations, because this topic has been researched extensively (see table 1), we focus on testing the main result of the model. That is, we focus our attention on how institutional choice affects the level of cooperation in a social dilemma. The experiment simulated the normal form game structure of figure 3. Subjects were matched and given experience playing with anonymous partners in a version of figure 3 that had the payoff structure of a prisoner's dilemma game. We allowed subjects experience in the standard prisoner's dilemma environment for two reasons. First, we wanted subjects to gain experience in a normal form game structure so that they would understand the incentives. More importantly, however, we also felt that experiencing being cheated on or cheating on someone else in the prisoner's dilemma forms the basis for an ingroup as subjects start to understand that "everyone is in the same boat."[14]

To concentrate on institutional choice and the endogenous nature of cooperation, $e(\gamma)$ was set to zero in the current design. As mentioned above, when enforcement is costless, the marginal benefit of the institution is always positive and, therefore, in equilibrium, the community will set γ equal to 1. While eliminating the cost of enforcing simplifies the experiment, it also provides us with a clear prediction that can be directly tested in the lab.

After gaining experience with the incentive structure of the game and having been anonymously repaired after every round, as in the model, half the subjects were given the opportunity to change the game and the other half were instructed to accept or reject the other player's choice. The proposer was able to choose among various values of γ, including the value that produced the game that had already been played. The model predicts that proposers will choose the game created using $\gamma = 1$, their partners will accept any proposition where γ is larger than the baseline, and that both players will be more likely to cooperate under the new in-

[14] In fact, anecdotal evidence from exit surveys demonstrates that many subjects, after experiencing the inefficient Nash outcome for two or three periods, looked at the institutional choice part of the experiment as a cooperative venture with the person they were matched with.

centive structure. Also, the model predicts that the probability of cooperation will be determined endogenously by the value of γ chosen. The data on subject choices is presented after the details of the experiment are described.

4.1 *Subjects*

A total of 70 undergraduates (44 male and 26 female) in anonymously repaired dyads were used as subjects. Participants were recruited from a summer Microeconomics class at the University of Massachusetts (henceforth UMass) and from the general student population at Middlebury College. To induce the proper incentives, the UMass subjects played for points that translated into extra credit for the class and the Middlebury subjects played for cash.

4.2 *Design*

A two-treatment related pairs design was used to test the effect of bargaining over the rules of the commons on subject's decisions to cooperate or defect. The experiment consisted of five rounds. For the first four rounds the subjects played a prisoner's dilemma game with randomly reassigned partners before each round. Prior to the fifth round, subjects were randomly repaired, and each pair chose a level of γ (implicitly by choosing a game matrix) for the fifth round. Round five proceeded as the prior four rounds, except that the matrix chosen by the pair was substituted for the baseline game.

4.3 *Procedure*

Subjects were seated in a large class room with enough room between each person to assure anonymity in decision making. As the subjects came into the room, they were handed an identification number and when everyone was in the room, the instructions were handed out. Subjects were given plenty of time to read the preprinted instructions.[15] After nearly everyone was finished, the instructions were read aloud by the experimenter and questions were answered.

The instructions included information that explained the nature of the incentives and how to understand the payoff table. In addition, the instructions assured subjects that their decisions would remain anonymous, that after each round they would be randomly repaired with another subject, that the experiment would last for as many rounds as could be completed in the allotted time, and gave no advanced warning that the interaction would change after round four. Lastly, the instructions finished by asking a control questionnaire to test whether subjects understood how to read the payoff matrix.

Rounds one through four were conducted as follows: Decision sheets were passed out which consisted of the payoff matrix labeled (v) in figure 5 and a sen-

[15] Instructions are available upon request.

tence reminding the participant of the decision they were to make.[16] The payoff matrix was constructed based on the game in figure 3. In this case, the gains to cooperation (G_c) were five dollars, the cost of cooperation (c) was two dollars, and the mutual defect outcome was two dollars for each subject. The level of γ used for the first four rounds was $\gamma = 0.4$ which resulted in a prisoner's dilemma situation (again, this is game (v) of figure 5).

Figure 5

Game Matrices for Given Values of γ

General Form of the Game

Other Player's Choice \ Your Choice	L	R
L	3 / 3	$5-2\gamma$ / $\gamma 5-2$
R	$\gamma 5-2$ / $5-2\gamma$	2 / 2

Matrix (i) $\gamma = 0.6$

Other Player's Choice \ Your Choice	L	R
L	3 / 3	3.8 / 1
R	1 / 3.8	2 / 2

Matrix (ii) $\gamma = 0.2$

Other Player's Choice \ Your Choice	L	R
L	3 / 3	4.6 / − 1
R	− 1 / 4.6	2 / 2

Matrix (iii) $\gamma = 0.8$

Other Player's Choice \ Your Choice	L	R
L	3 / 3	3.4 / 2
R	2 / 3.4	2 / 2

Matrix (iv) $\gamma = 1$

Other Player's Choice \ Your Choice	L	R
L	3 / 3	3 / 3
R	3 / 3	2 / 2

Matrix (v) $\gamma = 0.4$

Other Player's Choice \ Your Choice	L	R
L	3 / 3	4.2 / 0
R	0 / 4.2	2 / 2

16 The payoffs in figure 5 are measured in dollars. Session one (at UMass) was run as part of a course. In this case, the subjects played for points which translated into part of their participation grade. The payoff tables for this session can be derived by multiplying all the elements in figure 5 by 10. The general form of the interaction used to create the games with differing values of γ is presented in the upper left corner of figure 5.

After all subjects made their choices, the decision sheets were collected, and two sheets at a time were randomly chosen to be matched with each other. The decisions were recorded and the decision sheets were returned to the subjects so that they were informed of the outcome of each round.

After four rounds were completed, a new set of instructions was handed out that explained the bargaining segment of the experiment. The instructions said that a coin would be tossed to assign the positions of proposer and responder based on the identification number subjects had been given. Next, the instructions explained that the task of the proposers was to decide on a matrix to be used in round five. The five matrices (with associated level of γ) are given in figure 5. Subjects were then told that responders would be assigned the task of accepting or rejecting the choice made by the proposer. All subjects were told that if a proposal was accepted, then the chosen matrix would be used for the interaction in round five and if it was rejected, then the pair would use the same matrix that had been used in the prior four rounds. This matrix ($\gamma = 0.4$) was one of the possible choices for the proposers. Finally, after the matrix had been decided upon, the subjects were told that they would play any remaining rounds with the chosen matrix. Individual subjects earned the sum of all the cash they made in each of the five rounds. The entire experiment including the instructions lasted about an hour and a half.

4.4 Results

Table 2 presents the raw data from the five sessions of the experiment. Using this data, the major predictions derived from the model constructed in section 3 will be tested. Table 2 is organized by round and by pairing in round 5. For example, in session 1 subject number 1 was paired with subject number 8 in round 5. Further, the first line of the table consists of the decisions made by subject 1 who defected in all four rounds prior to bargaining, accepted the offer that was proposed ($\gamma = 1$) and cooperated in round 5.

Overall, the first round of the baseline game ($\gamma = 0.4$) is somewhat lower than the results of other social dilemma experiments which find initial levels of cooperation of between 40 and 60%. The average level of cooperation in round 1 was 26%.[17] This level of cooperation depreciated dramatically after round 1 as people learned the structure of the game (i.e., they were taken for suckers). The level of cooperation dropped immediately to 13% in round 2 and stayed extremely low until the end of round 4.

The sixth column of table 2 presents the results from the bargaining portion of the experiment. Thirty of thirty-five proposers chose $\gamma = 1$ and the average level of the institution that was proposed was $\gamma_{ave} = 0.93$. Column seven shows that all but three of the offers were accepted.

[17] Statistical tests show that behavior in session one where subjects earned class points did not differ from the other four sessions (Fisher Exact Test, $p = 1$ for all comparisons). Hence, the data has been pooled for what follows.

Post-bargaining play is characterized by a large increase in cooperation. The average level of cooperation in round 4 was 11% and it rose to 81% in round 5. On second glance, one notices that all subjects who played the game where $\gamma = 1$ cooperated (even though it is only a weakly dominant strategy) and the 18% who defected in round 5 all played a game where γ was less than 1. Therefore, the cooperation rate under the predicted rule was 100%. Figure 6 illustrates the changes in the level of cooperation over the 5 rounds of play.

The first prediction of the model is that, given the opportunity, players would choose the game where γ equaled 1. The evidence in favor of this prediction is quite strong, 86% of proposers choose $\gamma = 1$. Comparing the average institution level of 0.93 to the hypothesized mean of 1, we find the average is significantly lower than 1 (Wilcoxon Signed Rank Test, H_0: $\gamma_{ave} = 1$, $z = -2.22$, $p = 0.0132$). However, the mean institutional choice is significantly different from the level of γ that had been used prior to bargaining (Wilcoxon Signed Rank Test, H_0: $\gamma_{ave} = 0.4$, $z = 5.49$, $p = 0$) which confirms that subjects were interested in changing the structure of the interaction. These results demonstrate that subjects will change the rules of the game to allocate more of the benefits of cooperation to the cooperator if they are provided the opportunity.

While the majority of subjects choose γ equal to one, the average is significantly lower than 1 because a few subjects choose other institutions. Two subjects choose γ equal to 0.8 which, revisiting figure 5, generates a game where defect weakly dominates cooperate, but the penalty to being a "sucker" vanishes. In only two cases do subjects offer institutions that actually increase the gap between the sucker payoff and the defect on a sucker payoff.[18] It is apparent that for a majority of the subjects experiencing the prisoner's dilemma has fostered a sense of community because they seek institutions to protect cooperation.

However, the experiment highlights an aspect of social dilemma situations that has not been adequately accounted for in the model. Namely, there are a small number of agents who actively look to take advantage of others. Choosing γ equal to 0.2 implies a clear strategy of trying to change the rules of the game with the hope of defecting on a cooperator and earning even more. In fact, both subjects who offered $\gamma = 0.2$ had either experienced cheating on a cooperator or experienced being cheated on. In one case (session 5) the strategy paid off, as subject 6 was able to dupe subject 1 into cooperating.

The second prediction of the model concerns the behavior of responders. Responders are posited to accept all offers over the existing level of γ and reject any offers below this level. As seen in table 2, all three offers where $\gamma \leq 0.4$ were rejected, and thirty of the thirty-two offers where $\gamma > 0.4$ were accepted. This behavior clearly demonstrates that changes in the rules meant to improve social efficiency were welcomed by subjects who obviously understood the dilemma they faced.

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[18] In the one remaining case, the subjects choose to play the same game they had been playing in rounds 1 through 4.

Table 2

Raw Data from the Experiment

Session	Subject number	Round 1	Round 2	Round 3	Round 4	Value of γ proposed	Accept or reject	Round 5
1	1	d	d	d	d	–	a	c
	8	d	d	d	d	1	–	c
	3	c	d	d	d	–	a	c
	6	d	d	d	d	1	–	c
	5	c	d	d	d	–	a	c
	10	d	d	d	d	1	–	c
	7	d	d	d	d	–	a	c
	4	d	c	c	c	1	–	c
	9	d	d	d	c	–	a	d
	12	c	d	d	d	0.8	–	d
	11	c	d	d	d	–	a	c
	2	d	d	d	d	1	–	c
	13	c	d	d	d	–	a	d
	14	d	d	d	d	0.8	–	d
2	1	d	d	c	d	–	a	c
	30	d	d	d	d	1	–	c
	3	d	d	d	d	–	a	c
	24	d	d	d	d	1	–	c
	5	d	d	d	d	–	a	c
	2	d	d	d	d	1	–	c
	7	d	d	d	d	–	a	c
	4	c	d	d	d	1	–	c
	9	d	d	d	d	–	r	d
	10	d	d	d	d	1	–	d
	11	d	d	d	d	–	a	c
	12	d	d	d	d	1	–	c
	13	d	d	d	d	–	a	c
	8	d	d	d	d	1	–	c
	15	c	d	d	d	–	a	c
	16	d	d	d	d	1	–	c
	17	d	d	d	d	–	a	c
	28	d	d	d	d	1	–	c
	19	d	d	d	d	–	a	c
	22	d	d	d	d	1	–	c
	21	c	d	d	d	–	a	c
	26	d	d	d	d	1	–	c
	23	d	d	d	d	–	a	c
	18	d	d	d	d	1	–	c
	25	c	d	c	d	–	r	d
	20	d	c	d	d	1	–	d
	27	c	c	c	c	–	a	c
	6	d	d	d	d	1	–	c
	29	d	d	d	d	–	a	c
	14	d	d	d	d	1	–	c

Table 2

Continued

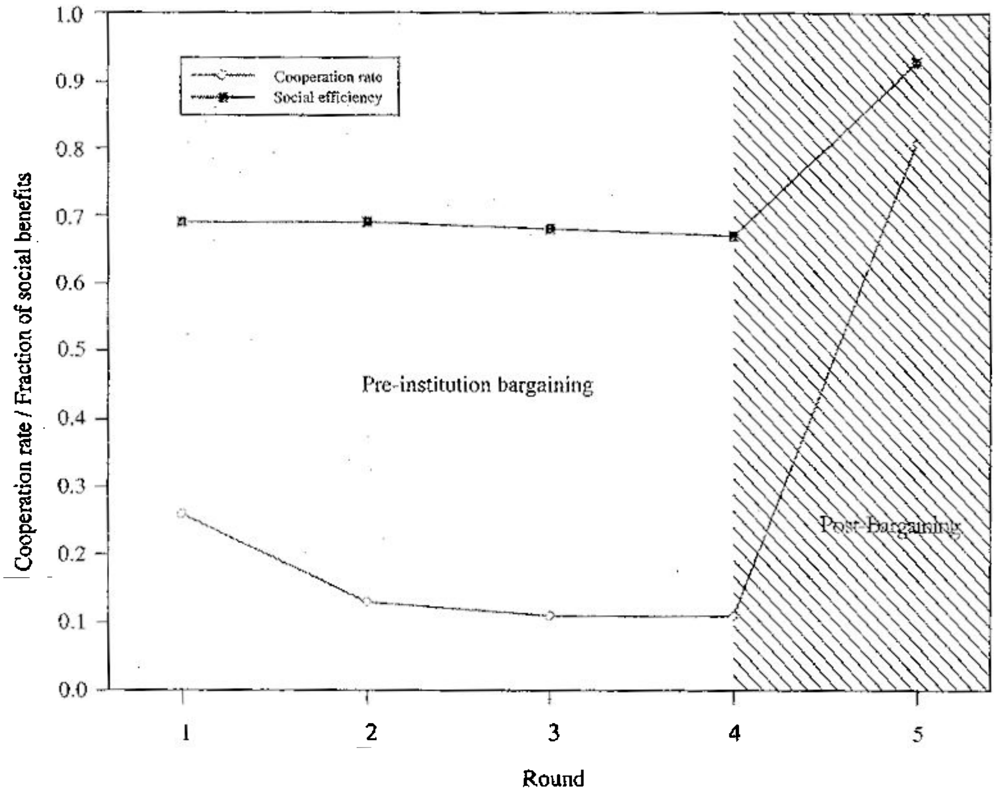
Session	Subject number	Round 1	Round 2	Round 3	Round 4	Value of γ proposed	Accept or reject	Round 5
3	1	d	d	d	d	–	a	c
	2	d	d	d	d	1	–	c
	3	d	d	d	c	–	a	d
	6	c	d	d	d	0.2	–	d
	5	d	d	d	d	–	a	c
	4	c	d	d	d	1	–	c
	7	c	d	d	d	–	a	c
	8	d	d	d	d	1	–	c
4	1	c	c	c	c	–	a	c
	6	d	d	d	d	1	–	c
	3	d	d	d	d	–	a	c
	10	d	d	d	d	1	–	c
	5	d	c	d	d	–	a	c
	8	c	c	c	c	1	–	c
	7	d	d	d	d	–	a	c
	12	c	c	d	d	1	–	c
	9	d	d	d	d	–	r	d
	4	d	d	c	c	0.4	–	d
	11	d	d	d	d	–	a	c
	2	d	c	c	c	1	–	c
5	1	d	c	d	d	–	a	c
	6	d	d	d	d	0.2	–	d
	3	c	d	d	d	–	a	c
	4	d	d	d	d	1	–	c
	5	d	d	d	d	–	a	c
	2	c	d	d	d	1	–	c

The last prediction of the model concerns post-bargaining play. The model predicts that subjects will overwhelmingly cooperate once the structure of the game has been changed so that both the gains to cooperation can be fully internalized and exploitative behavior can be controlled by social contract simultaneously. Table 2 and figure 6 both show that cooperation increases dramatically after the new game structure has been chosen. As another measure of the change in behavior, social efficiency, rises from 67% of the total gains to interaction to 93% after bargaining. This is also illustrated in figure 6.

The McNear Change Test was applied to the data to test the hypothesis that there was no change between pre- and post-bargaining behavior. The test statistic is distributed chi-squared with one degree of freedom. The statistic resulting from

Figure 6

Percent Cooperation and Social Efficiency by Round



the test using the data from rounds 4 and 5 is $\chi^2 = 41.89$, $p = 0$, which supports the posited behavioral change. However, this result is even stronger when considering only those pairs who chose $\gamma = 1$. All subjects who agreed on the institution $\gamma = 1$ cooperated, in round 5 and all but one subject in a pair that chose $\gamma < 1$ defected. The fact that everyone who played the game where γ equaled one cooperated, is indirect evidence that an ingroup was indeed formed simply by letting subjects gain experience in the dilemma first. This is especially true given cooperate only weakly dominates defect when $\gamma = 1$.

Recall that a secondary prediction of the model was that rules instituted where ($c/G_c < \gamma < 1$) may actually maintain or increase the amount of antagonism because the proposer could have chosen $\gamma = 1$. This behavior is also supported by the data, as in the two cases where γ was set to 0.8 the participants both defected because $\gamma = 0.8$ sends a signal of mistrust or malfeasance. Overall the data from the institutional choice portion of the experiment is strong evidence in favor of the model in that it demonstrates that the risk of ending in the breakdown state (defect, defect) is endogenously determined by the trust implicit in the choice of γ.

5. Conclusion

This paper has been an initial attempt towards the development of a behavioral theory of local collective action. It is behavioral in the sense that rather than relying on an oversimplified characterization of economic actors as egoists, the model developed here allows for a richer set of responses to strategic incentives. As a result, new insights into the mechanisms used by communities to develop institutional rules have been uncovered. Most importantly, the model and the experimental data supporting the model's predictions have established that conventions can evolve endogenously to change the incentives of agents in a way that facilitates cooperation. Also important is the result that demonstrates the fragility of institutional design. That is, this research has provided a theoretical framework to understand that the ability of communities to create working institutions is internally determined by the rules that are proposed. Therefore, trust is endogenously created by the rules adopted and, as a consequence, thought must be given to the development of rules that build confidence in cooperation among community members.

On a more practical level, this paper identifies one important policy prescription: efforts to highlight the similarities among agents facing social dilemma situations reinforce the establishment of an ingroup which, in turn, changes an environment hostile to cooperation into one that can support collective action. The formal establishment of a group, wherein group membership is defined by one's relationship to a social dilemma, is sure to strengthen community cohesion and precipitate discussions aimed at developing institutions to protect cooperation.

Admittedly, this has only been a first step. More theoretical and experimental work still needs to be done. In particular, given the support that the current experiment lends to a special case of the model, a more complicated design incorporating non-negligible costs of enforcing contracts is in the process of being constructed. The results of these experiments will identify the degree to which agents in social dilemmas trade off the hassles associated with enforcing rules against the benefits of having more structure. In addition to examining the role of enforcement costs in determining institutions, more theoretical work will be directed towards analyzing how other structural features of social dilemmas (e.g., community size, mechanisms for collective choice, etc.) bias behavior away from the predictions of the rational actor model and towards a more descriptive theory of local collective action.

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