1. Objectives and scope of the book

In recent years game theory has become more prominent as an aspect of research and applications in public policy disciplines such as economics, philosophy, management, and political science, and in work within public policy itself. One reason for this growing prominence may be understood from some comments of Thomas Schelling (1960) and Robert Aumann (for example, 2004). They have said that the subject matter of game theory would be better described as interactive decision theory. Schelling and Aumann shared the Nobel Memorial prize in 2005 for their work in game theory (Royal Swedish Academy of Sciences), and Aumann was the first president of the world Game Theory Society.

Why then use the term "game theory" for a field that is not really about games? The *game* is to *game theory* as the *experiment* is to *experimental science*. After all, experimental science is not about experiments. It is about the natural world. Nevertheless experiments are a powerful aid to our understanding of the natural world. Similarly, when we conceive interactive decisions as games, we have a powerful aid to understanding them (and among other things, to the design of experiments).

Game theory is, as Aumann says, an interdisciplinary field. "There are very few subjects that have such a broad, interdisciplinary sweep. Let me just put over here some of the ordinary disciplines that are involved in game theory. We have mathematics, computer science, economics, biology, (national) political science, international relations, social psychology, management, business, accounting, law, philosophy, statistics. Even literary criticism . . . We have sports" (Aumann, 2003, p.4). Of course, none of these disciplines depends on game theory for its existence. Nevertheless, game theory can be set apart as an attempt to understand collective human activity as the outcome of interactive decisions. On the one hand, this is a remarkably ambitious venture. On the other hand, to the extent that it is successful, it must surely be a crucial foundation for the study of public policy.

The objective of this book is to survey and advance our understanding of game theory as a tool of public policy analysis. The hope is to advance that understanding less by the statement and proof of broad theorems (although the value of such proofs is not to be minimized, and will play some role) as by the clarification and critical assessment of the theorems

we have, and by multiplication of examples and survey and extension of specific cases of application. In practice, the influence of game theory on public policy and the related disciplines has been less a consequence of broad theorems than of insightful examples. Accordingly, it is hoped that a critical reconsideration of some of those examples, and discussion of some new or less-known ones, will contribute to the study and ultimately the practice of public policy.

Public policy is a pragmatic field. The pragmatic perspective leads to a view of public policy as an outcome of a *process*, and public policy *analysis* is often carried on in terms of the *public policy process*. We might sketch the public policy process roughly as follows: (1) A *problem* is identified which seems to call for public initiative as a solution. (2) Alternative solutions are proposed. (3) Solutions are evaluated, and to the extent possible, the most promising solution specified. At this point the process may be abandoned, if it is found that the best solution does not require public initiatives. We should note, too, that different individuals with different values or interests may regard different proposals as best, and this is the stuff of which politics is made. From this point we suppose that one particular political perspective has been adopted, and the proposal is considered best from that particular perspective. (4) The proposal is advocated and public support for it sought, in the course of which new interest groups and organizations may come into being. (5) The proposal is brought before the legislative or executive branch of government at an appropriate level. (6) The proposal is enacted with or without modification. (7) The proposal is implemented. (8) Experience with the program as implemented leads to feedback from those affected. (9) The cycle begins again with proposals for improvement, replacement, or abandonment of the policy.

How will game theory fit into this outline? It is widely understood today that there are two great branches of game theory, the noncooperative and the cooperative branch. Of the two, noncooperative game theory has been the more influential, especially in the last quarter of the twentieth century and the beginning of the twenty-first. This is often treated as an institutional dichotomy: cooperative game theory is applicable when agreements are enforceable, while noncooperative game theory is applicable otherwise. This book will argue that, on the contrary, the two branches of game theory reflect different conceptions of rationality. Moreover, neither conception is altogether satisfactory. The book argues that noncooperative game theory is effective as a problem-finding or diagnostic method – noncooperative behavior is common enough so that a social arrangement that is unstable in the face of noncooperative behavior will probably fail. However, solutions based on noncooperative game theory may be unstable

in the face of cooperative or collusive behavior, and cooperative behavior is common enough that such solutions will themselves often fail.

This should be qualified in the following way, however. There is also some research that combines cooperative and noncooperative game theory, and one particular branch is sometimes called social mechanism design.[1] If game theory is interactive decision theory, we may think of the outcome of the interaction as being jointly determined by the decisions and the "rules of the game." In social mechanism design, a particular goal for action is specified, and the objective is to find "rules of the game" that will make the goal the outcome of the game assuming noncooperative or cooperative decisions as the case may be. In the context of social mechanism design, noncooperative game theory may also be useful at the second and third stages, proposal and evaluation of new policies. There have been some successes in this way, but also some failures, with both occurring in particular in the design of public auctions of electromagnetic spectrum for telecommunications.

In game theory a state of the game that meets certain conditions, such as stability in some specific sense, may be a candidate *solution* of the game. The word solution is meant in a mathematical rather than a pragmatic sense, here. An array of decisions that is stable in the sense that no-one can improve his outcome by changing his strategy unilaterally (while others continue their strategy decisions unchanged) is a Nash equilibrium, and the Nash equilibrium is probably the best known and most widely applied concept of noncooperative solution.

In cooperative game theory, binding agreements to choose a common decision or a joint strategy are considered to be possible. A group that makes such an agreement is said to form a "coalition." The word "coalition" is best known in its political usage, as a group of political parties in a parliamentary government who join together to form a majority and govern jointly. In cooperative game theory, the word has been generalized to refer to any group of players in a "game" who join together to choose their strategies jointly. Most games with more than two players, applicable to problems of public policy, will provide cases in which individual actors could benefit by forming coalitions with binding agreements to choose a joint strategy. Indeed, as Maskin (2004) points out,[2] "we live our lives in coalitions." Thus an account of social life (and especially of public policy) that ignores cooperative game theory must be quite incomplete.

In any case, the formation of coalitions will be crucial at stages 4–6 of the public policy process as sketched above. Coalitions are likely to be important at other stages as well. Noncooperative game theory can fail because it assumes that people act noncooperatively when in fact they can and do form coalitions, such as bidding cartels in auctions. Therefore

cooperative game theory may be essential at stages 2 and 3 as well. We acknowledged that stage 3, in particular, would be dependent on values and interests that might differ. Even when that is so, there may be scope for the differences to be accommodated and the distinct interests and values to be advanced jointly. That, too, is the stuff that politics is made of, and it is also a subject of cooperative game theory. We cannot avoid the conclusion that cooperative game theory is essential for a complete understanding of public policy.

This presents a number of difficulties. First, there are several concepts of solution in cooperative game theory. Which (if any) will be most helpful for our purposes? Second, much of the literature relies on powerful simplifying assumptions. Such simplifying assumptions permit the statement and proof of broad and powerful mathematical theorems, but at the same time they indicate the limits of the applicability of the theorems. Together, these simplifying assumptions mean that most cooperative game theory is not applicable to very many problems of public policy. To be specific,

(1)   Expressing the game in the simplified coalition function form means that it cannot be applied to any case in which there are *externalities* and consequent *inefficiencies*.
(2)   The common assumption of superadditivity means that if agents are rational, the grand coalition will always form and will efficiently determine the strategies of every agent. This means it is simply not applicable to any case in which decentralization is persistent.
(3)   The world we observe, the world relevant to public policy, seems to be one in which many coalitions form and often act independently and indeed competitively with one another. In cooperative game theory such an array of distinct coalitions is called a "coalition structure" (Aumann and Dreze, 1974). We would like a theory that would give us some insight as to just what coalition structures would be likely to form, and why, and game theory based on coalition functions and superadditivity is not helpful with that.

There are approaches to cooperative game theory (as we will discuss in the next chapter) that allow both for externalities and coalition structures, but these approaches are "mathematically intractable." That is, they probably do not have very general solutions, and if they do, the solutions are very hard to find and only tentative progress has been made in this direction. We might nevertheless find solutions for particular cases, and even develop a tool-kit for seeking such special-case solutions.

The objective of the book, then, will be a critical review of some major topics from both cooperative and noncooperative game theory, including

some less known ideas in noncooperative game theory, and some constructive proposals for new approaches, to assemble a tool-kit for the analysis of public policy, with the pragmatic purpose of identifying problems and exploring potential solutions. At the same time, we may find resources for a clearer understanding of the public policy enterprise itself.

NOTES

1. The 2007 Nobel Memorial Prize honored contributions of this sort, as did the 2012 Nobel.
2. This is a quotation from memory from Maskin's address.