TYPE OF GOOD AND COLLECTIVE ACTION

by

Elinor Ostrom

Workshop in Political Theory and Policy Analysis
Center for the Study of Institutions, Population, and Environmental Change
Indiana University

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Abstract

Mancur Olson started a major task for social scientists by distinguishing between two types of collective action and expecting that the success in providing goods would depend on the type of good. Olson classified what he called public goods into exclusive and inclusive public goods. He made radically different predictions for these two subclasses. In regard to "exclusive public goods," Olson expected groups to try to keep their size as small as possible, to try to get 100% participation since "even one non-participant can usually take all of the benefits brought about by the action of [others] for himself" (Olson, 1965: 41). Inclusive groups, on the other hand, will try to increase members. The more members in an inclusive group, the more individuals who may be willing to share the costs of providing a good of general benefit to all. Olson also predicts that bargaining and strategic interactions will be less intense in an inclusive group than in an exclusive one.

Instead of calling these two types of good "exclusive" and "inclusive" scholars have come to call one of the "public goods" characterized by difficulties of exclusion and fully joint consumption (e.g., one person's use does not subtract from the benefits available to others). The second type of good is referred to as a common-pool resource. Common-pool resources problems share with public good provision the problems of free riding, but they also include the problems of over harvesting and crowding. In the paper I will examine how attributes of groups – particularly their size – affect the likelihood of groups organizing to provide themselves public goods.

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It is an honor to be asked to write a paper in honor of Mancur Olson. Not only was Mancur Olson an incredible influence on all of the social sciences, he was a bubbly, enthusiastic, and friendly colleague capable of extending many kindnesses to colleagues. Not all leading scholars extend a helping hand to others. Olson was known to do so.

While Olson made contributions to many theoretical questions in the social sciences, his most influential contributions came in relationship to the theory of collective action. He was somewhat schizophrenic in his approach to this theory. Or, at least other scholars have been schizophrenic in their interpretation of his theory. In one of the most frequently quoted sentences in all of the social sciences, Olson argues that "unless the number of individuals is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, *rational, self-interested individuals will not act to achieve their common or group interests"* (Olson, 1965: 2; author's emphasis). This theoretical prediction was consistent with an assumption that individuals value their own immediate returns to self in a one-shot independent decision situation. For such situations—which are rare in the field—the prediction receives some empirical support in laboratory studies.

The big puzzle that many scholars, including Olson, have tried to address is that in many settings, is that behavior is not uniformly consistent with this prediction. Olson started us all down a path to search for the factors internal to the model of the individual being used and external to the individual that affect the structure of a situation that would change this prediction and explain observed behavior. In this paper, I will discuss factors in the setting rather than in the individual.

The Concept of Public Goods in the Theory of Collective Action

By centering his theory of collective action around the concept of a "public good," Mancur Olson (1965) built his edifice on a presupposition that the type of problem(s) that individuals attempt to solve affect the responses that they make to these problems. This is by no means a unique presupposition. Once this position is accepted, however, the knotty problem remains as to *which* attributes of goods are most important in dividing the problems that humans face into as parsimonious a set as possible. An endless number of attributes could be posited.

A major debate over this issue was brewing when Olson wrote "The Logic of Collective Action" (1965). The debate was initiated in 1954 by Paul Samuelson when he used one attribute—jointness of consumption—to divide the world into two classes: private consumption goods and public consumption goods. Samuelson assumed that private consumption goods could be divided and allocated to different consumers but that collective consumption goods are those that "all enjoy in common in the sense that each individual's consumption of such a good leads to no subtraction from any other individual's consumption of that good" (Samuelson, 1954: 387). While market catallactics would allow rational egoists to pursue narrow self-interest and yet produce socially optimal provision of private consumption goods, Samuelson argued that decentralized spontaneous solutions could not work to provide an optimal level of collective consumption goods. In 1959, Richard Musgrave argued that a different attribute of goods—whether or not someone can be excluded from benefitting once the good is produced—is more important than jointness of supply. Musgrave asserted that the exclusion principle can be used by itself to divide the world into private and public goods. The classification debate was associated with a major policy concern over the role of government in allocating resources.

Both Samuelson and Musgrave were interested in the same question. They attempted to find a single criteria that would enable them to predict when market institutions would perform optimally and when markets would fail. The difference in their approach can be illustrated in Figure 1. Samuelson uses his classification to argue that all of the left-hand column, and none of the right-hand column include goods that can be effectively allocated through market mechanisms. Musgrave uses his classification to argue that all of the top row and none of the bottom row include goods that are best allocated through the market.

[Figure 1 about here]

Olson explicitly adopted Musgrave's definition. Using this one-dimensional criteria, Olson then tried to establish a *general theory* for all goods meeting Musgrave's definition. It was a grand vision, but overly ambitious. Multiple scholars have shown that several of his propositions do not hold for all goods meeting the Musgrave definition even though these same propositions do hold for a subset of goods for which exclusion is problematic (Chamberlin, 1974; R. Hardin, 1982, V. and E. Ostrom, 1977). Obviously, Olson shared both Samuelson's and Musgrave's hope of developing as general a theory as possible.

Multiple Types of Collective Action Problems

Exclusion as the Key Attribute

Olson had a profound insight when he adopted Musgrave's criterion as the defining attribute for collective action problems. The name he used to characterize these problems—public goods—has appropriately come to be used for a subset of collective action problems. Public goods are those collective action problems identified as Cell D of Figure 1 where consumption by one person does not reduce the amount available to others. Cell C has come to be known as representing a set of collective action problems known as common-pool resources (V. Ostrom and E. Ostrom, 1977; E. Ostrom, Gardner, and Walker, 1994).

While Musgrave and Olson tended to assume that exclusion was impossible for a subset of all goods, more recent theoretical work has understood that the capacity to exclude potential beneficiaries depends both on the technology of physical exclusion devices, such as barbed wire fences and electronic sensing devices, as well as the existence and enforcement of various bundles of property rights (Cornes and Sandler, 1994; E. Ostrom, Gardner, and Walker, 1994). Thus, as discussed below, many people facing collective action problems in the field have changed the structure of the problem they face by building walls (the walled cities of medieval times were after all a way of excluding outsiders from the defenses of the city) or creating property rights (inshore fishers have long used customary law to enforce locally devised rules as to who was allowed to fish) (Acheson and Brewer, forthcoming; Hannah, forthcoming).

Consequently, all collective action problems share an initial characteristic that excluding non-contributors to a collective benefit is a nontrivial cost. Collective action problems differ in regard to how costly or difficult it is to devise physical or institutional means to exclude others. Some of these differences stem from the biophysical world itself. It will always be more difficult to exclude users from an ocean or other global commons than from a farmer's pond (Sandler, 1997). Other differences stem from the order in which the problem is located. In some legal codes, for example, it is illegal to exclude anyone from using water for domestic purposes.

Subtractability

The next conundrum to be resolved is whether one theory can explain all patterns and outcomes for collective action problems as Olson hoped, or whether a family of closely related theories is needed. After more than 30 years of unsuccessful efforts to build one explanatory theory for all collective action problems, and multiple insightful critiques of these efforts, I will argue strongly that further effort to build a single general theory is counterproductive. This paper is one of a series of papers devoted to specifying the important working parts of a family of collective action theories (which eventually will be brought together in a book entitled *Context and Collective Action*).

Olson actually started this task. He himself classified what he called public goods into exclusive and inclusive public goods and made radically different predictions for these two subclasses. His "exclusive public good" is Cell C. Here, Olson expected groups to try to keep their size as small as possible, to try to get 100% participation since "even one non-participant can usually take all of the benefits brought about by the action of [others] for himself" (Olson, 1965: 41). Inclusive groups, on the other hand, will try to increase members. The more members in an inclusive group, the more individuals who will share the costs of providing a good to all beneficiaries. Olson also predicts that bargaining and strategic interactions will be less intense in an inclusive group than in an exclusive one.

Instead of calling these two types of good "exclusive" and "inclusive" scholars have come to call one of the "public goods" characterized by difficulties of exclusion and fully joint consumption (e.g., one person's use does not subtract from the benefits available to others). The second type of good is referred to as a common-pool resource. Common-pool resources problems share with public good provision the problems of free riding, but they also include the problems of over harvesting and crowding.

In the field, groups using a common-pool resource who have found ways to reduce overappropriation almost always try to limit members, as Olson predicted, through clear and enforced boundary rules specifying exactly who can use the resource (E. Ostrom, 1990). Not all of the differences predicted by Olson have been tested, but laboratory experiments provide clear evidence that common-pool resources and public goods are different sub-classes of collective action problemsm (Ostrom, Gardner, and Walker, 1994). In a public good setting, non-cooperative actions by one individual do not make a dramatic different for others. In this setting, increasing the number of participants frequently brings additional resources that could be drawn on to provide a benefit that will be jointly enjoyed by all. It is because of the additional resources available in a larger group and the non-subtractability characteristic of public goods, that Marwell and Oliver (1993: 45) conclude that when "a good has pure jointness of supply, group size has a *positive* effect on the probability that it will be provided." For example, the level of resources provided to support public radio is greater when a larger population can be called upon than for a small. Thus, whether the dilemma is a public good or a common-pool appropriation problem affects how other variables impact on rates of cooperation.

In a common-pool resource situation, one person's aggressive withdrawals can generate very high costs for everyone else. In finitely repeated public goods experiments, the typical pattern is for subjects to contribute about 50% of the optimal level in the first round and then follow a pulsing decay pattern toward, but never reaching, the symmetric Nash equilibrium in the last rounds (as shown in Figure 2). In common-pool-resource problems, on the other hand, the typical pattern is just the opposite. In the initial rounds, subjects do much *worse* than Nash and then pulse upward toward the symmetric Nash equilibrium from below as shown in Figure 2.

[Figure 2 about here]

In addition to differences among collective action problems in regard to whether consumption is subtractive or not, many other characteristics affect the type of problems that people face in the field. In regard to common-pool resources, for example, Schlager, Blomquist, and Tang (1994) identify whether the products to be appropriated are mobile like fish or stationary like trees. Such attributes affect the costs of learning about the yield of a resource. Similarly, whether there is storage in the system affects the predictability of resource unit availability. When conducting field research these attributes have strong impacts on the likelihood of successful collective action and the form that collective action takes (see Tang, 1992; Lam, 1998; Schlager, 1994; Blomquist, 1992). Instead of trying to identify the myriad of specific factors that are potentially important in the context of any well-designed fieldwork, however, I will first discuss two abstract forms of representing some of these important differences—the shape of the production and appropriation functions that characterize a particular problem. In a later section, I will focus on how further attributes of a common-pool resource may affect the feasibility of diverse types of property regimes.

Production Functions

It is well understood that the production function to produce private goods takes on many shapes and forms that affect the expected efficiency of the firms in a particular industry. The same is true of public goods and common-pool resources. The most frequently assumed production function is linear. In a linear public goods game, there are N identical players who are each assigned an endowment, *E*. Each player *i* must then decide between keeping the endowment or contributing some part of the endowment xi_i to the production of a public good *G*. A production function that determines the total amount of the public good, *TG*, is:

$$TG = P\ (\sum x_i) \qquad (1)$$

In the linear public good game, *P* is referred to as the Marginal Per Capita Return (MPCR) and is defined as the value of switching one unit from private consumption to the production of the good (Isaac and Walker, 1988). If the MPCR is .25, for example, each person who contributes $1.00 generates a public good of $.25 for everyone in the game. If four people contribute $1.00 each, the total return just equals the total cost. In this instance, the minimum number of individuals contributing $1.00, where benefits exceed costs, or *k*, would be five.

In addition to MPCR, social psychologists have identified several aspects of the payoff function in a PD game that are posited to affect behavior. In the two-person PD game, Rapoport and Chummah (1965) called attention to the relationships among the payoffs that are called *Cooperator's Gain* (the difference between both cooperating and both defecting), *Greed* (the payoff for one player in defecting as contrasted to both cooperating), and *Fear* (the loss for one player in cooperating versus both defecting).

The production function that relates individual actions to group outcomes may take any of a wide diversity of forms as shown in Figure 3. The yield functions for common-pool resources have been represented since the seminal article of Scott Gordon (1954) as a quadratic function (see Figure 3d). Too many "contributions," rather than too few, is the problem to overcome in a common-pool resource dilemma. Marwell and Oliver (1993) focus on several other nonlinear production functions including general third-order functions (3c), decelerating (3e), and accelerating (3f) , that are characteristic of different types of public interest activities. [Figure 3 about here]

Marwell and Oliver analyzed a variety of monotonically increasing, nonlinear production functions relating individual contributions and the total benefits produced and distinguish between production functions that are decelerating and those that are accelerating. In the decelerating case, while every contribution increases the total benefits that a group receives, marginal returns decrease as more and more individuals contribute.[1] When contributions are made sequentially, the initial contributions have far more impact than later contributions. With an accelerating production function, initial contributions make small increments and later contributions yield progressively greater benefits. "Accelerating production functions are characterized by *positive interdependence*: each contribution makes the next one more worthwhile and, thus, more likely" (*ibid*.: 63). Settings where mass actions are needed in order to gain a positive response involve accelerating functions.[2] Their theoretical predictions concerning the success of collective action depend sensitively on the particular shape of the production function, on heterogeneity of wealth, on the sequence in which individuals contribute, and on the information generated by each action. Thus, they do not depend only on the type of production function to predict behavior and outcomes. Rather they analyze how a configuration of variables operates together – or how the effect of one set of variable depends upon other variables.

Step-level functions (3b) have also been of considerable interest to scholars of collective action.[3] Discussing the findings related to step-level production functions helps us to understand how a very subtle difference in just the production function of a collective good can make an immense difference in behavior and outcomes. In a step-level production function actions by up to k participants make no difference in the outcomes obtained, but actions by k or more participants discontinuously shift the benefit upward.[4] Russell Hardin (1976) was among the first to argue that when the shape of the production function for a public good was a step function, solving social dilemmas could be facilitated since no good would be provided if participants did not gain sufficient inputs to equal or exceed the provision point (k). Until the benefit is actually produced, it is not possible to "free ride" on the contribution of others. In these settings, individuals may assume that their participation is critical to the provision of the good. This type of production function creates an "assurance problem" rather than a strict social dilemma. For those who perceive their contribution as critical, not contributing is no longer the unique Nash equilibrium.

Sharing formulas can also make each person of a group, or a designated minimal contributing group, feel that their contribution is critical (van de Kragt, Orbell, and Dawes, 1983). By agreeing that each person will contribute a set proportion of what is believed to be the total cost of obtaining a good, the individuals in such a minimal contributing set face a choice between not contributing and receiving nothing or contributing and receiving the benefit (assuming others in the minimal contributing set also contribute). The game has been transformed from a social dilemma to an assurance game.

An early communication experiment was conducted by van de Kragt, Orbell, and Dawes (1983) in a one-shot provision-point public good game described more fully below. In all 12 communication experiments, subjects used the opportunity for discussion to decide exactly who would or would not be expected to contribute to the public good (*ibid*.). They used lotteries, overt volunteering, and in one case, the need of several subjects for the additional $5.00 associated with noncontribution. In 10 of these 12 experiments, the discussion led to a decision designating the optimal number of participants. In all 10 cases, those designated did contribute even though their decision was independently and privately made. In the other two experiments, the discussion led to the identification of a group of contributors larger than necessary. The authors attribute the high level of success in these communication experiments to the sense of criticalness that participants gained when a minimal contributing set was actually designated through their discussion period.

In a series of public good experiments, Robin Dawes, John Orbell, and colleagues used various institutional arrangements to create a discrete provision point or a step level function. All of these experiments had seven participants who were given a promissory note for $5.00 at the beginning of the experiment. Subjects were told that if a minimal contributing set (or *k*)—either 3 or 5—contributed their promissory note, all subjects would receive $10.00 including those who had not contributed. With less than the required number of contributions, no good would be provided. In a series of baseline experiments, subjects were not allowed to communicate and were told only the size of the minimal contributing set needed to obtain the public good. In one of these baseline experiments, subjects were asked to estimate three probabilities prior to their own and others' decisions: (1) the probability of their action being futile if they were to contribute, (2) the probability of their action being critical to the achievement of the public good, and (3) the probability of their action being superfluous. The level of cooperation in these one-shot games without communication is quite high. The public good is provided in seven out of ten of the experiments where the minimal contributing set equaled 3 (50% of the individuals contributed) and in four out of ten of the experiments with a minimal contributing set of 5 (64% of the individual contributed). On the other hand, the experiments where subjects were asked to estimate the probabilities of their own contribution being futile, critical, or superfluous, none of the five experiments achieved the minimal contribute set that had been set at 5 (23% contributed).[6]

The Allocation Function

In addition to the function that transforms contributions into a collective benefit, a second function, *A*, assigns individuals a share of the total benefits obtained. This function can initially be used to represent the "natural" allocation in a base game or the changed allocation rules used to transform the base game by an organized group or by external authorities. In a nondivisible good, each person would receive *TG*. For universal public goods, such as peace and stability, each individual benefits in a similar manner without subtraction from the existence of these states of affairs. In linear public goods experiments, *A* is frequently operationalized as 1/N. (Thus, if the MPCR is .25 as mentioned above, everyone receives the public good of 25 cents for everyone who contributes, whether or not they contributed themselves.) In a common-pool resource game, *A* can be operationalized as $x_i/\sum x_i$ or as a proportionate share of the total. These are three simple allocation functions, but a host of allocation functions are actually found in field settings including allocation according to: (1) the value of assets held (the function that Olson used); (2) seniority of claims; and (3) spatial or temporal formula. Sandler (1998) stresses that underlying aggregation "technologies" vary in the degree to which they are supportive of collective action.

Marks and Croson (1998) examine alternative rebate rules in the provision of a step-level public good. They find that contributions to the provision of the good are significantly higher under a "utilization rebate" rule than under two other rules examined. In this, contributions that are made above those necessary to provide a public good are used to provide more of a similar public good but one that has a continuous production function. If the original good were a infrastructure, for example, the additional funds could be used to plant trees around the infrastructure. In this setting what one contributes to the provision of the step-level infrastructure can be allocated to the continuous "environmental" public good. In their experiments, Marks and Croson (1998) find that contributions were significantly higher in those experiments with a utilization rebate rule than in those experiments where no rebate was made for over-contributions or where the rebate was distribution to contributors on a proportional basis. In the latter two cases, contributions were very close to the deficient Nash equilibrium for the game.

As indicated above, the initial specification of a collective action problem is one where once a collective benefit is produced, exclusion is nontrivial. Within this very broad definition of a collective action problem, a very large number of different situations exist depending on whether consumption is subtractive or not and on other variables that affect the shape of production and allocation functions. It is this variety of situations in the world – as contrasted to the overly simplified models of the world used in much of contemporary policy analysis – that are the foundation for considerable policy debate. There are several key confusions, besides those related to the core definitions of what is a public good and what is a common-pool resources, that have added confusion to policy debates.

The Confusion between a Resource System and a Property Regime

The term "common-property resource" is frequently used to describe the type of economic good that has been defined above as a "common-pool resource." Recognizing a class of goods that share these two attributes enables scholars to identify the core theoretical problems facing all individuals or groups who wish to utilize such resources for an extended period of time. Using "property" in the term used to refer to a type of good, reinforces the impression that goods sharing these attributes tend everywhere to share the same property regime.

Common-pool resources share with public goods the difficulty of developing physical or institutional means of excluding beneficiaries (Ostrom, Gardner, and Walker, 1994). Unless means are devised to keep nonauthorized users from benefiting, the strong temptation to free ride on the efforts of others will lead to a suboptimal investment in improving the resource, monitoring use, and sanctioning rule-breaking behavior. Second, the products or resource units from common-pool resources share with private goods the attribute that one person's consumption subtracts from the quantity available to others. Thus, common-pool resources are subject to problems of congestion, overuse, and potential destruction unless harvesting or use limits are devised and enforced. In addition to sharing these two attributes, particular common-pool resources differ on many other attributes that affect their economic usefulness including their size, shape, and productivity and the value, timing, and regularity of the resource units produced (see Ostrom, et al., 2002).

Common-pool resources may be owned by national, regional, or local governments, by communal groups, by private individuals or corporations or used as open access resources by whomever can gain access. Each of the broad types of property regimes has different sets of advantages and disadvantages, but at times may rely upon similar operational rules regarding access and use of a resource (Feeny et al., 1990). Examples exist of both successful and unsuccessful efforts to govern and manage common-pool resources by governments, communal groups, cooperatives, voluntary associations, and private individuals or firms (Bromley et al., 1992; Singh, 1994; Singh and Ballabh, 1996). Thus, as discussed below, there is no automatic association of common-pool resources with common-property regimes—*or, with any other particular type of property regime.*

The Confusion between the Resource and the Flow of Resource Units

Common-pool resources are composed of resource systems and a flow of resource units or benefits from these systems (Blomquist and Ostrom, 1985). The resource system (or alternatively, the stock or the facility) is what generates a flow of resource units or benefits over time. Examples of typical common-pool resource systems include lakes, rivers, irrigation systems, groundwater basins, forests, fishery stocks, and grazing areas. Common-pool resources may also be facilities that are constructed for joint use, such as mainframe computers and the Internet. The resource units or benefits from a common-pool resource include water, timber, medicinal plants, fish, fodder, central processing units, and connection time. Devising property regimes that effectively allow sustainable use of a common-pool resource requires rules that limit access to the resource system and other rules that limit the amount, timing, and technology used to withdraw diverse resource units from the resource system (Gibson, McKean, and Ostrom, 2000).

Property as Bundles of Rights

A property right is an enforceable authority to undertake particular actions in a specific domain (Commons, 1968). Property rights define actions that individuals can take in relation to other individuals regarding some "thing." If one individual has a right, someone else has a commensurate duty to observe that right. Schlager and Ostrom (1992) identify five property rights that are most relevant for the use of common-pool resources, including access, withdrawal, management, exclusion, and alienation. These are defined as:

Access: The right to enter a defined physical area and enjoy nonsubtractive benefits (e.g., hike, canoe, sit in the sun).

Withdrawal: The right to obtain resource units or products of a resource system (e.g., catch fish, divert water).

Management: The right to regulate internal use patterns and transform the resource by making improvements.

Exclusion: The right to determine who will have an access right, and how that right may be transferred.

Alienation: The right to sell or lease management and exclusion rights (Schlager and Ostrom, 1992).

In much of the economics literature, private property is defined as equivalent to alienation. Property-rights systems that do not contain the right of alienation are considered to be ill-defined. Further, they are presumed to lead to inefficiency since property-rights holders cannot trade their interest in an improved resource system for other resources, nor can someone who has a more efficient use of a resource system purchase that system in whole or in part (Demsetz, 1967). Consequently, it is assumed that property-rights systems that include the right to alienation will be transferred to their highest valued use. Larson and Bromley (1990) challenge this commonly held view and show that much more information must be known about the specific values of a large number of parameters before judgments can be made concerning the efficiency of a particular type of property right.

Instead of focusing on one right, it is more useful to define five classes of property-rights holders as shown in Table 1. In this view, individuals or collectivities may hold well-defined property rights that include or do not include all five of the rights defined above. This approach separates the question of whether a particular right is well-defined from the question of the effect of having a particular set of rights. "Authorized entrants" include most recreational users of national parks who purchase an operational right to enter and enjoy the natural beauty of the park, but do not have a right to harvest forest products. Those who have both entry and withdrawal use-right units are "authorized users." The presence or absence of constraints upon the timing, technology used, purpose of use, and quantity of resource units harvested are determined by operational rules devised by those holding the collective-choice rights (or authority) of management and exclusion. The operational rights of entry and use may be finely divided into quite specific "tenure niches" (Bruce, 1995) that vary by season, by use, by technology, and by space. Tenure niches may overlap when one set of users owns the right to harvest fruits from trees, another set of users owns the right to the timber in these trees, and the trees may be located on land owned by still others (Bruce, Fortmann, and Nhira, 1993). Operational rules may allow authorized users to transfer access and withdrawal rights either temporarily through a rental agreement, or permanently when these rights are assigned or sold to others (see Adasiak, 1979, for a description of the rights of authorized users of the Alaskan salmon and herring fisheries).

[Table 1 about here]

"Claimants" possess the operational rights of access and withdrawal plus a collective-choice right of managing a resource that includes decisions concerning the construction and maintenance of facilities and the authority to devise limits on withdrawal rights. The net fishers of Jambudwip, India, for example, annually regulate the positioning of nets so as to avoid interference, but do not have the right to determine who may fish along the coast (Raychaudhuri, 1980). Farmers on large-scale government irrigation systems frequently devise rotation schemes for allocating water on a branch canal (Shivakoti and Ostrom, 2002).

"Proprietors" hold the same rights as claimants with the addition of the right to determine who may access and harvest from a resource. Most of the property systems that are called "common-property" regimes involve participants who are proprietors and have four of the above rights, but do not possess the right to sell their management and exclusion rights even though they most frequently have the right to bequeath it to members of their family (see Berkes, 1989; Bromley et al., 1992; K. Martin, 1979; McCay and Acheson, 1987).

Empirical studies have found that some proprietors have sufficient rights to make decisions that promote long-term investment and harvesting from a resource. Place and Hazell (1993) conducted surveys in Ghana, Kenya, and Rwanda to ascertain if indigenous land-right systems were a constraint on agricultural productivity. They found that having the rights of a proprietor as contrasted to an owner in these settings did not affect investment decisions and productivity. Other studies conducted in Africa (Migot-Adholla et al., 1991; Bruce and Migot-Adholla, 1994) also found little difference in productivity, investment levels, or access to credit. In densely settled regions, however, proprietorship over agricultural land may not be sufficient (Feder et al. 1988; Feder and Feeny, 1991). In a series of studies of inshore fisheries, self-organized irrigation systems, forest user groups, and groundwater institutions, proprietors tended to develop strict boundary rules to exclude noncontributors; established authority rules to allocate withdrawal rights; devised methods for monitoring conformance, and used graduated sanctions against those who do not conform to these rules (Agrawal, 1994; Blomquist, 1992; Schlager, 1994; Tang, 1994; Lam, 1998).

"Owners" possess the right of alienation—the right to transfer a good in any way the owner wishes that does not harm the physical attributes or uses of other owners—in addition to the bundle of rights held by a proprietor. An individual, a private corporation, a government, or a communal group may possess full ownership rights to any kind of good including a common-pool resource (Montias, 1976; Dahl and Lindblom, 1963). The rights of owners, however, are never absolute. Even private owners have responsibilities not to generate particular kinds of harms for others (Demsetz, 1967).

What should be obvious by now is that the world of property rights is far more complex than simply government, private and common property. These terms better reflect the status and organization of the holder of a particular right than the bundle of property rights held. All of the above rights can be held by single individuals or by collectivities. Some communal fishing systems grant their members all five of the above rights, including the right of alienation (Miller, 1989). Members in these communal fishing systems have full ownership rights. Similarly, farmer-managed irrigation systems in Nepal, the Philippines, and Spain have established transferable shares to the systems. Access, withdrawal, voting, and maintenance responsibilities are allocated by the amount of shares owned (E. Martin and Yoder, 1983abc; E. Martin, 1986; Siy, 1982; Maass and Anderson, 1986). On the other hand, some proposals to "privatize" inshore fisheries through the devise of an Individual Transferable Quota (ITQ), allocate transferable use rights to authorized fishers but do not allocate rights related to the management of the fisheries, the determination of who is a participant, nor the transfer of management and exclusion rights. Thus, proposals to establish ITQ systems, which are frequently referred to as forms of "privatization," do not involve full ownership.

The next two sections are devoted to a discussion of the attributes of common-pool resources that are conducive to communal proprietorship or communal ownership as contrasted to individual ownership. Groups of individuals are considered to share communal property rights when they have formed an organization that exercises at least the collective-choice rights of management and exclusion in relationship to some defined resource system and the resource units produced by that system. In other words, all communal groups have established some means of governing themselves in relationship to a resource (E. Ostrom, 1990). Where communal groups are full owners, members of the group have the further right to sell their access, use, exclusion, and management rights to others, subject in many systems to the approval of the other members of the group. Some communal proprietorships are formally organized and recognized by legal authorities as having a corporate existence that entails the right to sue and be sued, the right to hold financial assets in a common bank account, and to make decisions that are binding on members. Other communal proprietorships are less formally organized and may exercise *de facto* property rights that may or may not be supported by legal authorities if challenged by nonmembers. Obviously, such groups hold less well-defined bundles of property rights than those who are secure in their *de jure* rights even though the latter may not hold the complete set of property rights defined as full ownership. In other words, well-defined and secure property rights may not involve the right to alienation.

Attributes of Common-Pool Resources Conducive to the Use of Communal Proprietorship or Ownership

Even though all common-pool resources share the difficulty of devising methods to achieve exclusion and the subtractability of resource units, the variability of common-pool resources is immense, as briefly mentioned above, in regard to other attributes that affect the incentives of resource users and the likelihood of achieving outcomes that approach optimality. Further, whether it is difficult or costly to develop physical or institutional means to exclude nonbeneficiaries depends both on the availability and cost of technical and institutional solutions to the problem of exclusion and the relationship of the cost of these solutions to the expected benefits of achieving exclusion from a particular resource.

Let us start initially with a discussion of land as a resource system. Where population density is extremely low, land is abundant, and land generates a rich diversity of plant and animal products without much husbandry, the expected costs of establishing and defending boundaries to a parcel of land of any size may be greater than the expected benefits of enclosure (Demsetz, 1967; Feeny, 1993). Settlers moving into a new terrain characterized by high risk due to danger from others, from a harsh environment, or from lack of appropriate knowledge, may decide to develop one large, common parcel prior to any divisions into smaller parcels (Ellickson, 1993). Once land becomes scarce, conflict over who has the rights to invest in improvements and reap the results of their efforts can lead individuals to want to enclose land through fencing or institutional means to protect their investments. There are tradeoffs in costs to be considered, however. The more land included within one enclosure, the lower the costs of defending all the boundaries, but the higher the costs of regulating the use of the enclosed parcel.

The decision to enclose need not be taken in one step from an open-access terrain to a series of private plots owned exclusively by single families (Field, 1984, 1985, 1989; Ellickson, 1993). The benefits of enclosing land depend on the scale of productive activity involved. For some agricultural activities, as discussed below, there may be considerable benefits associated with smaller parcels fully owned by a family enterprise. For other activities, the benefits may not be substantial. Moving all the way to private plots is an efficient move when the expected marginal returns from enclosing numerous plots exceed the expected marginal costs of defending a much more extended system of boundaries and the reduced transaction costs of making decisions about use patterns (Nugent and Sanchez, 1995).

In a classic study of the diversity of property-rights systems used for many centuries by Swiss peasants, Robert Netting (1976, 1981) observed that the same individuals fully divided their agricultural land into separate family-owned parcels, but that grazing lands located on the Alpine hillsides were organized into communal property systems. In these mountain valleys, the *same* individuals used different property-rights systems side-by-side for multiple centuries. Each local community had considerable autonomy to change local rules, so there was no problem of someone else imposing an inefficient set of rules on them. Netting argued that attributes of the resource affected which property-rights systems were most likely for diverse purposes. Netting identified five attributes that he considered to be most conducive to the development of communal property rights:

1. low value of production per unit of area,
2. high variance in the availability of resource units on any one parcel,
3. low returns from intensification of investment,
4. substantial economies of scale by utilizing a large area, and
5. substantial economies of scale in building infrastructures to utilize the large area.

Steep land where rainfall is scattered may not be suitable for most agricultural purposes, but can be excellent land for pasture and forests if aggregated into sufficiently large parcels. By developing communal property rights to large parcels of such land, those who are members of the community are able to share environmental risks due to the unpredictability of rain-induced growth of grasses within any smaller region. Further, herding and processing of milk products is subject to substantial economies of scale. If individual families develop means to share these reduced costs, all can save substantially. Building the appropriate roads, retaining walls, and processing facilities may also be done more economically if these efforts are shared.

While the Swiss peasants were able to devote these harsh lands to productive activities, they had to invest time and effort in the development of rules that would reduce the incentives to overgraze and would ensure that investments in shared infrastructure were maintained over time. In many Swiss villages, rights to common pasturage were distributed according to the number of cows that could be carried over the winter using hay supplies produced on the owners' private parcels. In all cases, the village determined who would be allowed to use, the specific access and withdrawal rights to be used, how investment and maintenance costs were to be shared, and how the annual returns from common processing activities were to be shared. All of these systems included at least village proprietorship rights, but some Swiss villages developed full ownership rights by incorporating and authorizing the buying and selling of shares (usually with the approval of the village). Netting's findings are strongly supported by studies of mountain villages in Japan, where thousands of rural villages have held communal property rights to extensive forests and grazing areas located in the steep mountainous regions located above their private agricultural plots (McKean, 1982, 1992). Similar systems have existed in Norway for centuries (Sandberg, 1993; 2001; Örebech, 1993).

The importance of sharing risk is stressed in other theoretical and empirical studies of communal proprietorships (Nugent and Sanchez, 1993; Gupta, 1986; Antilla and Torp, 1996). Unpredictability and risk are increased in systems where resource units are mobile and where storage facilities, such as dams, do not exist (Schlager, Blomquist, and Tang, 1994). Institutional facilities for sharing risk, such as formal insurance systems or institutionalized mechanisms for reciprocal obligations in times of plenty, also affect the kinds of property-rights systems that individuals can devise. When no physical or institutional mechanisms exist for sharing risk, communal property arrangements may enable individuals to adopt productive activities not feasible under individual property rights. A recent study has demonstrated that the variance in the productivity of land over space—due largely to the variance in rainfall from year to year—is strongly associated with the size of communally held parcels allocated to grazing in the Sudan (Nugent and Sanchez, 1995). Ellickson (1993) compares the types of environmental and personal security risks faced by new settlers in New England, in Bermuda, and in Utah to explain the variance in the speed of converting jointly held land to individually held land in each of these settlements.

A consistent finding across many studies of communal property-rights systems is that these systems do not exist in isolation and are usually used in conjunction with individual ownership. In most irrigation systems that are built and managed by the farmers themselves, for example, each farmer owns his or her own plot(s) while participating as a joint proprietor or owner in a communally organized irrigation system (Tang, 1992; Sengupta, 1991, 1993; Vincent, 1995; Wade, 1992; Coward, 1980). Water is allocated to individual participants using a variety of individually tailored rules, but those irrigation systems that have survived for long periods of time tend to allocate water and responsibilities for joint costs using a similar metric—frequently the amount of land owned by a farmer (E. Ostrom, 1990, 1992). In other words, benefits are roughly proportional to the costs of investing and maintaining the system itself.

Further, formally recognized communal systems are usually nested into a series of governance units that complement the organizational skills and knowledge of those involved in making collective-choice decisions in smaller units (Johnson, 1972). Since the Middle Ages, most of the Alpine systems in both Switzerland and Italy have been nested in a series of self-governing communities that respectively governed villages, valleys, and federations of valleys (Merlo, 1989). In modern times, cantonal authorities in Switzerland have assumed an added responsibility to make periodic, careful monitoring visits to each alp on a rotating basis and to provide professional assessments and recommendations to local villages, thereby greatly enhancing the quality of knowledge and information about the sustainability of these resources (Glaser, 1987).

Contrary to the expectation that communal property systems lacking the right to alienate ownership shares are markedly less efficient than property-rights systems involving full ownership, substantial evidence exists that many communal proprietorships effectively solve a wide diversity of local problems with relatively low transaction costs (Hanna and Munasinghe, 1995ab; Wilson, 1995; Sandberg, 1993, 1996ab; Gaffney, 1992; Kaul, 1996). Obtaining valid and reliable measures of outputs and costs for a large number of property-rights systems covering similar activities in matched environmental settings is extremely difficult. In regard to irrigation, a series of careful studies of the performance of communal proprietorship systems as contrasted to government-owned and managed systems, clearly demonstrates the higher productivity of the communal systems controlling for relevant variables (Tang, 1992; Benjamin et al., 1994; E. Ostrom, 1996; Lam, 1998). Schlager's (1994) studies of inshore fisheries demonstrate that fishers who have clearly defined proprietorship are able to solve difficult assignment problems and assign the use of space and technology so as to increase both the efficiency and equity of their systems. Wilson's (1995) studies also demonstrate that communal proprietorship systems are more efficient than frequently thought.

Performance of communal property-rights systems vary substantially, however, as do the performance of all property-rights systems. Some communal systems fail or limp along at the margin of effectiveness just as private firms fail or barely hang on to profitability over long periods of time. In addition to the environmental variables discussed above that are conducive in the first place to the use of communal proprietorship or ownership, the following variables related to the attributes of participants are conducive to their selection of norms, rules, and property rights that enhance the performance of communal property-rights systems (E. Ostrom, 1993):

1. Accurate information about the condition of the resource and expected flow of benefits and costs are available at low cost to the participants (Blomquist, 1992; Gilles and Jamtgaard, 1981).

2. Participants share a common understanding about the potential benefits and risks associated with the continuance of the status quo as contrasted with changes in norms and rules that they could feasibly adopt (E. Ostrom, 1990; Sethi and Somanathan, 1996).

3. Participants share generalized norms of reciprocity and trust that can be used as initial social capital (Cordell and McKean, 1992).

4. The group using the resource is relatively stable (Seabright, 1993).

5. Participants plan to live and work in the same area for a long time (and in some cases, expect their offspring to live there as well) and, thus, do not heavily discount the future (Grima and Berkes, 1989).

6. Participants use collective-choice rules that fall between the extremes of unanimity or control by a few (or even bare majority) and, thus, avoid high transaction or high deprivation costs (E. Ostrom, 1990).

7. Participants can develop relatively accurate and low-cost monitoring and sanctioning arrangements (Berkes, 1992).

Many of these variables are, in turn, affected by the type of larger regime in which users are embedded. If the larger regime recognizes the legitimacy of communal systems, and is facilitative of local self-organization by providing accurate information about natural resource systems, providing arenas in which participants can engage in discovery and conflict-resolution processes, and providing mechanisms to back up local monitoring and sanctioning efforts, the probability of participants adapting more effective rules over time is higher than in regimes that ignore resource problems or presume that all decisions about governance and management need to be made by central authorities.

Two additional variables—the size of a group and its homogeneity—have been noted as conducive to the initial organization of communal resources and to their successful performance over time (E. Ostrom, 1992; Libecap, 1989ab; Kanbur, 1991). As more research has been conducted, however, it is obvious that much more theoretical and empirical work is needed since both variables appear to have complex effects. Changing the size of a group, for example, always involves changing some of the other variables likely to affect the performance of a system. Increasing the size of a group is likely to be associated with at least the following changes: (1) an increase in the transaction costs of reaching agreements; (2) a reduction of the burden borne by each participant for meeting joint costs such as guarding a system, and maintenance; and (3) an increase in the amount of assets held by the group that could be used in times of emergency (Cornes, 1986). Libecap (1995) found that it was particularly hard to get agreements to oil unitization with groups greater than four. Blomquist (1992), on the other hand, documents processes conducted in the shadow of an equity court that involved up to 750 participants in agreeing to common rules to allocate rights to withdraw water from groundwater basins in southern California. The processes took a relatively long period of time, but they have now also survived with little administrative costs for half a century. Agrawal (2000) has shown that communal forestry institutions in India that are moderate in size are more likely to reduce overharvesting than are smaller groups because they tend to utilize a higher level of guarding than smaller groups.

Group heterogeneity is also multifaceted in its basic causal processes and effects. Groups can differ along many dimensions including their assets, their information, their valuation of final products, their production technologies, their time horizons, their exposure to risk (e.g., headenders versus tailenders on irrigation systems), as well as their cultural belief systems. Libecap's (1989b) research on inshore fisheries has shown that when fishers have distinctively different production technologies and skills, all potential rules for sharing withdrawal rights have substantial distributional consequences and are the source of conflict that may not easily be overcome. Libecap and Wiggins' (1984) studies of the prorationing of crude oil production reveal an interesting relationship between the levels and type of information available to participants and the likelihood of agreement at various stages in a bargaining process. In the early stages of negotiation, all oil producers share a relatively equal level of ignorance about the relative claims that each might be able to make under private-property arrangements. This is the most likely time for oil unitization agreements to be reached successfully. If agreement is not reached early, each participant gains asymmetric information about their own claims as more and more investments are made in private information. Agreements are unlikely at this stage. If producers then aggressively pump from a common oil pool, all tend to be harmed by the overproduction and are willing late in the process to recognize their joint interests. Libecap's (1995) study of marketing agreements among orange growers also shows a strong negative impact of heterogeneity. The theoretical work of Mancur Olson (1965) on privileged groups, on the other hand, predicts that when some participants have substantial assets and whose interests are aligned with achieving an agreement, such groups are more likely to be organized. The empirical support for this proposition comes more from studies of global commons (Mitchell, 1995; Oye and Maxwell, 1995).

Attributes of Common-Pool Resources Conducive to Use of Individual Rights to Withdrawal, Management, Exclusion, and Alienation

The advantage of individual ownership of strictly private goods—where the cost of exclusion is relatively low and one person's consumption is subtractive from what is available to others—is so well established that it does not merit attention here. Industrial and agricultural commodities clearly fit the definition of private goods. Individual rights to exclusion and to transferring control over these goods generate incentives that lead to higher levels of productivity than other forms of property arrangements.

It has frequently been assumed that land also is clearly always a private good and therefore best allocated using market mechanisms based on individual ownership rights. Agricultural land in densely settled regions is usually best allocated by a system of individual property rights. Gaining formal title to land, however, may or may not increase efficiency. Feder et al. (1988)

conducted an important econometric study that showed that agricultural land in Thailand without a formal title was worth only one-half to two-thirds of land with a formal title. Further, increasing the security of private-property rights also led to an increased value of the crops produced (between one-tenth and one-fourth higher than those without secure title). More secure titling also provided better access to credit and led to greater investments in improved land productivity (see also Feder and Feeny, 1991).

Title insurance is one mechanism used to reduce the risk of challenges to ownership of land. Registering brands is still another technique used to increase the security of ownership over resource units in the form of cattle that may range freely over a large area until there is a communal effort to undertake a round-up. Gaining formal titles is, however, costly. In societies that do not yet have high population densities and where customary rights are still commonly understood and accepted, formal titling may be an expensive method of increasing the security of a title that is not associated with a sufficiently higher return to be worth the economic investment (see Migot-Adholla et al., 1991). In addition, it should now be clear that the cost of fencing land by physical and/or institutional means is nontrivial and that there are types of land and land uses that may be more efficiently governed by groups of individuals rather than single individuals.

A commonly recommended solution to problems associated with the governance and management of mobile resources units, such as water and fish, is their "privatization" (Christy, 1973; Clark, 1980). What private ownership usually means in regard to mobile resource units, however, is individual ownership of withdrawal rights. Water rights are normally associated with the allocation of a particular quantity of water per unit of time or the allocation of a right to take water for a particular period of time or at a particular location. Fishing rights are similarly associated with quantity, time, or location. These rights are typically "withdrawal" rights that are tied to resource units and not to a resource system. In addition to the individual water rights that farmers hold in an irrigation system, they may also jointly own—and, therefore, govern and manage—the irrigation facilities themselves (Tang, 1992). In addition to the quotas or "fishing units" that individual fishers may own, no one owns the fishing stock and governmental units may exercise various types of management rights in relationship to these stocks (Schlager, 1990). In groundwater basins that have been successfully litigated, individual pumpers own a defined quantity of water that they can produce, rent, or sell, but the groundwater basins themselves may be managed by a combination of general-purpose and special-purpose governmental units and private associations (Blomquist, 1992).

Implementing operational and efficient individual withdrawal rights to mobile resources is far more difficult in practice than demonstrating the economic efficiency of hypothetical systems (Yandle, 2001). Simply gaining valid and accurate measurements of "sustainable yield" is a scientifically difficult task. In systems where resource units are stored naturally or by constructing facilities such as a dam, the availability of a defined quantity of the resource units can be ascertained with considerable accuracy, and buying, selling, and leasing rights to known quantities is relatively easy to effectuate in practice. Many mobile resource systems do not have natural or constructed storage facilities and gaining accurate information about the stock and reproduction rates is very costly and involves considerable uncertainty (Allen and McGlade, 1987; Wilson et al., 1991). Further, as Copes (1986) has clearly articulated, appropriators from such resources can engage in a wide diversity of evasive strategies that can destabilize the efforts of government agencies trying to manage these systems. Further, once such systems have allocated individual withdrawal rights, efforts to further regulate patterns of withdrawal may be very difficult and involve expensive buy-back schemes (Örebech, 1982). Experience with these individual withdrawal-rights systems has varied greatly in practice (see Pinkerton, 1992, 1994; McCay, 1992; McCay et al. 1996; Wilson and Dickie, 1995; Yandle and Dewees, forthcoming).

Exactly which attributes of both physical and social systems are most important to the success of individual withdrawal rights from common-pool resources is not as well established as the attributes of common-pool resource systems conducive to group proprietorship or ownership. On the physical side, gaining accurate measurements of the key variables (quantity, space, technology) that are to be involved in management efforts is essential. Resource systems that are naturally well-bounded facilitate measurement as well as ease of observing appropriation behavior. Storage also facilitates measurement. Where resource units move over vast terrain, the cost of measurement is higher than when they are contained (e.g., it is easier to develop effective withdrawal-rights systems for lobsters than for whales).

Considerable recent research has also stressed the importance of involving participants in the design and implementation of such property-rights systems (Agrawal and E. Ostrom, 2001). When participants do not look upon such rules as legitimate, effective, and fair, the capacity to invent evasive strategies is substantial (Seabright, 1993; Wilson, 1995). The size of the group involved and the heterogeneity of participants also affect the costs of maintaining withdrawal-rights systems (Edwards, 1994). And, the very process of allocating quantitative and transferable rights to resource units may undo some of the common understandings and norms that allowed communal ownership systems to operate at lower day-to-day administrative costs.

Common Property Regimes in the Twenty-First Century

Much of this paper has focused on natural resources. Many of the lessons learned from the operation of communal property regimes in these sectors, however, are quite relevant for a wide diversity of similar property regimes that are currently in wide use and likely to have a substantial presence in the next century. Many housing developments—both apartment houses and individual family dwellings—involve individual property to the housing unit itself combined with communal property to the grounds, recreational facilities, and other joint facilities. While individuals can buy and sell their individual housing units, at the time of purchase, they assume a set of duties in respect to the closely related communal properties. Monthly assessments for the repair and maintenance of these common facilities are not unlike the assessments made by a community of irrigators on themselves for the maintenance of their own system. Further, purchase and sales frequently require the permission of other members of the group. Similarly, many sports clubs allocate use quotas to members and assess members' regular fees for the maintenance of the commonly owned facilities.

The modern corporation is frequently thought of as the epitome of private property. While buying and selling shares of corporate stock is a clear example of the rights of alienation at work, relationships within a firm are far from being "individual" ownership rights. Since the income that will be shared among stockholders, management, and employees is itself a common pool to be shared, all of the incentives leading to free riding (shirking) and overuse (padding the budget) are found within the structure of a modern corporation (Putterman, 1995; Seabright, 1993; Ghoshal and Moran, 1996). Thus, where many individuals will work, live, and play in the next century will be governed and managed by mixed systems of communal and individual property rights.

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Table 1. Bundles of Rights Associated with Positions

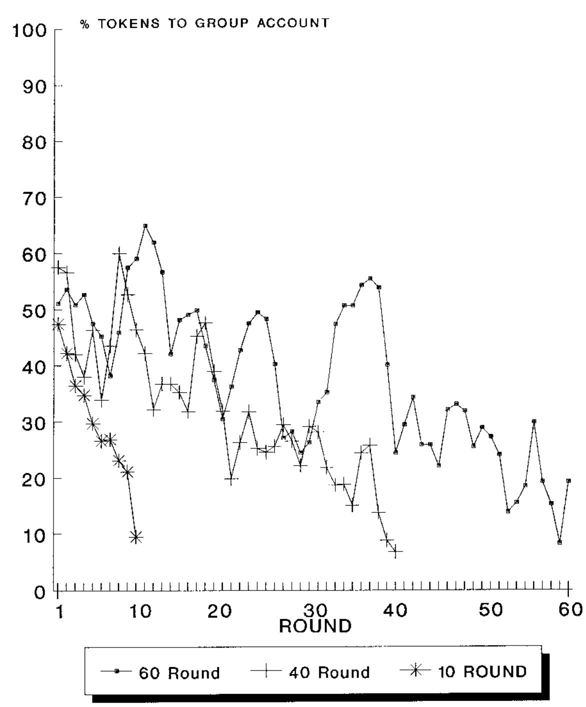
	Owner	Proprietor	Authorized Claimant	Authorized User	Authorized Entrant
Access	X	X	X	X	X
Withdrawal	X	X	X	X	
Management	X	X	X		
Exclusion	X	X			
Alienation	X				

Source: E. Ostrom and Schlager (1996: 133).

Figure 1. Samuelson's and Musgrave's Classification of Goods

	Samuelson's Classification	
Musgrave's Classification	one person's consumption subtracts from total available to others	one person's consumption does not subtract from total available to others
Exclusion is Feasible	Cell A	Cell B
Exclusion is Not Feasible	Cell C	Cell D

Figure 2. Contributions to Public Goods: 10, 40, and 60 Round Horizons



Source: Adapted from Isaac, Walker, and Williams (1994: 29).

Figure 3. The Effect of Increasing Investment Endowment (25-token design)

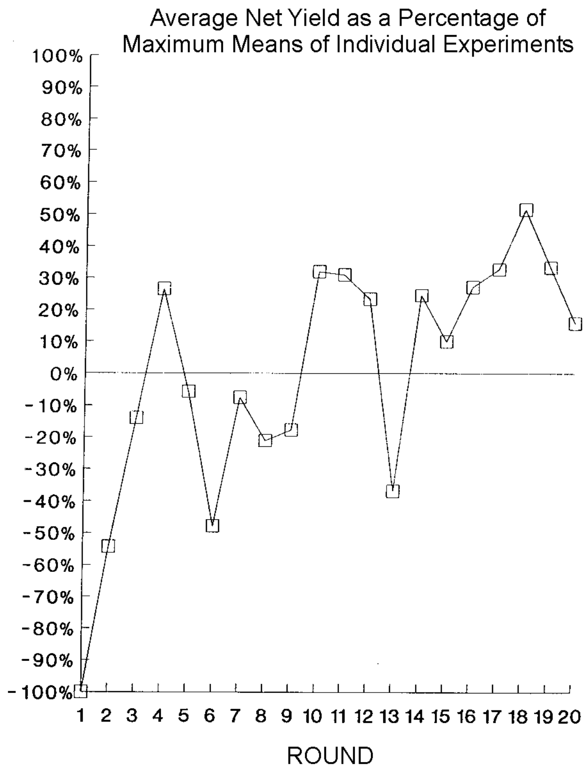
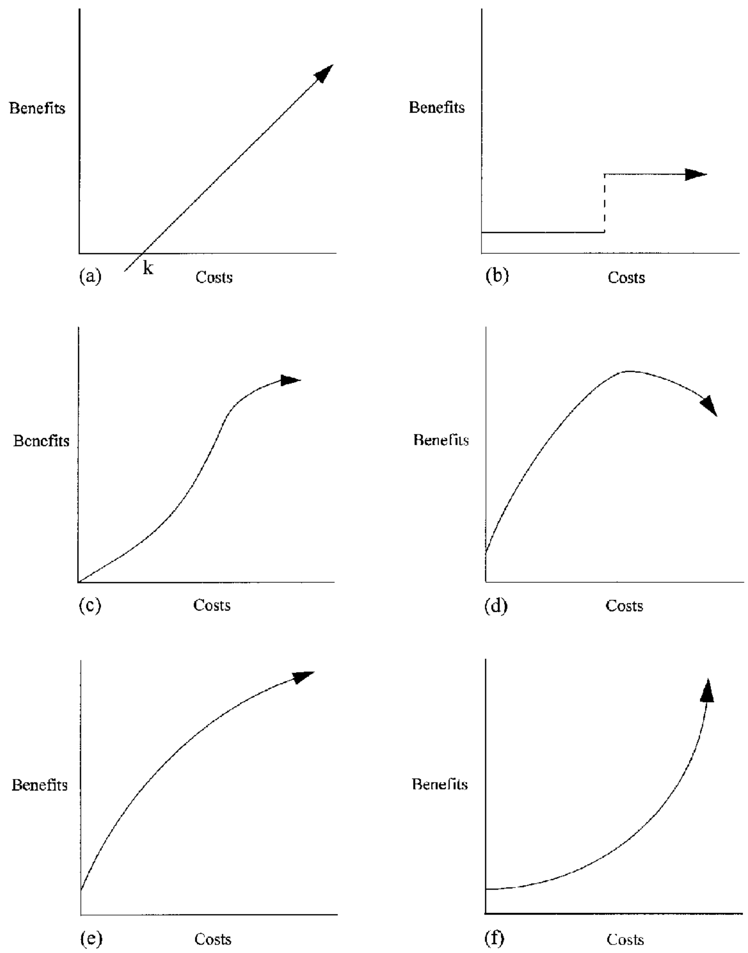


Figure 4. General Types of Production Function



(a) linear, (b) step function, (c) general third order, (d) quadratic, (e) decelerating, (f) accelerating.

Source: Modified from Marwell and Oliver (1993: 59).

Notes

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1. The example they use to illustrate such a production function is calling about a pothole in a neighborhood where a city administration is sensitive to citizen support (*ibid*.: 62). The first call brings the pothole to the attention of city officials and puts it on the list of things to be repaired (raising the probability of repair from zero to perhaps .4 or higher). The second call increases the probability of repair still further, but not as much as the first call. Later calls continue to increase the probability but with a smaller and smaller increment.

2. A strike involving only a few workers is unlikely to produce the level of benefits yielded by a strike involving a very large proportion of the workers of a firm or in an industry.

3. Step-level functions are, however, not strictly social dilemmas when there is complete information about the exact shape of the function. When individuals perceive themselves as critical to the achievement of a collective good, the game becomes a coordination game rather than a social dilemma.

4. Step functions characterize facilities such as bridges, tunnels, and roads that have little value if not completed. Some scholars have argued that many public goods are characterized by provision points (Taylor, 1987; Hampton, 1987; Taylor and Ward, 1982).

6. These experiments were also conducted at Utah State University several years after the first experiments had been conducted at University of Oregon.