CHAPTER 15

Cooperation and Social Capital

We began this book with a discussion of the fishers of Brixham Harbor and the power companies using The Geysers. We contrasted their unresolved CPR dilemmas with the improved situations of several groundwater basins in southern California, where users were involved in the design of new institutions. Thus, our first concern was with individuals facing problems in field settings. In order to grapple successfully with that concern, however, we have had to focus on issues that are of more theoretical than immediate policy interest. Some readers looking for general solutions to CPR problems may be disappointed with what they have found so far in this book. We hope, instead, that the reader has recognized the importance of theoretical issues for the development of policy analysis that is grounded on empirically supported theory. A policy is only as good as the theory underlying it.

Theoretical Choices in Doing Policy Analysis

In the empirical sections of this volume, we have found some support for theoretical predictions derived from the theory of fully rational individuals in finitely repeated, complete information CPR games. In CPR dilemmas where individuals do not know one another, cannot communicate effectively, and thus cannot develop agreements, norms, and sanctions, aggregate predictions derived from models of rational individuals in a noncooperative game receive substantial support. These are sparse environments and full rationality appears to be a reasonable assumption in them.

We would advise anyone in field situations closely matching these conditions to expect others to select strategies that generate aggregate outcomes close to Nash equilibrium and to act accordingly. In large-scale CPR dilemmas where communication opportunities for all parties are extremely limited, such an expectation means that others are likely to overappropriate, underprovide, and/or engage in high levels of conflict about assignment and technological externality problems. If faced with the necessity of acting in such situations ourselves, we would follow this advice. We would also try
hard to find a way to get out of such unproductive situations or to change their structure.

In richer environments that vary from the institutionally sparse homeland of noncooperative game theory in ways that do not affect the strategic structure of the modeled game, some predictions based on the same theoretical foundations are not supported by our empirical investigations. Simply allowing individuals to talk with one another is a sufficient change in the decision environment to make a substantial difference in behavior, even though promises made without external enforcers are considered to be theoretically irrelevant. Individuals in many field settings not only come to agreements but craft their own rules and enforce these rules without relying extensively on external authorities. Even in the southern California groundwater cases where formal courts and government officials were an important part of the institutional facilities used by participants, the importance of external authorities lay more in the reliable technical information and in the arenas for negotiation they provided than in their design of rules. Designing rules was largely left to the participants themselves. Once the groundwater producers designed their own rules, external authorities assisted in monitoring and enforcing those rules in conjunction with local users.

Readers of chapter 9 will have a variety of reactions to our appeal to bounded rationality as an explanation of the empirical anomalies we have encountered. Some will see that appeal as an indictment of the use of rationality in game-theoretic models of CPR situations. This is not our intention, and we hope to dissuade anyone from drawing such a conclusion. Others will see this appeal as an unwarranted attack on rational choice theories. Again, this is not our intention, and we hope to dissuade anyone from drawing that conclusion. We conclude from our work that assuming fully rational play in a noncooperative game gives us useful and powerful tools to analyze CPR dilemmas. We will continue to assume rational play in noncooperative games as important theoretical tools relevant to our future work. The structure and analytical fabric of this book would not be possible without these tools. Still, all tools have limits. All artisans should know how to use their tools.

It is because we find complementarity in diverse theories and models that we need the IAD framework presented in chapter 2. This framework provides a set of paradigmatic questions to ask, a metalanguage in which to ask them, and a spectrum of variable types for analyzing any microsetting. In order to use tools, one has to have a language about tools—their uses, strengths, and limits. To talk about any particular theoretical language, one needs a metalanguage to engage in the discourse. Game theory provides tools for solving games. To solve a game, one has to develop a model of that game. To puzzle, evaluate, and change that model, one uses game theory as a metalanguage. The IAD framework is a metalanguage for discussing various questions about
theories—game theory, economic theory, rational choice theory, bounded rationality, and public choice theory. These are our essential theoretical tools, and we are responsible for using them properly and treating them with respect.

Thus, we search for the appropriate conjunction of theories of bounded rationality and full rationality. Both provide tools that can be used to understand how individuals act in diverse situations. In simple situations, full rationality will continue to be the most economic and powerful tools we have for predicting and explaining human behavior. In complex situations, however, it is often unreasonable to assume that individuals can undertake complete analyses and adopt unchanging strategies for a long series of repeated games. Efforts to explain cooperation in such settings based on full rationality have had to make assumptions that we do not find appropriate for explaining behavior of real decision makers with limited analytical abilities.

Assuming that individuals, who are making decisions in a time frame that cannot exceed two hours, face an infinitely long sequence of decisions is rather dubious. Assuming that individuals would actually employ grim trigger strategies if someone were to break an agreement is not empirically supported. Assuming that individuals undertake incredible feats of calculation that are required under assumptions of incomplete information seems to us to go in the direction of assuming even higher levels of calculating skills rather than the lower levels we observe in empirical settings.

For scholars who are interested in understanding human behavior in field settings and in developing better polices—ones that are genuine reforms—there are reasons to employ assumptions of both full and bounded rationality selectively. The former is especially useful for the development of tight theoretical models. If an analyst wants to know what rational, self-interested individuals, without normative connections to one another, would do in a particular physical and institutional setting, game equilibrium models based on full rationality are essential techniques to provide an initial answer to this question. The series of games illustrated in chapter 4, created by changing rule configurations, would be difficult to analyze without the tools used in that chapter. Since the rules analyzed were stylized versions of rules discovered in empirical settings, the analysis provides an understanding of why such rules work in practice, even in environments where individuals may not be communicating or sharing much sense of community other than a willingness to abide by these rules.

For understanding human behavior in settings where complexity and uncertainty swamp the limited calculation capabilities of normal humans, however, bounded rationality is a more appealing assumption. In these settings, individuals do not appear to perform a complete analysis of all future moves and then decide—once and for all—on a strategy of how to play the
entire game facing them. Instead, they take shortcuts, and sometimes detours, to arrive at their actual play. The more remote is a behavioral assumption from observed behavior, the less likely is it that the assumption will be useful for policy purposes. In some cases, game equilibrium models of rational play lead to an outcome set where players can do almost anything and still be consistent with the theory. The prediction that individuals might do anything from a large set of feasible strategies is neither useful nor precise.

Assuming that individuals adopt heuristics and learn from past experience enables one to come much closer to predicting and explaining human behavior and outcomes in complex situations. For example, we predict that in most settings where individuals have a chance to communicate effectively with one another and develop joint agreements, they will use measured responses to cope with potential deviations. We specify a distinct reaction space that we expect to see used if individuals use measured-response heuristics. The subspace that counts as a measured response is a small box theoretically carved out of the large space of feasible outcomes. We predict that if most early responses are in the “measured response box” and few responses are “large,” subjects will achieve outcomes that approach optimality. The prediction is sustained by our initial evidence. Obviously, further work is needed to increase confidence in these predictions.

The difference between the type of heuristics we propose and traditional game analysis is important. As mathematical objects, games have solutions and game theorists find them. Ordinary players are another matter. The play of even the simplest games usually involves an initial sense of an ambiguous situation and some kind of characteristic orientation toward ambiguity (V. Ostrom 1994). In field settings, individuals have to learn from mistakes and acquire insight into the strategic structure of the situation. The heuristic for a good poker player, as opposed to the theory of poker, differ. Small changes in the “rules of the house” can make a major difference in the strategic structure of a game. When one moves from parlor games to CPRs in natural settings, the number of potential game structures that could be involved in a CPR situation is astronomical. We can never expect to know all of the games that could be constructed by real players in real settings. As we have seen in the experimental laboratory, small changes can make a major difference in the behavior of those involved. Given this variety, it is no wonder that human behavior approaches, but only approaches, full rationality. Models based on full rationality assumptions will be the most useful when applied to simple, repeated situations that are not subject to easy reconstitution by the participants themselves.

Thus, we think it is important when analyzing complex empirical settings to recognize that individuals have both less and more capabilities than assumed in full rationality models. In such situations, individuals are less capable of making complete analyses than would rational individuals. This
leads them to make decisions sequentially in light of what they learn about the situation, rather than in a once-and-for-all calculation of a complete strategy. On the other hand, individuals may be more capable of changing their situations and of adopting workable heuristics (norms) than is typically presumed. Individuals who start as strangers with no normative relationship to one another may soon begin to discuss a problem with one another and eventually acquire a sense of community and moral responsibility. The capability of humans to agree upon rules that structure their own games has not been taken sufficiently into account in traditional analysis. We hope this book will help change that in the future.

In an empirical setting where individuals have at least some autonomy to decide on their own rules, we can also develop useful predictions. If the interests of the individuals involved are relatively symmetric, face-to-face communication is possible, and the situation is relatively simple, we expect individuals to select rules that are

1. already known to them, either by experience or by reputation;
2. easy to learn, follow, and monitor;
3. likely to reduce the complexity of the situation; and
4. perceived as likely to improve joint outcomes.

For example, if individuals face an assignment problem, such as the one we discuss in chapter 4, we expect that they will draw on their prior experience to devise ways of allocating space or time to participants. If many assignment problems with which they are familiar are resolved by using “first in time, first in right” rules, it comes as no surprise that such a rule is proposed and adopted by participants anxious to improve upon the status quo. Alternatively, if they are more familiar with rotation systems rather than “first in time, first in right” rules, it is likely that individuals will develop a rotation system of some sort.

Rules do not operate by themselves. To be implemented successfully, participants must be able to understand rules and know how to make them work. This knowledge is part of the social capital that individuals develop over time when they have the autonomy to do so. Like all forms of capital, social capital takes a long time to develop and can be destroyed rapidly. Shared understandings about rules that tend to improve outcomes in some settings may be more important in enabling individuals to achieve higher outcomes through cooperation than extensive, written mandates that can never be fully understood or implemented.

Rules are used at times as tools for reducing the complexity of the

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1. Borrowing rules to use in one setting from others is a time-honored practice. Many localities in Europe, for example, adopted the charters of other localities perceived to be relatively similar and to be successfully governed.
situations that individuals face. As we show in chapter 3, the more actions that participants can take, the more complex the strategic calculation for all participants. In very complex settings, it is difficult for participants to gain sufficient understanding of the transformations linking individual actions to outcomes. Simply reducing the number of authorized actions available to all participants may enable them to understand more fully the consequences of various strategies in the reduced subspace.

Individuals appropriating from the same resource and dealing with each other over a long period of time have many opportunities to make small adjustments in the rules they initially adopt. As they learn more and more about the structure of their resource, the strategies used by other participants, and joint outcomes achieved, they can change rules so as to experience improvement over time. Lack of conformance to their agreed-upon sharing and assignment rules will be seen as evidence either that these rules are not well suited to local circumstances or that incentives to cheat overwhelm current monitoring and sanctioning efforts.

Just as verbal agreements in the lab may be undone by a few individuals who engage in large deviations, verbal agreements in the field may be undone by a few individuals who do not follow agreed-upon strategies. Boundedly rational individuals with heuristics that involve cooperation and extending trust are often able to reach and sustain agreements. Boundedly rational individuals without such heuristics are not. The latter are prisoners of their own deep (and under some circumstances, justified) distrust of others. Adding modest self-monitoring and self-sanctioning capabilities to verbal agreements, however, helps prevent many agreements from unraveling. Such arguments can withstand the predations of a few or the temptations that all may face over the course of time. Measured response heuristics backed with moderate sanctioning capabilities appear to be used by participants in many different types of field situations, including establishing and sustaining international agreements (Keohane 1984, 1986; L. Martin 1992; Oye 1986).

Prior studies of robust CPR institutions have found that self-organized systems tend to rely on graduated sanctions starting with small fines or verbal rebukes that constitute hardly more than a symbolic deterrent (E. Ostrom 1990).2 Nevertheless, such small sanctions appear to be very effective in

2. A very recent study of indigenous forest institutions in Nepal provides several instances of these kinds of graduated rules. In the village of Seli, for example, the villagers have devised rules related to harvesting from a community-governed forest. Violators of these rules are fined in cash. Chhetri and Pandey describe the penalty system as follows:

Someone violating the regulation for the first time generally pays a penalty of five rupees which goes up to Rs 50 and Rs 150 for the second and third violations respectively. A fourth-time violator is tried in front of all the user members and they may fix any amount of fine deemed appropriate depending on the seriousness of the violation. (1992, 25)

The researchers mention that they were told that almost everyone in the village has been penalized
showing that rule infractions have been detected and in foretelling the promise of stronger sanctions, if necessary, in the future. Thus, it appears that sanctions often developed in field settings use a similar approach to punishment as the measured responses observed for players in our CPR communication experiments.

We do not claim that the rules adopted by boundedly rational individuals during a learning process achieve optimality. In laboratory settings with all necessary information for finding an optimal solution, subjects frequently came tantalizingly close to, without actually reaching, the optimum. Very few field settings generate the quality of information that laboratory subjects have at their disposal. There is also a question of how individuals in field settings process the information they do have. Field settings are so wrapped up in complexity and uncertainty that satisfactory rules-in-use are a significant achievement, regardless of whether such individuals can actually achieve the optimal solution.

It is also possible that initial decisions to adopt a particular rule reduce the possibility of ever achieving a fully optimal outcome. When rules are used in part to reduce complexity so learning can occur, the best outcome may exist in a subspace that was cut off early in the process of crafting rules. One can expect that the efforts of individuals to constitute and improve their own rule systems are likely to improve the outcomes they achieve. They may even discover local optima. Whether global optima are ever discovered by participants (or, for that matter by external officials) in highly complex field settings is far less probable. One can expect path dependence to be as important a constraint in the design of institutions as it is in the design of technology (see Arthur 1989; North 1990). As we point out in chapter 14, the CPR problems faced in many field settings—characterized by resources that lack stationarity and storage—are particularly difficult for participants, observers, government officials, or anyone else to solve. More theoretical and empirical work is needed to identify those types of empirical settings where the individuals involved are most likely to develop satisfactory rules-in-use and those where perverse incentives or lack of relevant and accurate information make it extraordinarily difficult for self-organization to achieve satisfactory results.

Further, rules that are easy to learn, to follow, and to monitor are not always the rules that lead to the optimal return derived from a model that assumes away uncertainty, monitoring, and sanctioning costs. Many farmer-owned and governed irrigation systems, for example, use simple rotation systems where farmers with adjacent land are assigned sequential rights to

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at least once because the rules are strictly interpreted. The fines go into a common fund used to buy utensils and equipment for communal work in the forest and are loaned to villagers at "reasonable" rates of interest. The exchange rate at the time of this study would have been about $1.00 = Rs 40.
water. These systems are extremely easy to operate. The sequence is frequently repeated. No one farmer really needs to know the entire sequence (Netting 1974). All each farmer needs to know is which day of the week and which hour is assigned to a particular plot, or alternatively, who are the two or three farmers whose turns come immediately prior in the sequence. Based primarily on technical grounds, water engineers have frequently pointed out that higher crop yields could be obtained by using more complex mechanisms to allocate water. Since these proposals do not take into account the added transaction costs involved in administering, monitoring, and sanctioning violators under a more complex rule system, it is not clear whether the theoretical gains in efficiency are operationally feasible.

Our evidence suggests that individuals with considerable experience crafting their own rules acquire a larger repertoire of satisfactory rules than those without such experience. Individuals in relatively simple systems are apt to develop rules more nearly optimal than individuals in more complex systems, especially systems involving substantial asymmetries of interest. Individuals facing complex systems may have a much harder time learning what works and what does not work. If such individuals are also participants in overlapping organizational arrangements that help generate information about successful efforts to govern CPR institutions, then they have a better chance at testing, modifying, and improving their rules.

Policy prescriptions based solely on models that generate deficient equilibria are likely to recommend either that external authorities impose and enforce rules or that no external help is needed. The prescription that external authorities must impose change leads to attempts to impose uniform national or regional laws. In any country where the attributes of the physical world vary substantially across locations, the same set of rules that engender positive outcomes in one physical location can engender negative outcomes in other locations. The imposition of uniform rules can lead to dramatic differences in outcomes or to extreme discretion on the part of officials who adjust the uniform rules to fit local circumstances. Such discretion opens the door to corruption. Those who are adversely affected are tempted to bribe officials to look the other way. 3 Encouraging federations of self-organized CPR users to exchange information about their experiences may be more important in enhancing the efficiency and equity of CPR use patterns than attempting to design and enforce uniform rules devised by an external authority.

By the same token, the broad policy prescription that no intervention is ever necessary, since individuals will always solve these problems, is equally suspect. Once one recognizes how difficult it is to obtain information about

3. Robert Wade (1988a) carefully documents how local villagers may engage in collective action to obtain funds to bribe government officials just to stay away.
the structure and flow from a CPR in the field, the importance of agencies that provide reliable information about local CPRs (such as the United States Geological Survey and the California Department of Natural Resources) is immediately obvious. Assuming that individuals have the information to calculate optima diverts attention from the importance of providing accurate, reliable information as part of the institutional arrangements that facilitate improved outcomes. Further, it is important to recognize that individuals can develop endogenous sanctioning systems when they are dealing with a well-developed community of understanding, but that these systems may need to be complemented by external authorities. Self-organized CPRs may need access to external enforcement of their agreements from time to time to ensure that common understandings are shared and enforced. Appropriate policies involve the provision of fair and inexpensive conflict resolution and back-up enforcement mechanisms, rather than the imposition of rule making and rule enforcement by external officials, on the one hand, or complete neglect on the other.

**Surmounting CPR Dilemmas**

The capacity to change the structure of a situation is a variable in field settings, not a constant. In most enduring relationships, participants have the capability to call "time out— it's time we talked about this situation and tried to change it for the better." In many CPR situations, it is necessary to examine the process of rule change. While playing short-term games within the existing institutional and parametric structure, we often find participants engaged in a long-term process of redefining their institutional structure. Indeed, it is precisely this process that gives us renewed hope in the sustainability of CPRs the world over. Even the most degraded CPR may yet be saved by changes in the behavior of its appropriators.

In this book, we have examined how individuals behave in a multiplicity of CPR dilemmas. In many of these, but not all, individuals overcome the temptations present to overuse the CPR. They do this by communicating their desires to reach acceptable sharing agreements. They build trust in these agreements by extending reciprocity through the use of personal heuristics like measured reactions. In difficult settings, they use measured reactions to bolster their agreements as well as imposing sanctions on those who violate agreements. Individuals who extend reciprocity to others and who learn to

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4. Chapter 4 of this book is an example of a formal treatment of how diverse rules affect the structure of a CPR assignment problem. Milgrom, North, and Weingast (1990) overly analyze the evolution of court institutions and the effect of these changes on trade patterns. Calvert 1993 addresses the importance of making rule changes endogenous rather than treating rules always as exogenous. See also E. Ostrom and Gardner 1993.
craft their own effective rules can accomplish more than individuals who do not, especially when they can identify others following the same heuristics.\textsuperscript{5} Such individuals achieve more than predicted by noncooperative game theory as currently understood.

Our analysis of successful self-organized CPR institutions makes us optimistic about human capacities to overcome the "social dilemmas" they face. It also makes us pessimistic about the likelihood of self-organized improvements in three types of settings. The first is where individuals have no expectation of mutual trust and no means of building trust through communication and continued interaction. The second is where mistrust is already rampant, and communication and continued interactions do not reduce the level of distrust. The third is where many, but not all, individuals are willing to extend reciprocity to others but lack authority to create their own self-governing institutions. Without the capacity to create rules and establish the means of monitoring and sanctioning these rules, reciprocity alone is frequently insufficient to cope with individuals who succumb to the temptations to cheat. If those who are preyed upon cannot develop sanctions against their predators, the likelihood of achieving higher outcomes through their own efforts is low.

Our findings from field studies also alert us to the differences among CPR situations and to the problems involved in crafting appropriate rules in complex situations. These difficulties may be overcome when external authorities facilitate the acquisition of reliable information, the development of long-term contracts, and enforcement mechanisms to complement internal mechanisms. The difficulties do not simply disappear by presuming that larger governmental units must impose solutions on those facing complex, highly variable settings. Finding solutions of any sort in these turbulent environments is a difficult and costly task. Efforts to establish one set of rules to cover large territories, which include significantly different types of local environments, are as problematic as the presumption that those involved may find adequate solutions entirely on their own.

The capacity of CPR users to govern themselves is often a necessary condition for overcoming the temptations involved in a CPR dilemma. The capacity to design and enforce one's own rules, however, is not a sufficient condition to ensure the resolution of difficult and complex dilemmas. Without some willingness to extend reciprocity to others, while building trust and better rules, initial agreements can rapidly unravel. Without access to reliable information about complex processes, participants may not understand the

\textsuperscript{5} In a very interesting paper, Charles F. Sabel (1993) discusses the extent of constitutional ordering in many different private and public settings and how these developments are overlooked by scholars using standard theories of decision making within already created settings.
ambiguous situations they face. The likelihood of crafting and sustaining rules in situations involving many exogenous changes is dramatically reduced. The capacity to design their own rules will not enhance the outcomes achieved by the nontrusting and narrowly selfish individuals of the world, but will enhance the outcomes of those who are prepared to extend reciprocity to others and interact with others with similar inclinations.6 Those who have developed forms of mutual trust and social capital can utilize these assets to craft institutions that avert the CPR dilemma and arrive at reasonable outcomes.

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6. See the insightful recent book by Robert D. Putnam, with Robert Leonardi and Raffaella Nanetti, which explores the question of why new democratic institutions are effectively used by citizens in some parts of Italy and not others.