Scientific Background on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2009

ECONOMIC GOVERNANCE

compiled by the Economic Sciences Prize Committee of the Royal Swedish Academy of Sciences

Economic Governance

Introduction

Institutions are sets of rules that govern human interaction. The main purpose of many institutions is to facilitate production and exchange. Examples of institutions that affect human prosperity by enabling production and exchange include laws, business organizations and political government. Economic governance research seeks to understand the nature of such institutions in light of the underlying economic problems they handle.

One important class of institutions is the legal rules and enforcement mechanisms that protect property rights and enable the trade of property, that is, the rules of the market. Another class of institutions supports production and exchange outside markets. For example, many transactions take place inside business firms. Likewise, governments frequently play a major role in funding pure public goods, such as national defense and maintenance of public spaces. Key questions are therefore: which mode of governance is best suited for what type of transaction, and to what extent can the modes of governance that we observe be explained by their relative efficiency?

This year's prize is awarded to two scholars who have made major contributions to our understanding of economic governance, **Elinor Ostrom** and **Oliver Williamson**.

In a series of papers and books from 1971 onwards, Oliver Williamson (1971, 1975, 1985) has argued that markets and firms should be seen as alternative governance structures, which differ in how they resolve conflicts of interest. The drawback of markets is that negotiations invite haggling and disagreement; in firms, these problems are smaller because conflicts can be resolved through the use of authority. The drawback of firms is that authority can be abused.

In markets with many similar sellers and buyers, conflicts are usually tolerable since both sellers and buyers can find other trading partners in case of disagreement. One prediction of Williamson's theory is therefore that the greater their mutual dependence, the more likely people are to conduct their transactions inside the boundary of a firm.

The degree of mutual dependence in turn is largely determined by the extent to which assets can be redeployed outside the relationship. For example, a coal mine and a nearby electric generating plant are more likely to be jointly incorporated the greater the distance to other mines and plants.

Elinor Ostrom (1990) has challenged the conventional wisdom that common property is poorly managed and should be completely privatized or regulated by central authorities. Based on numerous studies of user-managed fish stocks, pastures, woods, lakes, and groundwater basins, Ostrom concluded that the outcomes are often better than predicted by standard theories. The

perspective of these theories was too static to capture the sophisticated institutions for decision-making and rule enforcement that have emerged to handle conflicts of interest in user-managed common pools around the world. By turning to more recent theories that take dynamics into account, Ostrom found that some of the observed institutions could be well understood as equilibrium outcomes of repeated games. However, other rules and types of behavior are difficult to reconcile with this theory, at least under the common assumption that players are selfish materialists who only punish others when it is their own interest. In field studies and laboratory experiments individuals' willingness to punish defectors appears greater than predicted by such a model. These observations are important not only to the study of natural resource management, but also to the study of human cooperation more generally.

The two contributions are complementary. Williamson focuses on the problem of regulating transactions that are not covered by detailed contracts or legal rules; Ostrom focuses on the separate problem of rule enforcement.

Both Ostrom's and Williamson's contributions address head-on the challenges posed by the 1991 Laureate in Economic Sciences, Ronald Coase (1937, 1960). Coase argued that no satisfactory theory of the firm could rely entirely on properties of production technologies, because economies of scale and scope might be utilized either within or across legal boundaries. Instead, the natural hypothesis is that firms tend to form when administrative decision-making yields better outcomes than the alternative market transaction. While Coase's argument eventually convinced economists about the need to look inside the boundaries of firms, it offered only the preliminaries of an actual theory of the firm. Without specifying the determinants of the costs associated with individual bargains or the costs of administrative decision-making, Coase's statement has little empirical content. The challenge remained to find ways of sharpening the theory enough to yield refutable predictions. What exactly do organizations such as firms and associations accomplish that cannot be better accomplished in markets?

Oliver Williamson

In a seminal paper in 1971, and an ensuing book, *Markets and Hierarchies,* four years later, Oliver Williamson developed a detailed theory of the firm in the Coasean spirit. For reasons to be explained below, Williamson claimed that organizing transactions within firms is more desirable when transactions are complex and when physical and human assets are strongly relationship-specific. Since both complexity and specificity can be usefully measured, Williamson's theory had the required empirical content.

Theory

Williamson's theoretical argument is fourfold. First, the market is likely to work well unless there are obstacles to writing or enforcing detailed contracts.[1] For example, at the beginning of a buyer-seller relationship, there is usually competition on at least one side of the market. With competition, there is little room for agents on the long side of the market to behave strategically, so nothing prevents agreement on an efficient contract. Second, once an agent on the long side of the market has undertaken relationship-specific investments in physical or human capital, what started out as a transaction in a "thick" market, is transformed into a "thin" market relationship in which the parties are mutually dependent. Absent a complete long-term contract, there are then substantial surpluses (quasi-rents) to bargain over ex post. Third, the losses associated with ex-post bargaining are positively related to the quasi-rents. Fourth, by integrating transactions within the boundaries of a firm, losses can be reduced.

The first two points are relatively uncontroversial, but the third may require an explanation. Why do bargaining costs tend to be higher when it is harder to switch trading partners? Williamson offers two inter-related arguments. First, parties have stronger incentives to haggle, i.e., to spend resources in order to improve their bargaining position and thereby increase their share of the available quasi-rents (gross surplus from trade). Second, when it is difficult to switch trading partners, a larger surplus is lost whenever negotiations fail or only partially succeed due to intense haggling.

The final point says that these costs of haggling and maladaptation can be reduced by incorporating all complementary assets within the same firm. Due to the firm's legal status, including right-to-manage laws, many conflicts can be avoided through the decision-making authority of the chief executive.[2]

Williamson's initial contributions emphasized the benefits of vertical integration, but a complete theory of the boundaries of firms also has to specify the costs. Such an argument, based on the notion that authority can be abused, is set forth in a second major monograph from 1985, *The Economic Institutions of Capitalism* (especially Chapter 6). The very incompleteness of contracting, that invites vertical integration in the first place, is also the reason why vertical integration is not a uniformly satisfactory solution. Executives may pursue redistribution even when it is inefficient.[3]

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[1] One obstacle to contracting is that parties have private information at the contracting stage. Here, we disregard pre-contractual private information problems aside here. These issues form the core of the mechanism design literature, which offers a complementary perspective on economic governance; cf. the 2007 Prize in Economic Sciences.

[2] See Masten (1988) for a discussion of relevant legislation in the United States. As regards his own understanding of what exactly goes on inside firms, Williamson gives substantial credit to Barnard (1938).

[3] A commonly held view has been that hierarchical organization is costly because it entails administrative costs. However, as noted by Williamson (1985), this view is unsatisfactory, because it is eminently possible to move the boundaries of firms without changing administrative routines at all.

To summarize Williamson's main argument, suppose that the same set of people can attempt to conduct the same set of transactions either in the market or within the boundaries of a firm. Organizing the transaction within a firm centralizes decision rights, thereby saving on bargaining costs and reducing the risk of bargaining impasse, but at the same time allows executives more scope to extract rents in inefficient ways. The net effect of this trade-off depends on both the difficulty of writing useful contracts ex ante and the extent to which assets are relationship-specific ex post. Williamson's hypothesis is that governance will be aligned to the underlying technology and tastes depending on this trade-off. Transactions will be conducted inside firms if they involve assets which are only valuable to particular sellers or buyers, especially if uncertainty or complexity raise the cost of writing complete and enforceable contracts. Otherwise, they will take place in the market.

Evidence

By now, there is a wealth of evidence showing that vertical integration is affected by both complexity and asset specificity. Shelanski and Klein (1995) provide a survey of empirical work specifically directed toward testing Williamson's hypotheses, and Masten (1996) presents a compilation of some of the best articles in this genre. More recent studies include Novak and Eppinger (2001) and Simester and Knez (2002). Lafontaine and Slade (2007) provide a broad overview of the evidence concerning the determinants of vertical integration. They summarize their survey of the empirical literature as follows:

> The weight of the evidence is overwhelming. Indeed, virtually all predictions from transaction cost analysis appear to be borne out by the data. In particular, when the relationship that is assessed involves backward integration between a manufacturer and her suppliers, there are almost no statistically significant results that contradict TC [transaction cost] predictions. (p. 658)

Consider, for example, Joskow's (1985, 1987) studies of transactions between coal mines and electric generators. The mining of coal and the burning of coal to generate electricity are two quite unrelated processes. However, it is quite costly to transport coal, so if there is only one mine nearby that produces coal of adequate quality, there is a high degree of mutual dependence between the owner of the mine and the owner of the electric plant. Roughly speaking, Williamson's theory says that the further away a mine/generator pair is located from other mines and generators, the greater is the likelihood that the pair is jointly owned.

The natural variation in asset specificity that arises due to the difference in distance between adjacent coal repositories implies that Joskow could credibly identify a causal relationship between asset specificity and contractual relations. As Williamson's theory predicts, the contracts are relatively rudimentary and have shorter duration when asset specificity is low, and become more detailed and long-lasting as asset specificity increases. In cases of extreme specificity, contracts either last very long (up to fifty years), or the mine and the generator are both owned

by the same firm. Thus, as asset specificity goes from low to high, the relationship between mine operators and electric generators is gradually transformed from a pure market relationship to a pure non-market relationship.

Normative implications

Williamson's major contribution is to provide an explanation for the location of firms' boundaries. However, the theory also has normative implications for firms as well as for competition legislation. Let us briefly address these normative implications.

The evidence cited above suggests that vertical integration of production is affected by the trade-off that Williamson identified. This does not imply that the owners of these firms have understood the underlying economic logic. More plausibly, the empirical regularity instead emerges because firms that have inappropriate boundaries tend to be less profitable and are hence less likely to survive. If so, Williamson's theory has normative content that is of value to managers.

In fact, Williamson's books have frequently been compulsory reading in courses on corporate strategy at business schools throughout the world, with the explicit aim of training managers to improve their decision-making. To the extent that this teaching is successful, Williamson's research not only helps to explain observed regularities but also entails better utilization of the world's scarce resources.

Williamson's theory of vertical integration clarifies why firms are essentially different from markets. As a consequence, it challenges the position held by many economists and legal scholars in the 1960s that vertical integration is best understood as a means of acquiring market power. Williamson's analysis provides a coherent rationale for, and has probably contributed to, the reduction of antitrust concerns associated with vertical mergers in the 1970s and 80s. By 1984, merger guidelines in the United States explicitly accepted that most mergers occur for reasons of improved efficiency, and that such efficiencies are particularly likely in the context of vertical mergers.[4]

Subsequent work: Broadening the arguments
By now there is a huge literature on the boundaries of the firm, and we shall not attempt to describe it all here; see Gibbons (2005) for an overview of both closely and more distantly related work. We offer only a brief look, starting with some of the complementary research that emerged soon after 1975.

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[4] Prior to his pioneering work on vertical integration, Williamson had already begun to have an impact on U.S. competition policy. While working for the Assistant Attorney General for Antitrust at the U.S. Department of Justice, he wrote a paper, subsequently published as Williamson (1968), suggesting that horizontal mergers should sometimes be allowed on efficiency grounds. According to Kolasky and Dick (2003), Williamson's suggestion noticeably affected the U.S. Justice Department's very first Merger Guidelines, which were issued in 1968.

Whereas Williamson focused on the problem of efficient conflict resolution, much subsequent work instead emphasized that incomplete contracts in combination with asset specificity can create inefficiency even if conflicts are resolved efficiently ex post. When parties are obliged to make large relationship-specific investments, they do not care primarily about the efficiency of the division of future surplus, but about their own private return. For example, if a supplier must invest in highly specific machinery in order to serve a particular customer, and the state-contingent terms of trade cannot be easily detailed in advance, the supplier might worry that the customer could extract a significant portion of the surplus when the price is finally negotiated. This problem is known as *the hold-up problem*.[5]

An important early statement of the hold-up problem is due to Klein, Crawford, and Alchian (1978), and the first formal studies of hold-up problems with explicitly non-contractible investments are Grossman and Hart (1986) and Hart and Moore (1990) (henceforth GHM). GHM focus on ex-ante investment distortions instead of ex-post conflict costs. Their key argument is that asset ownership entails a negotiation advantage. Thus, instead of asking which assets should have the same owner, GHM asks who should own which assets. Put simply, while neglecting several important caveats, GHM conclude that ownership should be given to the party who makes the most important non-contractible relationship-specific investment. In relation to Williamson's theory, GHM's theory is complementary. For reasons explained by Whinston (2003), the additional predictions have proven harder to test, but the limited evidence that exists is supportive (Lafontaine and Slade, 2007).

Subsequent work: Deepening the analysis

In comparison with other modern research in economics, Williamson's theory of the firm remains relatively informal. A likely reason is that the economics profession has not yet perfected the formal apparatus required to do justice to the theory (Williamson, 2000). Two major challenges have been to model contractual incompleteness and inefficient bargaining.

Contractual incompleteness is presumably related to bounded rationality, and useful models of bounded rationality have taken a long time to emerge – despite the pioneering efforts of the 1978 Laureate in Economic Sciences Herbert Simon (1951, 1955). Nowadays, however, there are several detailed formal models of the relationship between bounded rationality and contractual incompleteness, including for example Anderlini and Felli (1994), Segal (1999), and Tirole (2009).

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[5] Implicit in the above statement is the assumption that the ex-ante investments cannot be contracted upon. As shown by Crawford (1988), the hold-up problem vanishes if investments are contractible (see also Fudenberg, Holmström and Milgrom, 1990 and Milgrom and Roberts, 1990).

As regards inefficient bargaining, the most common approach is to ascribe disagreement to asymmetric information.[6] Consistently with this view, Williamson (1975, p. 26) argued that conflict may arise due to opportunistic bargaining strategies such as "selective or distorted information disclosure" and "self-disbelieved threats and promises". Abreu and Gul (2000) and Compte and Jehiel (2002) develop state-of-the-art bargaining models in which there can be substantial losses due to the latter form of strategic posturing. Thus, the relevant question is not whether Williamson's theory can be formalized, but when we will see fully fledged formalizations of it.

Williamson's work has also inspired a wealth of research that seeks to articulate how conflicts are resolved within firms. One line of research, initiated by Kreps (1990), studies the crucial problem of how conflicts are resolved in the absence of a contract that will be enforced externally. Kreps uses the theory of repeated games to explain how reputational mechanisms can substitute for contracts, and sets forth a game theoretic model of the firm – or its owner/ manager – as a bearer of reputations. (Repeated game logic is also an important aspect of Ostrom's contributions; see below.) Baker, Gibbons, and Murphy (2002) study this issue in a model that is more explicitly geared to analyze internal governance; see also the related work by Garvey (1995) and Halonen (2002).

Wider implications

Although Williamson's main contribution was to formulate a theory of vertical integration, the broader message is that different kinds of transactions call for different governance structures. More specifically, the optimal choice of governance mechanism is affected by asset specificity. Among the many other applications of this general idea, ranging from theories of marriage (Pollak, 1985) to theories of regulation (Goldberg, 1976), one has turned out to be particularly important, namely corporate finance.

Williamson (1988) notes that the choice between equity and debt contracts closely resembles the choice between vertical integration and separation. Shareholders and creditors not only receive different cash flows, but have completely different bundles of rights. For example, consider the relationship between an entrepreneur and different outside investors. One class of investors, creditors, usually do not acquire control rights unless the entrepreneur defaults, whereas another class of investors, stockholders, typically have considerable control rights when the entrepreneur is not in default. Williamson suggests that non-specific assets, which can be redeployed at low cost, are well suited for debt finance. After a default, creditors can simply seize

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[6] Other theories of inefficient bargaining outcomes rely on irreversible strategic commitments, as suggested by Schelling (1956), a recipient of the 2005 Prize in Economic Sciences (see also Crawford, 1982) or cognitive biases, as suggested by Babcock and Loewenstein (1997). In recent work on incomplete contracts, Hart and Moore (2008) have made the assumption that ex-post bargaining is inefficient because of such psychological mechanisms.

these assets from the entrepreneur. Specific assets on the other hand are less well suited for debt finance, because control rights lose their value if they are redeployed outside the relationship.

Subsequent formal modeling, by Aghion and Bolton (1992), Hart and Moore (1989), Hart (1995) and many others, confirms the usefulness of the incomplete contracts approach for analyzing corporate finance decisions. More generally, this line of work has been instrumental in promoting the merger between the fields of corporate finance and corporate governance – a merger process that was initiated by Jensen and Meckling (1976).

Another far-reaching lesson from Williamson's governance research is that core questions concerning actual and desirable social organization span several disciplines. Both through his writings and his founding editorship of the *Journal of Law, Economics and Organization*, Oliver Williamson has contributed to eliminating many of the barriers to intellectual exchange among different disciplines of the social sciences.

Elinor Ostrom

Common-pool resources (CPRs) are resources to which more than one individual has access, but where each person's consumption reduces availability of the resource to others. Important examples include fish stocks, pastures, and woods, as well as water for drinking or irrigation. On a grander scale, air and the oceans are common pools.

Some common pools exist primarily due to technological properties of the resource. For example, difficulties in controlling people's resource usage prevent the transformation of a common pool resource into a private resource.

However, not all costs of precluding access are strictly technological. There are also cases in which common pools could be profitably privatized, whereupon access could easily be controlled, but where privatization attempts fail because the users cannot agree on the terms. For example, water basins and oil pools are frequently located underneath land that has many different owners. Although these owners as a group would benefit from consolidating exploration under the umbrella of a single firm, it can be remarkably difficult to reach private agreement about the division of the surplus (see e.g. Libecap and Wiggins, 1984, 1985). In general, a combination of technological and institutional factors determines whether resources are managed as common property.

The overexploitation of common-pool resources is a well-known problem that has occupied social thinkers for at least two millennia and probably even longer. Individual users of a resource may have strong private incentives to act in ways that are detrimental to the group as a whole. Early formal analyses of this problem are due to Warming (1911) and Gordon (1954), who studied the special case of open access, i.e., when there is entry of users until the marginal benefit equals the marginal cost to the last entrant. The case of a fixed number of users was later

studied by Clark (1976) and Dasgupta and Heal (1979).[7] The models provide plausible conditions, at least under the simple but restrictive assumption that users interact in a single period only, under which excess utilization is the unique equilibrium outcome.

More than forty years ago, the biologist Garrett Hardin (1968) observed that overexploitation of common pools was rapidly increasing worldwide and provided the problem with a catchy and relevant title: "The Tragedy of the Commons".

In economics, two primary solutions to the common-pool problem have been suggested. The first is privatization. The feasible forms of privatization depend on technologies available for measurement and control. For example, if detailed monitoring of appropriation is prohibitively expensive, effective privatization may require concentration of ownership in the hands of one or a few agents.

An alternative solution, often associated with Pigou (1920), is to let the central government own the resource and levy a tax extraction. This solution initially entails coercion, in the sense that original users are disenfranchised. But under ideal circumstances – especially zero monitoring costs and full knowledge of appropriators' preferences – the taxes will be the same as the prices of an efficient market. Under such ideal circumstances, there is also an equivalent solution to the problem based on quotas instead (Dasgupta and Heal, 1979).

Coase (1960) argued that the Pigovian solution works so well in theory only because the real problems are assumed away. Taxation is a perfect solution in the absence of transaction costs, but governmental regulation itself is unnecessary in this case. Absent transaction costs, private agreements between the parties concerned suffice to achieve efficiency. Thus, if it is possible to determine fully efficient taxes or quotas, it might also be possible for the users to negotiate the optimal outcome.

Coase insisted that the case of zero transaction costs is a purely theoretical construction. In practice, all forms of governance have costs. The real challenge is to compare various private and public orderings while taking all the relevant transaction costs into account. Depending on the transaction costs, the market, the firm or the government may constitute the best governance mechanism.

A third solution – previously discarded by most economists – is to retain the resource as common property and let the users create their own system of governance. In her book *Governing the Commons: The Evolution of Institutions for Collective Action* (1990), Elinor Ostrom objects to the presumption that common property governance necessarily implies a "tragedy". After

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[7] The case of a fixed number of users echoes two other classic problems of cooperation, namely the problem of voluntary provision of public goods and the problem of oligopoly behavior. In each case, the individual's incentive is in conflict with the group interest. (Typically, the corresponding one-shot game has a unique and inefficient equilibrium.) See Olson (1965) for a seminal study that addresses the problem of cooperation more generally.

summarizing much of the available evidence on the management of common pools, she finds that users themselves envisage rules and enforcement mechanisms that enable them to sustain tolerable outcomes. By contrast, governmentally imposed restrictions are often counterproductive because central authorities lack knowledge about local conditions and have insufficient legitimacy. Indeed, Ostrom points out many cases in which central government intervention has created more chaos than order.[8]

Ostrom's contributions

Ostrom bases her conclusions primarily on case studies. Over the years, Ostrom's own field work gave rise to some of the cases, starting with her doctoral dissertation in 1965. Here, she studied the institutional entrepreneurship involved in an effort to halt the intrusion of saltwater into a groundwater basin under parts of the Los Angeles metropolitan area.

However, a few case studies rarely permit broad generalizations. The key to Ostrom's breakthrough insights was instead the realization, about twenty years later, that there exist thousands of detailed case studies of the management of CPRs, and that most of them were written by authors interested in only one or a small set of cases.[9] By collecting and comparing these isolated studies, it should be possible to make substantially stronger inferences.

In most of the cases, local communities had successfully managed CPRs, sometimes for centuries, but Ostrom also pays close attention to unsuccessful cases. Ostrom empirically studies both the rules that emerge when local communities organize to deal with common pool problems and the processes associated with the evolution and enforcement of these rules. She documents that local organization can be remarkably efficient, but also identifies cases in which resources collapse. Such case studies help to clarify the conditions under which local governance is feasible. They also highlight circumstances under which neither privatization nor state ownership work quite as well as standard economic analysis suggests.

In order to interpret her material, Ostrom makes extensive use of concepts from non-cooperative game theory, especially the theory of repeated games, associated with Robert Aumann, a recipient of the 2005 Prize in Economic Sciences. As early as 1959, Aumann proved remarkably powerful results concerning the extent to which patient people are in principle able to cooperate. But it took a long time before anyone made the connection between these abstract mathematical results and the feasibility of CPR management. Moreover, even as theorists developed such relationships (e.g., Benhabib and Radner, 1992), their results were frequently ignored.

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[8] In addition to the examples provided in Ostrom (1990), see for instance the cases mentioned in Ostrom et al. (1999). Both the case of overgrazing in Inner Asia, as documented by Sneath (1998), and the case of inadequate modern irrigation in Nepal, as documented by Lam (1998), provide striking examples of how common property management sometimes outperform seemingly attractive alternatives.

[9] In a study of common pool management in Indian villages, Wade (1988) is another notable early effort to generalize from a set of cases. See also the edited volumes by Berkes (1989) and Pinkerton (1989). Among subsequent studies, Baland and Platteau (1996) is particularly noteworthy.

Over the years, game theorists have provided increasingly exact conditions under which full cooperation is feasible, in highly structured settings, among individuals with both unbounded cognitive capacity (e.g., Mailath and Samuelson, 2006) as well as small cognitive capacity (e.g., Nowak, 2006). Around 1990, and to some extent even today, theory had much less to say about the level of cooperation that would be most likely among individuals with plausible cognitive capacities in settings structured to some extent by the participants themselves. Thus, Ostrom's data could not be used to test any particular game-theoretic model. However, as we shall see, the data provide valuable inspiration for the development of such models.

Main findings

Under plausible assumptions about the actions available to resource users, repeated game reasoning indicates that cooperation becomes more difficult as the size of the group of users increases, or as the users' time horizon decreases due, for example, to migration. These predictions are largely borne out by Ostrom's empirical studies. However, a more interesting question is whether – when these factors are held constant – some groups of users are better able to cooperate than others. That is, are there any *design principles* that can be elucidated from the case material?

Ostrom proposes several principles for successful CPR management. Some of them are quite obvious, at least with the benefit of hindsight. For example, (i) rules should clearly define who has what entitlement, (ii) adequate conflict resolution mechanisms should be in place, and (iii) an individual's duty to maintain the resource should stand in reasonable proportion to the benefits.

Other principles are more surprising. For instance, Ostrom proposes that (iv) monitoring and sanctioning should be carried out either by the users themselves or by someone who is accountable to the users. This principle not only challenges conventional notions whereby enforcement should be left to impartial outsiders, but also raises a host of questions as to exactly why individuals are willing to undertake costly monitoring and sanctioning. The costs are usually private, but the benefits are distributed across the entire group, so a selfish materialist might hesitate to engage in monitoring and sanctioning unless the costs are low or there are direct benefits from sanctioning. Ostrom (1990, pp. 94–98) documents instances of low costs as well as extrinsic rewards for punishing. However, from Ostrom, Walker and Gardner (1992) onwards, she came to reject the idea that punishment is always carried out for extrinsic benefit; intrinsic reciprocity motives also play an important role.

Another nontrivial design principle is that (v) sanctions should be graduated, mild for a first violation and stricter as violations are repeated.

Ostrom also finds that (vi) governance is more successful when decision processes are democratic, in the sense that a majority of users are allowed to participate in the modification of the rules and when (vii) the right of users to self-organize is clearly recognized by outside authorities.

In *Governing the Commons,* as well as in later publications, Ostrom documents and discusses such principles and why they contribute to desirable outcomes. Even though these design principles do not provide an easy solution to the often complex policy problems involved, in cases where they are all heeded, "collective action and monitoring problems tend to be solved in a reinforcing manner" (Ostrom, 2005, p. 267).

Ostrom furthermore identifies some design principles that are applicable even under privatization or state governance. For example, positive outcomes always seem easier to reach when monitoring is straightforward, and Ostrom carefully sets forth how monitoring can be simplified in common pools. For example, calendar restrictions (hunting seasons, etc.) are often much easier to monitor than quantity restrictions.

A final lesson from the many case studies is that large-scale cooperation can be amassed gradually from below. Appropriation, provision, monitoring, enforcement, conflict resolution and governance activities can all be organized in multiple layers of nested enterprises. Once a group has a well-functioning set of rules, it is in a position to collaborate with other groups, eventually fostering cooperation between a large number of people. Formation of a large group at the outset, without forming smaller groups first, is more difficult.

Needless to say, Ostrom's research also prompts a number of new questions. It is important to investigate whether cooperation *must* be built from below, or whether other approaches are feasible when dealing with large-scale problems. In recent years, Ostrom has accordingly taken on the extensive question of whether the lessons from small local commons can be exploited to solve the problems of larger and even global commons (e.g., Dietz, Ostrom, and Stern, 2003).

A related question, which echoes Williamson's attempt to link governance to asset characteristics, is to explore in more detail the relationship between the underlying technology and/or tastes and the mode of governance (e.g., Copeland and Taylor, 2009).

Experiments

Since Ostrom's initial research was based on field studies, her theorizing was inductive. While the ensuing propositions were put to the test as new field studies emerged, the multidimensionality of relevant factors precludes a rejection of the theory. In order to test individual propositions more directly, Ostrom and colleagues have therefore conducted a series of laboratory experiments on behavior in social dilemmas; see Ostrom, Gardner, Walker (1994). Building on the seminal experimental work of Dawes, McTavish, and Shaklee (1977) and Marwell and Ames (1979, 1980) – as well as ensuing work by economists and psychologists in the 1980s – Ostrom examined whether findings from the field could be recreated in the more artificial, but controlled, laboratory environment.

In a typical experiment, a number of subjects interact during several periods, without knowing exactly which period is the last. In each period, each subject can contribute towards a public good. Across the interesting decision range, an individual's marginal cost of contribution is larger than his marginal benefit, but smaller than the total benefit. Thus, a rational and selfish individual would contribute nothing if the game were played in a single period only.

An important feature of the experiments was the introduction of sanctioning possibilities. In one experimental treatment, subjects would be informed about the contributions of all the other subjects in the previous round and be allowed to selectively punish each of the opponents. A punishment would be costly to both the punished opponent and the punisher. Thus, a rational and selfish individual would not punish if the game were played for one period only.

With the notable exception of Yamagishi (1986), previous experimental work did not allow subjects to punish each other selectively. Since punishment appears to be crucial in the field, it is of considerable interest to see whether it matters in the laboratory and, if so, why. Ostrom, Walker and Gardner (1992) find that many subjects engage in directed punishment in the laboratory, but that such punishment works much better if subjects are allowed to communicate than when they are not (Yamagishi, 1986, had confined attention to the no-communication condition).

These laboratory findings have triggered a large volume of subsequent experimental work. For example, Fehr and Gächter (2000) show that punishment occurs and disciplines behavior in social dilemmas even if the experimental game has a known horizon and subjects are unable to gain individual reputations for punishing, thereby suggesting that people get intrinsic pleasure from punishing defectors. Masclet et al. (2003) demonstrate that purely symbolic sanctions can be almost as effective as monetary sanctions, suggesting that induviduals' fear of explicit disapproval is a major reason why sanctions matter. Kosfeld, Okada, and Riedl (2009) show that subjects voluntarily establish large groups that impose internal sanctions on cheating members, but that small groups tend to dissemble even if dissembling harms members as well as outsiders (indeed, the threat that small groups will collapse is presumably what keeps the group large).

These experiments in turn reinforce Ostrom's argument that a proper understanding of human cooperation requires a more nuanced analysis of individuals' motives than has been usual in economic science, especially regarding the nature and origin of reciprocity (Ostrom, 1998, 2000). Such models have been developed at a daunting pace during the last two decades, partly inspired by Ostrom's call. An introduction to the relevant social preference (proximate cause) literature is given by, e.g., Fehr and Schmidt (2006); for introductions to the evolutionary (ultimate cause) literature, see, e.g., Sethi and Somanathan (2003) and Nowak (2006).

Ostrom's evidence from the field and from the laboratory also affects what set of games theorists should study in order to grasp the logic of the collective action observed in the field. The conventional parable of a repeated *n*-person prisoners' dilemma has produced a wealth of conceptual insights, but this parable is too sparse to adequately capture the directed punishments

and rewards that are used in the observed common pools. Sethi and Somanathan (1996) is the seminal study of cooperation in a CPR game (which has the essential characteristics of an *n*-person Prisoners' Dilemma) that allows each player to punish any other player after each round of CPR interaction.

Final remarks

Over the last few decades, economic governance research has emerged as an important area of inquiry. The works of Elinor Ostrom and Oliver Williamson have greatly contributed to its advancement.

Oliver Williamson has formulated a theory of the firm as a conflict resolution mechanism and Elinor Ostrom has subsequently demonstrated how self-governance is possible in common pools. At first glance, these contributions may seem somewhat disparate. However, in stark contrast to areas of economic analysis which presume that contracts are complete and automatically enforced by a smoothly functioning legal system, both Ostrom and Williamson address head on the problems of drawing up and enforcing contracts.

Let us also note that Ostrom's and Williamson's endeavors are vital parts of a broader attempt to understand the problems of conflict resolution and contract enforcement (Dixit, 2004, 2009). Some of this work relies on verbal theorizing and historical examples (e.g., that of the Laureate in Economic Sciences Douglass North, 1990, 2005). Other contributions have used repeated game models to study associations such as merchant guilds (Greif, Milgrom, and Weingast, 1994), as well as the emergence of third parties, such as law merchants and private judges (Milgrom, North, and Weingast, 1990), and even the Mafia (Dixit, 2003). For a broad perspective on the emergence of institutions that support market exchange, see Greif (2006a,b).

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