Toward a More Comprehensive Typology and Theoretical Foundations of the Logic of Collective Action

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Abstract : Current theories on the logic of collective action have two problems in common. First, with some exceptions, authors are not very careful about specifying what kind of collective action or goods they are dealing with. Secondly, current theories of interest groups have not been specific about the theoretical foundations on which their arguments are standing. Given these theoretical problems, this paper has three purposes. The purposes will be elaborated in three subsequent sections. Section II will investigate a more comprehensive multi-dimensional typology of collective action problems. Section III will discuss the relevance of the theory of public goods and game theory to the analysis of collective action problems. In Section IV, by picking up two representative examples, we will demonstrate the conditions under which two major analytical frameworks can be best applied.

INTRODUCTION

David Truman (1951) argued that interest groups arise more or less spontaneously in response to feelings of common interests among individuals who are experiencing some form of deprivation or frustration. Therefore, when individuals discover that they have a common interest that can be advanced through a collective action, they are stimulated to form a group, which then serves as a vehicle for the transmission of the interest into political system.

Olson (1965), who argued that unless the number of individuals in a group is quite small, or unless there is coercion or some other selective incentives, a group of people with a common interest would not take action to further that interest, challenged Truman's pluralistic perspective about group formation. The first obstacles to collective action arises because everyone views their contribution as a 'drop in the bucket,' in recognition that their marginal costs of contributing far outweigh any marginal benefits derived from the contribution's negligible impact on the provision of collective goods. Second, individuals have an incentive not to cooperate with others in making contributions because they know that their participation is not pivotal for group success and, as free riders, they will receive benefits in any case, should some collective goods be provided.

Olson's insights stimulated a large body of theoretical work on the logic of collective action. Their theoretical concern can be summarized as follows: given Olson's generally negative conclusions, how can we explain an explosion in the number of interest groups and their activities? As Walker (1983) stated, "interest groups are like bumblebees, theory says that they cannot fly, but they do."

There are several important elaborations to explain this.

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(1) Many theorists (Wilson, 1973; Salisbury, 1969; Moe, 1981) emphasized that an individual's decision may be determined by incentives other than economic gain. They especially stressed solidarity and purposive incentives.
(2) Moe (1980) added an additional dimension to the interest group arguments. He pointed out that there are substantial private benefits to interest group entrepreneurs (e.g. Ralph Nader, Martin Luther King Jr., Jerry Falwell, etc), if the entrepreneurs are successful organizers. Thus, to the extent that some, if not all, collective costs that Olson attributed to the free rider can be captured by the entrepreneurs, there is a smaller collective action problem.
(3) Hardin (1982), Axelrod (1984), and Taylor (1987) argued that the logic of collective action can be reduced to the prisoner's dilemma game, and showed that, without changing the payoffs of game, if we increase the number of iterations, cooperation may emerge. In summary, since your future cooperation may depend on my cooperation today, I have an incentive to cooperate today as far as future is important.

This is a brief review of current theories of interest groups. We can identify two problems in these current theories on the logic of collective action. First, with some exceptions (Chamberlin, 1974; Hardin, 1982), authors are not very careful about specifying what type of collective action or goods they are dealing with. Clearly, interest groups seek diverse kinds of collective goods. For example, although all collective goods are non-excludable, some goods also have a nonrivalness property (joint consumability); that is, the benefits that any individual receives from the goods provided remains constant as the size of the group increases. Other goods do not have that characteristic.

Similarly, the type of group members' contribution that makes the provision of collective goods possible may be diverse. For example, in some cases, an individual's choice problem can be reduced to a binary choice problem: vote or not, cooperate or defect, attend a political campaign of not, contribute a unit of collective goods or not, etc. In other cases, it may be a continuous choice problem: how much money one should donate, how much one may pollute, etc. Furthermore, the overall characteristics of a collective action game may differ from situation to situation. Sometimes it is a one-shot game. In many cases, however, we are concerned about the effects of a collective action over time in order to overcome recurrent collective action problems.

Secondly, current theories of interest groups have not been specific about the theoretical foundations of their arguments. Most theories have adopted an Olsonian type of logic. We should notice, however, that Olson's statement in *The Logic of Collective Action* (1965) is ostensibly based on an older tradition of economic analysis: that is, the theory of public goods. The other major analytical tradition that contributed to the understanding of the problem of collective action is the game theory. Over the years, there have been numerous instances of the recognition of collective action problems in various literary forms; however, the generalization of the problem stems from the two recent theoretical advances referred to above.

This paper has three purposes, which will be elaborated in three subsequent sections. Section II investigates a more comprehensive multi-dimensional typology of collective action problems. Section III discusses the relevance of the theory of public goods and the game theory to the analysis of collective action. In Section IV, by selecting two representative examples, we will demonstrates the conditions under which two major analytical frameworks can best be applied to collective action problems. The final section summarizes the results and proposes the future research topics.

TOWARD A MORE COMPREHENSIVE TYPOLOGY OF COLLECTIVE ACTION

Characteristics of Collective Goods

Inclusive vs. Exclusive

Collective goods are usually assumed to have the property of nonexcludability; that is, individuals who do not share in paying for the goods are not excluded from enjoying the benefits of the goods. However, depending on whether the consumption of the goods by a single individual reduces another's consumption of the goods (the property of non-rivalness, joint consumability or joint supply) we can classify collective goods into inclusive and exclusive goods.

Additional consumers do not detract from the consumption of previous consumers with inclusive goods, which can be considered 'pure public goods,' and the value of the goods is a function of the number of consumers, whereas the cost of providing the goods is constant. For example, if a decrease in the corporate income tax occurs, an unlimited number of firms can receive the benefits of the lower taxes without detracting from the benefits other firms receive.

On the other hand, with exclusive goods, the same degree of rivalness of consumption applies as that of with private goods, even though the nonexcludability property is still provided such as in Olson's example of a price increase brought about in an industry through output restriction (Olson, 1965: 39-43). The benefits of this price increase (i.e. increased profits) are available to any producers who supply the demand for the industry's product. The total increased profit, however, is limited, and the consumption of this profit is subject to rivalness.

Chamberlin (1974) argued that with inclusive collective goods that are not inferior, the relationship between group size and the amount of the goods provided is opposite to Olson's assertion. Chamberlin demonstrated that if a collective goods is inclusive and non-inferior, the amount of the goods actually provided by a group increases with group size, which is contrary to one of Olson's main conclusions: "the larger a group is, the farther it will fall short of providing an optimal supply of any collective goods" (Olson, 1965: 36).

Collective Goods vs. Collective Bads

Although current theories of collective action primarily discuss groups that are interested in the provision of goods, in many collective action problems, especially political issues, the best outcomes are the elimination of harm rather than the provision of goods. For example, elimination of air pollution or the removal of a noisy public loudspeaker is an elimination of a collective bad problem. Whether a particular provision is good or bad is a subjective matter, however. For those who enjoy jazz in a public place, loud music may be a good; however, for those who cherish silence it may be a bad.

In addition, one might argue that there should be no asymmetry in the collective consequences of good and bad. That is, if the noise is a bad, its absence is a good, and what people do to prevent the bad is surely equivalent to what they do to provide the obverse goods. Nevertheless, members of a certain group may uniformly perceive either that they suffer from a bad or that they fail to benefit from a goods. The group's action may depend on whether its members see their problems as the elimination of a bad or the provision of a goods.

Kahneman and Tversky (1979: 277-280; 1981: 454) argued, in their Prospect Theory, that an individual's value function is commonly S-shaped as in Figure 1. This is quite contrary to the expected utility theory's overall concave utility function. Their arguments can be summarized as follows:

(1) The value function is defined on deviation from the referent point (that is, 'status quo' point).
(2) The value function is generally concave (risk averter) for gains and commonly convex (risk lover) for losses.
(3) The value function is steeper for losses than for gains. That is, the response to losses is greater than the response to gains.

If we apply Kahneman & Tversky's Prospect Theory to our collective action problem, we conclude that despite the formal equivalence of their payoff structure, cooperation to oppose a loss (elimination of a collective bad) may be easier than cooperation to support a gain (provision of a collective goods).

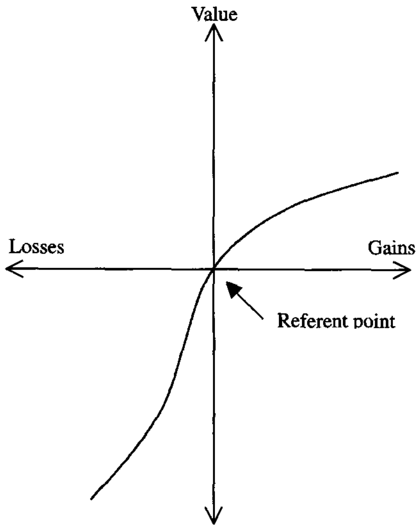

Figure 1. Value Function

Step Goods vs. Continuous Goods

Another important dimension of collective action is whether goods are step goods or continuous goods. A group of people in a small town wants to construct a bridge that cost $100,000. If their donations to building a bridge are less than $100,000, they cannot have a bridge. Therefore, the bridge is a collective step goods to the community. Perhaps, the best-known example of a step goods is the election of a political candidate. Continuous goods can be shown by an example: if a group of people wants to help starving children, then their total contribution may be a continuous collective goods to the group. We should note that the analytical tool for a collective action problem differs depending on whether it is a step or continuous goods.

Type of Contribution: Binary vs. Continuous

Besides the properties of collective goods considered above, the type of contribution by group members also characterizes collective action problems. An individual group member's choice may be binary (i.e., whether to vote), or a choice of the level of contribution (i.e., how much to contribute).

Type of Collective Action Game

Cooperative Provision vs. Non-cooperative Provision

The general characteristics of the game of collective action may be another typology of collective action problems. In game theory, it proves helpful to categorize games into two types: those in which the agents communicate with one another and agree to act in certain ways are cooperative games, and those that do not allow such opportunities are non-cooperative games.

In the cooperative provision of collective goods cases, group members are allowed to make cost free coalitions within which they can coordinate their actions, and negotiate their costs and the benefits that accrue. This framework suggests a natural equilibrium concept: the core, which consists of set of allocations such that no individual or a group of individuals can improve their position by forming an alternative coalition. Some economic theorists (Foley, 1970; Muench, 1978; Ellickson, 1978) applied the core concept in the field of cooperative collective action problems. Their results, however, were opposite to the case of pure private goods where as the number of individuals is increased, the set of core allocations shrinks and converges in the limit to the set of competitive equilibria. Unfortunately, no such shrinkage can be found in cooperative collective action problems. Because of this negative result, most game theory discussions have centered on the non-cooperative provision scheme.

One-Shot Game vs. Iterated Game

A collective action game can be a one-shot game. The game can also be iterated, even though the rules, strategies, and the payoffs to each player are the same as in the one-shot game. The iterated game is different in that it yields the opportunity for tacit communication among players so that one recognizes that other players' future choices are contingent on one's own immediate choice. Therefore, even though a rational player does not provide collective goods in a one-shot game, the player might have an incentive to provide collective goods in an iterated game. This point will be examined in more detail in the next section.

THEORETICAL FOUNDATIONS OF THE LOGIC OF COLLECTIVE ACTION

Theory of Public Goods

Public goods, like inclusive collective goods, are defined by two properties–nonexcludability and nonrivalness (Samuelson, 1954, 1955). The central relationship between the analysis of public goods and the problem of collective action is that nonexcludability from consumption of collectively provided goods usually eliminates any direct incentive for individual consumers to pay for the goods. In public goods theory, there are two different assumptions about an individual's behavior: Nash-Cournot behavior and Non-Nash-Cournot behavior.

Nash-Cournot Behavior Assumptions

Nash-Cournot behavior or zero-conjectural variations or the independent adjustment process postulates that individuals in a group choose the level of contribution consistent with their constraints, given the value of the collective goods the rest of the group has provided. This process is a dynamic adjustment in which each individual reacts to the behavior of others on the assumption that the others will not perceive the individual's action. In other words, others' behavior is assumed constant regardless of any intervening action. This assumption is equivalent to the 'imperceptibility' of an individual's action in a large group in Olson's arguments (Olson, 1965: 44-45).

With this assumption, the dominant methodology in public goods theory is to derive reaction curves for each individual member and determine the equilibrium level of the total provision of public goods at the point at which the reaction curves intersect (Chamberlin, 1974: 709-710). After deciding the equilibrium level of total provision, the Nash-Cournot equilibrium level is compared with the set of Pareto optimal allocations.[1] One of the principle results is that the comparison between the actual and optimal levels reveals the tendency for the equilibrium level of the private provision of public goods to fall short of its Pareto-optimal level (Cornes and Sandler, 1986: 69-94). This subo-ptimality of Nash-Cournot equilibrium has motivated some economists (Clarke, 1971; Bergstrom and Cornes, 1983) to investigate demand-revelation schemes that guarantee the optimal provision of public goods.

From the positive economics perspective that emphasizes efficient allocation of resources, the comparison between the Pareto optimal level and the actual level makes sense. From the political economy perspective that emphasizes equitable distribution of resources as well as efficient allocation, however, the comparison is not the whole story. The question is how much we should rely on the Pareto-optimality condition as the only criterion for the collective action problems. We should also note the danger in being exclusively concerned with Pareto-optimality; an economy can be Pareto-optimal even when some are living in luxury and others are near starvation, as long as the lot of the poor can not improve without depleting the lot of the rich.

Departures from Nash-Cournot Assumption

We can identify two departures from the Nash-Cournot analysis. First, some oligopoly theorists such as Frish (1933) and more recently, Bresnahan (1981) and Perry (1982) argue that static Nash-Cournot equilibrium, the zero-conjecture variation equilibrium we

1) We could derive the Pareto-optimal condition in the presence of public goods as follows. The sum of the marginal rate of substitution between a private and a public goods over all members should be equal to the marginal cost of providing one unit of a public goods: , $\sum_i MRS_i = MC$ (Samuelson, 1954, 1955).

investigated earlier, is open to the objection. If individuals experiment by making small changes in their contributions, the presence of a non-zero response is revealed over time. A truly rational individual would learn from such an experience and appropriately revise their assessment of others' responses. Therefore, they emphasize that incorporating non-zero conjectures may profitably modify the public goods model.

Secondly, some theorists in public finance and public choice departed from Nash-Cournot analysis by seeking alternative institutional settings to the market mechanism, i.e., private provision of public goods mechanism. A proper assessment of the performance of alternative institutional structures in the presence of public goods requires a positive theory of their formation and behavior. Public choice theorists (Downs, 1957; Buchanan and Tullock, 1962; Niskanen, 1971; Buchanan, 1975) have taken up this challenge. The general thrust of much of this literature is that typical political processes are characterized by political failures that are analogous to market failures treated so extensively in microeconomics.

Game Theory and the Logic of Collective Action

The greater strength of the game theory in collective action problems is that it makes the strategic aspects of intragroup interactions explicit. Most game theoretical representations of collective action problems have been centered on the non-cooperative provision of collective goods (Schelling, 1973; Axelrod, 1984; Hardin, 1982).

This paper will demonstrate the applicability of game theory to the logic of collective action in two examples. First, it is generally argued that the underlying logic in the case of Olson's latent groups (group failures in the provision of collective goods) is equivalent to that of Prisoner's Dilemma game (Hardin, 1982: 25-28).

Table 1. Prisoner's Dilemma Game I

		Player B	
		C	D
Player A	C	3.3	0.5
	D	5.0	1.1

C : cooperation
D : defect

If the Prisoner's Dilemma game is a one-shot game, 'defect' is the best strategy for each player, regardless of the other player's strategy, as in Table 1. 'Both defect' is actually a dominant strategy in a one-shot version of the Prisoner's Dilemma game.

As noted in the previous section, however, if the game becomes iterated, the conclusion will be different. Hardin (1982), Axelrod (1984), and Taylor (1987) proved that if we increase the number of iteration, cooperation (contributing collective goods) could be a dominant strategy. As noted in Section I, the reason for cooperation in the iterated Prisoner's Dilemma is that your future cooperation may depend on my cooperation today. I have an incentive to cooperate today as far as future is important.

Secondly, as noted above, in the non-cooperative binary choice model, theorists have demonstrated the equivalence of the logic of collective action problems and that of

Prisoner's Dilemma game. If we recall our typology of collective actions in Section II, however, that generalization is valid only in restricted cases. If we assume exclusive collective goods (nonexcludability and rivalness), there is equivalence between the logic of collective action problems and that of the Prisoner's Dilemma game. The story will be different if we assume inclusive collective goods (nonrivalness as well as nonexcludability). The arguments can be more clearly demonstrated by using a two-person, two-strategy case.

Suppose each player (A, B) has two strategies: either contributing one unit of collective goods or not. The cost of contributing one unit of collective goods is three and the benefit to the group is five. With these simple assumptions, we can draw a payoff matrix for each case. In an exclusive goods case, if both A and B contribute one unit of collective goods respectively, the payoff to both will be 2 ([5 × 2/2]-3). If A contributes and B does not, the payoff to A will be -0.5 ([5/2]-3) and that to B will be 2.5 (5/2). In an inclusive goods case, however, if A and B both contribute, their payoff will be 7 respectively ([5 × 2]-3). If A contributes and B does not, the payoff to A will be 2 (5-3) and to B, 5. These inferences allow us to construct payoff the matrices as in Table 2:

Table 2. Exclusive vs. Inclusive Collective Goods

		Player B	
		Contribute	Not Contribute
Player A	Contribute	2, 2	-0.5, 2.5
	Not Contribute	2.5, -0.5	0, 0*

<Exclusive Goods>

		Player B	
		Contribute	Not Contribute
Player A	Contribute	7, 7*	2, 5
	Not Contribute	5, 2	0, 0

<Inclusive Goods>

*Dominant Strategy Nash Equilibrium

The payoff matrices in Table 2 show that the equivalence between the logic of collective action problems and that of the Prisoner's Dilemma game holds only in the case of exclusive collective goods, because the dominant strategy in exclusive collective goods case is 'Not Contribute' and in the inclusive goods case, it is 'Contribute.'

APPLICATIONS OF THEORETICAL FRAMEWORKS

In Section II & III, we investigated the diverse types and theoretical foundations of collective action problems. Because we identified six different dimensions (inclusive vs. exclusive, collective goods vs. collective bads, step goods vs. continuous goods, binary contribution vs. continuous contribution, cooperative vs. non-cooperative, and one-shot vs. iterated) in Section II, the total possible models of collective action will be 64. Since it is impossible to investigate all 64 models in this paper, we select two cases to demonstrate the conditions under which two major analytical frameworks can be applied to the logic of collective action problems.

Case I

In this case, we will investigate one-shot provision of inclusive continuous collective goods whose provision depends on each group member's non-cooperative choice of the level of continuous contribution. That is, we assume the characteristics of collective goods to be inclusive, continuous, and collective; continuous contribution as the type of contribution; and non-cooperative and one-shot provision as the rules of collective action game.

Let us consider a simple public goods model where there are one public goods, one private goods, and n players. Each individual (i) consumes an amount, x_i, of private goods and donates an amount, $g_i \geq 0$, to the provision of public goods (G). The total supply of public goods, G, is the sum of contributions of all individuals ($G=\sum_i g_i$). The utility function of individual i is $U_i(x_i,G)$. Individual i is endowed with wealth, w_i, which is allocated between the consumption of private goods and his contribution to public goods. Individual i's choice problem is to maximize his utility by choosing x_i and g_i, which can be formalized as follows:

$$\text{Max.}_{x_i,g_i} U(x_i, G) \text{ s.t. } x_i + g_i = w_i \ \& \ g_i \geq 0$$

Let $G_{-i} = \sum_{j \neq i} g_j$ be the donation of every one but individual i. Alternatively, we can write $G_{-i} = G - g_i$. Then, the maximization problem will be equivalent to

$$\text{Max.}_{x_i,G} U(x_i, G) \text{ s.t. } x_i + G = w_i + G_{-i}^* \ \& \ G \geq G_{-i}^*$$

Ignoring the inequality constraint, and assuming Nash-Cournot behavior, this choice problem is formally the same as a standard demand problem for a consumer with income, $w_i + G_{-i}^*$. Let $f_i(w)$ be individual i's demand function for the public goods, representing the value of G that i would choose as a function of the right-hand side of the above budget constraint, $w_i + G_{-i}^*$. Then, his demand for the public goods considering the inequality constraint will be as follows:

$$G^* = \text{Max.}\{f_i(w_i + G_{-i}^*), G_{-i}^*\}$$

Subtracting G_{-i}^* from each side of this equation, we have individual i's optimal response

$$g_i^* = \text{Max.}\{f_i(w_i + G_{-i}^*) - G_{-i}^*, 0\}$$

Note that the donation function, $f(\cdot)$, is the income-consumption curve (Engel curve). With the assumption that f is differentiable, and that the derivative is increasing and bounded away from 1 ($0 < f' < 1$), that is, both the public goods and the private goods are (strictly) normal, Bergstrom, Blume and Varian (1984) proved the existence, the uniqueness, and the stability of this equilibrium.

Case II

In this case, we will investigate infinitely iterated provision of exclusive, continuous collective goods whose provision depends on each group member's non-cooperative choice of a binary contribution. As we argued at the end of the last section, if a collective good is an exclusive goods, the logic of collective action problems can be reduced to the Prisoner's Dilemma game. It is generally agreed that with the finite iteration of Prisoner's Dilemma game 'defect' (or 'not contribute one unit of collective goods') is the dominant strategy for each player in every period of iteration. The logic is quite simple. If there are n repetitions of the Prisoner's Dilemma game, at $t = n$, because there is no next period, everyone will choose the best strategy (dominant strategy, that is, 'defect') regardless of previous history. At $t = n-1$, because everyone knows that they will choose 'defect' at $t = n$, they will choose 'defect' in that period. The same kind of inference applies back to the first period. They will choose 'defect' in the first period. Therefore, everyone will choose 'defect' strategy in every period.

As noted in the previous sections, if we assume infinite iteration, the story will be quite different. In this section, we will formalize the arguments of Axelrod (1984) and Hardin (1982) into a standard game theoretic version and try to discover the implications. Before going further, it is important to clarify the equilibrium concepts in the game theory - especially, the Nash equilibrium and the subgame perfect Nash equilibrium. First, the Nash equilibrium can be defined as follows: A combination of actions or strategies for a player is a Nash equilibrium, if each player's strategy maximizes his expected utility given the actions of other players. For example, if every driver drives on his left side of the road, my best reply to others' strategies will be to drive on my left side of the road. Driving on one's left side of the road will be a Nash equilibrium. Unfortunately, the Nash equilibrium lacks uniqueness in many cases. Therefore, many refined Nash equilibrium concepts emerged, including the subgame perfect Nash equilibrium, which is defined as follows: A set of strategies is a subgame perfect Nash equilibrium, if it induces a Nash equilibrium in every subgame.

Axelrod's main arguments can be transformed into a theorem: a 'tit for tat' strategy in an infinitely iterated Prisoner's Dilemma game is a subgame perfect Nash equilibrium. Because 'tit for tat' is a Nash equilibrium, if one player chooses a 'tit for tat' strategy, the other player cannot improve by choosing any other strategies. Therefore, the 'tit for tat' strategy is the best reply to itself. This result is similar to Proposition 2 in Axelrod's work (1984: 59): "Tit for Tat is collectively stable." Furthermore, because 'tit for tat' is a subgame perfect Nash equilibrium, it is a Nash equilibrium in every subgame of an infinitely iterated Prisoner's Dilemma game. That means, regardless of the history up to certain period, 'tit for tat' is the best reply to 'tit for tat' in the remaining periods. Thus, by using the theorem that we proposed, we can derive a stronger conclusion than that of Axelrod's; namely, 'tit for tat' is collectively stable in every subgame as well as in the entire game.

CONCLUSION: SUMMARY AND FUTURE RESEARCH TOPICS

This paper identified two theoretical problems in the current theories on the logic of collective action. First, with some exceptions, current theories are too casual about specifying what kind of collective action or goods they are dealing with. Secondly, current theories of interest groups have not been specific about the theoretical foundations of their arguments. Given these theoretical problems, this paper investigated a more comprehensive, multi-dimensional typology of collective action problems and its relevance of the theory of public goods and game theory for the analysis of collective action problems.

Although we proposed diverse types of collective action, many other important dimensions of the collective action problems might have been overlooked. Furthermore, many theoretical arguments other than those of public goods and the game theory can be successfully applied to the analysis of the collective action problems. This paper has emphasized the importance of being more specific about the types of the collective action and that each type needs a different theoretical framework for analysis.

Finally, we would like to propose future research topics by identifying the limitations of current theoretical arguments. Despite its theoretical rigor, we could identify several criticismsagainst the analysis of public goods theory on collective action problems.

(1) Most models assumed Nash-Cournot behavior (i.e., zero-conjectural variation, $dG_{-i}^*/dg_i = 0$). However, as we observed above, there are many importance instances in which we should assume non-zero conjectural variations.

(2) Even though some theorists investigated the models with heterogeneous tastes and endowments, they have ignored set-up costs in the provision of collective goods. In reality, however, any provision of collective goods requires considerable amount of set-up costs.

(3) Most theoretical and experimental models have assumed that each individual's utility depends on private consumption and the sum of everyone's voluntary contributions. We should note, however, that a complete descriptive model of collective action would allow each consumer to be concerned about his own contribution as well as the total supply of collective goods. Even where the goods supplied are pure public goods, and where the contribution of different individuals are technically perfect substitutes, a satisfactory model should accommodate preferences of people who feel a 'warm glow' from having 'done their bit.'[2)]

Next, we will identify criticisms against the current game theoretic analysis of collective action problems. Most works have centered on an iterated Prisoner's Dilemma game and show that under certain conditions, mutualcooperation is an equilibrium; however, there are two problems with this approach. First, it depends on the numerical value of the discount rate used to weigh future payoffs vis-à-vis the present. Secondly, there are numerous equilibria in infinitely repeated games. For example, 'all defect in every period' is also a subgame perfect Nash equilibrium. Furthermore, with some exceptions, most models deal with two-person cases, whereas our ultimate interest is in

2) That is, the utility function for individual (i) should be $U_i(x_i, g_i, G)$ instead of $U_i(x_i, G)$.

collective goods models with many players. Axelrod's tournament consisted of rounds of two-player contests. However, if we increase the numbers of players, many propositions in his book become unclear and inaccurate.

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