Collective Action: Current Perspectives

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In a recent review, conducted on behalf of the UK Government, Stern (2007) concluded that "climate change is a serious global threat, and demands an urgent global response ... the benefits of strong and early action far outweigh the economic costs of not acting." The cuts in emissions that he suggested might generate global benefits. However, the costs would be borne individually by those making significant cuts (developed nations of the West) or by those sacrificing future opportunities (rapidly developing nations).

A shared desire to cut greenhouse-gas emissions generates a classic problem of collective action: a group with common interests must rely on voluntary individual optimization for the pursuit of those interests. Stern's "urgent global response" to a "serious global threat" requires nations to act. Such sovereign states need only respond to their own incentives; any participation is voluntary. Within each state, the pursuit of national objectives is not automatic; environmental effects stem from the decisions of individual agents. Even if it were in a state's collective interest to support a collective action against climate change, it cannot be assumed that constituents of that state would individually offer their backing.

To economists, the collective-action problem boils down to the private provision of a public good or the private exploitation of a common resource. Law and order, military defence, and pollution control are classic texbook examples of public goods: the benefits of provision are non-excludable, and so private providers fail to capture the full impact of their contributions. This market failure leads to inefficient under-provision. On the other hand, the commons exploitation of traffic congestion and commercial fishing yield negative externalities: market failure yields to inefficient over-indulgence in these activities. In both cases, individuals fail to pursue efficiently their collective objectives.

The idea that group members will not always pursue their common interests was once not accepted widely. In his original *Palgrave* entry, Olson (1987) observed that "economists, like specialists in other fields, often took it for granted that groups of individuals with common interests tended to act to further those common interests, much as individuals might be expected to further their own interests." He persuasively argued that "the existence of a common interest need not provide any incentive for an individual action in the group interest." Hence consumers may fail to campaign for their collective protection, unions may fail to protect all of their members, oligopolists may fail to maintain collusive prices, and nations of the world may fail to prevent further climate change.

Olson's point was simple and is now familiar: when contemplating his choice, an individual considers only the private impact of his actions. For the classic case of a public good, an individual faces the full marginal cost of provision but fails to account for the benefit spilling over to others; the presence of positive externalities leads to under-provision. If an individual could internalize these externalities, perhaps by excluding the consumption of others and charging them for it, then efficiency could be restored. Alas, pure public goods are non-excludable, and hence this route to efficiency is blocked.

Nevertheless, so long as individuals enjoy some private benefit from voluntary action then we can expect some, albeit too little, provision of public goods. The extent of any inefficiency depends upon the nature of the collective-action problem, the availability of mechanisms to restore efficiency, and the size and nature of the relevant group. Olson (1965) concluded that "unless the number of individuals in a group 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." In the context of small groups, when partial provision is deemed possible, he identified "a surprising tendency for the 'exploitation' of the great by the small." These claims led to his theory of groups: (i) collective actions fail when the groups are large; (ii) larger factions bear a disproportionate share of any provision; and (iii) selective incentives are necessary if groups are to succeed. These three claims are considered in turn, before attention turns to a rather different persepective on collective action.

The first claim is Olson's "group size" hypothesis: private provision should fall as a group grows larger. Olson (1965) painted a picture of a meeting at which too few people make careful contributions: "When the number of participants is large, the typical participant will know that his own efforts will probably not make much difference to the outcome, and that he will be affected by the meeting's decision in much the same way no matter how much or how little effort he puts into studying the issues." More directly, the claim is that the private benefit of any voluntary contribution falls with the group's size; equivalently, the private cost for any particular level of public provision rises with the group size. This claim leans on two implicit assumptions. Firstly, an increase in the number consuming the good leads to an increase in the provision cost, and hence the good is (at least partially) rival; it is an impure public good. Secondly, the group size corresponds to the number of consumers, and not to the size of the contributor pool.

These two implicit assumptions that underpin the group-size hypothesis are often valid. For instance, the global climate change that worried Stern (2007) corresponds to a "large group" global collective-action problem (Sandler, 2004). Nevertheless, the assumptions often exclude interesting collective-action problems. The first assumption rules out pure public goods. Consider, for instance, the contemporary voluntary provision of open-source software (Raymond, 1998; Johnson, 2002; Lerner and Tirole, 2002). The typical licence under which such software is distributed "requires that the source code ... be made available to everyone, and that the modifications made by its users also be turned back to the community" (Lerner and Tirole, 2001). This a modern instance of the "collective invention" documented by Allen (1983). Open-source software is automatically non-excludable. Of course, software is a classic instance of a non-rival good: consumption by one individual does not hamper the consumption opportunities of others. Hence, an increase in the size of the group consuming the good, while fixing the size of the group able to provide it, has no direct impact on incentives.

Olson's second claim was that provision costs fall on larger members of a group. The idea is that such members consume large shares of the public good, and so face a relatively large private benefit. Once again, this builds upon the assumption that the collective output is rival; for a pure public good, the same logic would predict that those who care most contribute most, and such contributors need not be large in a conventional sense.

Olson's third claim concerned the possible response to the problem of collective action. Such a response requires, according to this claim, selective incentives that are "functionally equivalent to the taxes that enable governments to provide public goods ... [they] either punish or reward individuals depending on whether or not they have borne a share of the costs of collective action, and thus give the individual an incentive to contribute ... " (Olson, 1987). The classic example of selective incentives is the "closed shop" of labor unions; to enjoy the benefits of collective union bargaining power each worker must be a member, and hence pay the costs of any strike action. Interestingly, when the selective incentive is based on preventing a group member from enjoying the collective output then the implicit assumption is that the public good is at least partially excludable.

In sum, Olson (1965, 1987) forcefully clarified the inescapable logic of collective action: any theory of group behavior must rely upon the incentives faced by individuals, and not simply assume that groups pursue their common interests. His theory of groups remains relevant for many contemporary problems. However, it steps outside the world of pure public goods by assuming the interdependent consumption of an impure public good, and does not allow for interdependence of production. Put more succinctly, Olson's groups consist of public-good consumers rather than public-good providers.

Attention now re-focuses on collective-action problems in which economic players non-cooperatively choose whether to participate in the private production of a pure public good. Crucially, there can be interdependence of production: the incentive to participate in a collective action depends on the expected participation of others. Decisions become genuinely strategic, and this changes the nature of the collective-action problem.

A little notation proves helpful. Amongst n players, write x_i for the action of player i, and collect the actions of everyone together into a vector x. Payoffs satisfying

$$u_i(x) = G(x) - c_i(x_i) \qquad (\dagger)$$

comprise the value $G(x)$ of a public good and the private cost $c_i(x_i)$ that player i incurs when contributing to it; the externality imposed on others is captured by $(n-1)G(x)$. The nature of the strategic interaction amongst players depends upon the form taken by $G(x)$.

A simple specification is when x_i is a positive real number and $G(x) \equiv \sum_{i=1}^{n} x_i$. A player's decision is strategically independent of others' actions: he simply equates the private marginal benefit of the public good to its private marginal cost via the first-order condition $1 = c'(x_i)$, yielding the usual under-provision problem (Cornes and Sandler, 1996).

A second natural specification to consider is where $G(x) \equiv F(\sum_{i=1}^{n} x_i)$ for some nicely behaved concave production function $F(\cdot)$. This falls within the class of Cournot contributions games (Chamberlin, 1974; McGuire, 1974; Young, 1982; Cornes and Sandler, 1985; Bergstrom, Blume, and Varian, 1986; Bernheim, 1986). Here, strategic interaction is non-trivial since the marginal benefit of increased public-good provision depends on the total contributions of all players. Nevertheless, a unique Nash equilibrium involves under-provision. The associated literature concerned itself with the comparative-static properties of such models, including the response of public-good output and the burden of provision to the redistribution of income (Warr, 1983; Kemp, 1984).

These first two examples of Equation (†) simply flesh out the implicit model of Olson (1965). The nature of the collective-action problem changes significantly when $G(x)$ takes on more interesting and yet plausible shapes. For instance, $G(\cdot)$ might take a weakest link ($G(x) = \min\{x_i\}$) or best shot ($G(x) = \max\{x_i\}$) form (Hirshleifer, 1983, 1985); these are special cases of symmetric but non-additive specifications (Cornes, 1993).

Here, however, attention turns to situations in which the success of a collective action (that is, the successful provision of a public good) turns upon either the participation of a critical mass of players, or contributions that exceed a particular threshold. Returning once more to the economics of climate change, a plausible scenario is one in which the ice caps melt unless carbon emissions are pushed down below a critical level. Whereas in a Cournot contributions game the incentive to contribute decreases with the participation of others, here it may increase: a nation may find it worthwhile to chase environmental targets if and only if it expects others to play their part in international agreements.

A central feature of threshold-based scenarios is that an individual's decision depends on aggregate participation. This is easiest to explore in a binary-action game where $x_i \in \{0,1\}$ for each player i; hence $x_i = 1$ can be interpreted as individual participation in a collective action. In many such situations, the incentive to participate depends on the number of others who do so. Hence, writing $\Delta u_i(x)$ for this incentive,

$$\Delta u_i(x) \equiv P(m) \quad \text{where} \quad m = \sum\nolimits_{j \neq i} x_j. \tag{‡}$$

When $P(m) < 0$ for all m, no players participate; this is an n-player Prisoners' Dilemma. If $P(m)$ decreases with m, then the unique equilibrium entails the participation of m^* players, where $P(m^* - 1) > 0 > P(m^*)$; for the Cournot games considered above the participation m^* might be socially sub-optimal. If $P(m)$ increases with m, so that there is a threshold m^* satisfying $P(m^* - 1) < 0 < P(m^*)$, then there are two pure-strategy Nash equilibria: one in which everyone participates, and one in which the collective action fails. This means that the problem of collective action becomes one of coordination.

Games satisfying Equation (‡) drew the insightful attention of Schelling (1973, 1978). He opened his analysis by describing the use of protective helmets in ice hockey: players were willing to wear helmets only if others did so too. Other sociological examples are easy to find: members of a crowd will join a protest only if others do so (Berk, 1974; Granovetter, 1978) and successful consumer boycotts require a critical mass (Innes, 2006).

Political situations can also fit Equation (‡). Consider a plurality rule election in which a group wishes to prevent the success of a disliked incumbent candidate. They can so if and only if a critical number m^* abandon their first-preference candidate and vote for their second choice. Setting $P(m^* - 1) > 0$ and $P(m) < 0$ otherwise yields a strategic-voting model (Palfrey, 1989; Myerson and Weber, 1993; Cox, 1994, 1997; Myatt, 2006).

In sociology, collective-action games with threshold properties fall under the umbrella of the theory of critical mass (Oliver, Marwell, and Teixeira, 1985; Oliver and Marwell, 1988; Marwell, Oliver, and Prahl, 1988; Marwell and Oliver, 1993). Alas, sociologists had no theoretical machinery for selecting between multiple equilibria. In economics, multiple equilibria arise in threshold-driven step-level public goods games (Palfrey and Rosenthal, 1984). Once again, the problem of coordination boils down to a need to choose amongst multiple equilibria. Fortunately, recent contributions to economics allow some progress to be made on the equilibrium-selection problem.

To explore further, it is instructive to consider a simple world: two individuals (A and B) either participate (Y) or not (N) in a collective action. Participation involves a private cost (either c_A or c_B), but may provide a public good to be enjoyed by both players. A natural representation is via a simple 2×2 strategic-form game (Figure 1).

Provision Game

	Y	N
Y	$2v - c_B$ $2v - c_A$	v $v - c_A$
N	$v - c_B$ v	0 0

Volunteer's Dilemma

	Y	N
Y	$v - c_B$ $v - c_A$	v $v - c_A$
N	$v - c_B$ v	0 0

Teamwork Dilemma

	Y	N
Y	$v - c_B$ $v - c_A$	0 $-c_A$
N	$-c_B$ 0	0 0

FIGURE 1. Public-Good Contribution Games

In the "Provision Game" a participant produces a public good worth v to everyone. A player's marginal product is strategically independent: the incentive for player A to participate is always $v - c_A$, and hence he does so if and only if $v > c_A$. However, this generates a spillover of v for player B, and hence the social gain is $2v - c_A$. The parameter configuration $2v > c_A > v$ yields the classic under-provision of a public good.

But what if there is strategic interdependence? Suppose that only one player need provide, so that a second participant generates a cost but no additional benefit. This "Volunteer's Dilemma" (Diekmann, 1985) is a textbook game of "chicken" (Lipnowski and Maital, 1983). If $2v > c_A > v$ and $2v > c_B > v$ then neither player is willing to participate even though it is socially optimal for someone to do so. However, if $v > c_A$ then player A participates so long as player B does not. If $v > c_B$, then there are two pure-strategy Nash equilibria in which a single player provides the public good. But who provides?

One possibility is to use risk dominance (Harsanyi and Selten, 1988) as a selection criterion. The risk dominant equilibrium is that which maximizes the product of players' incentives to remain at the equilibrium. So, in the volunteer's dilemma, the equilibrium in which A provides is risk dominant if $(v - c_A)c_B > (v - c_B)c_A$, which holds if and only if $c_A < c_B$: the most efficient provider volunteers. Following Olson (1965), the strong (low-cost providers) bear the cost of provision to the benefit of the weak.

A coordination problem also arises in the "Teamwork Dilemma" (Figure 1) where both players are needed for the collective action to succeed. This is an assurance or "stag hunt" game: so long as $v > c_A$ and $v > c_B$ there is a pure-strategy equilibrium in which both players participate, and a second with no participation in which the collective action fails. The former equilibrium is risk dominant if and only if $(v - c_A)(v - c_B) > c_A c_B$, which boils down to $v > c_A + c_B$; this requires a single private (not social) benefit from the public good to exceed the total private cost of provision. If $2v > c_A + c_B > v$, then the collective action fails even though it would be socially optimal for it to succeed. Once again, this is a return to Olson (1965): success of the collective action relies on private incentives.

All well and good, but can the criterion of risk dominance be justified? In the recent literature two contrasting approaches lead to the same answer.

The theory of global games (Carlsson and van Damme, 1993; Morris and Shin, 2003) supposes that players do not share common knowledge of the payoffs of games. Instead, players must rely upon privately observed signals of the game being played. For instance, players may be unsure of the true value v of the public good, and see an estimate of it. Crucially, this estimate allows them to infer not only this value but also the probable signals received by others, and hence their opponents' likely behavior. When signals become very precise then the play of a simple 2×2 game almost always coincides with the risk-dominant Nash equilibrium (Carlsson and van Damme, 1993).

Others have selected equilibria by studying the evolving play. Players (or populations from which players are drawn) may adjust their play over time in the direction of myopic best-reply, but occasionally "mutate" to a different strategy (Kandori, Mailath, and Rob, 1993; Young, 1993, 1998). As the probability of mutations vanish, play in the long run focuses around a single stochastically stable equilibrium (Foster and Young, 1990). In a symmetric teamwork dilemma, it picks out the risk dominant equilbrium.

Can modern literature say anything about the general case of Equation (†)? Players act as though they are attempt to maximize jointly the single real-valued function

$$\rho(x) \equiv G(x) - \sum\nolimits_{i=1}^{n} c_i(x_i). \qquad (\star)$$

This is a potential function, and yields a potential game (Monderer and Shapley, 1996). This function has a natural interpretation: the private benefit that a single individual derives from a public good, minus the total private costs involved in its provision.

Clean results emerge when play of a potential game evolves via a payoff-responsive stochasic strategy-revision process (Blume, 1993, 1995, 1997; Brock and Durlauf, 2001; Blume and Durlauf, 2001, 2003). Over time, players occasionally revise their strategies. When a player does so, his decision is not a myopic best reply to the current play of others, but rather a quantal response (McKelvey and Palfrey, 1995): the log odds of choosing one action rather than another is determined by the difference in their payoffs, and so he is more likely to choose better performing strategies. An inspection of Equation ($\star$) reveals that the difference in a player's payoffs is equal to the difference in potential; the potential function captures the essential strategic interaction of the game.

Allowing play to evolve, the strategy-revision process is drawn towards the states-of-play with the highest potential. In the long run, when quantal responses approximate best replies, the process spends almost all time in the state that maximizes $\rho(x)$: evolution leads players to maximize the difference between a single private benefit and total private costs rather than social welfare which would incorporate the full social benefit of $nG(x)$.

This approach can be applied to the teamwork dilemma: the potential of the state-of-play in which neither player participates is zero, and the potential of the equilibrium in which the collective action succeeds is $v - (c_A + c_B)$. The latter equilibrium has positive potential if and only if $v > c_A + c_B$: only if a private individual would be willing to step forward and pay the full cost of provision himself will the collective action succeed. So, whereas it may at first appear that the success of a collective action (the coordinated play of $\{Y, Y\}$ in the teamwork dilemma) can follow from the interdependence of team members, evolving play results in failure (the play of $\{N, N\}$ in the teamwork dilemma) unless a private individual would be willing to fund the collective action himself.

On reflection, this should be unsurprising. Each step of evolving play (or each step of reasoning in the global games literatures) is driven by reference to private incentives. So what lesson should be taken away? Even when a group's problem is one of coordination, its members cannot escape Olson's (1965; 1987) fundamental logic of collective action.

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