Afterword

ARIEL RUBINSTEIN

During the past ten years Princeton University Press has done a remarkable job of republishing, in a beautiful and eye-catching format, many of the seminal works from the early days of game theory at Princeton. This new printing of *Theory of Games and Economic Behavior*, marking the book's sixtieth anniversary, continues the celebration of game theory. Since the original publication of the book, game theory has moved from the fringe of economics into its mainstream. The distinction between economic theorist and game theorist has virtually disappeared. The 1994 Nobel Prize awarded to John Nash, John Harsanyi, and Reinhard Selten was viewed not just as recognition of three great scholars but also as a victory for game theory as a discipline. Evidence of the immense importance of this book in the development of game theory is the fact that, notwithstanding the intense search for the ancient origins of its ideas, there is consensus that the book was the first major publication in the field. It set the tone for the subsequent half century of research, after which game theory joined the Walrasian economy as one of the major paradigms within economics.

The game theorist reading this book does not need another lecture on the importance of the book and the development of game theory. Very few other books in economics have been as highly praised and influential. Only a handful of topics have received as much attention or been surveyed as intensively in contemporary economics as game theory. The reader of the book who is not a scholar of game theory, and is interested in catching up with the development of the discipline since the book was published, can choose from a number of excellent introductory books. They are written in a variety of styles and levels of mathematical sophistication and are directed at laypersons as well as scholars of economics, law, political science, management theory, mathematics, and biology.

So, what remains to be said? I have chosen to offer some skeptical observations about game theory. Overall, it is skepticism which makes the game of academic discourse much more interesting.

Whoever came up with the name "game theory" was a genius not only in mathematics but also in public relations. Imagine if it had been called the "Theory of Rationality and Decision Making in Interactive Economic Situations." Would this book and the theory as a whole have enjoyed the same degree of popularity? The word "game" has a young and familiar

sound. All of us play games—board games, computer games, political games. But game theory is not a box of magic tricks that can help us play games more successfully. There are very few insights from game theory that would improve one's game of chess or poker. These games are only used in game theory as convenient illustrations.

So is game theory useful in any way? The popular literature is full of nonsensical claims to that effect. But within the community of game theorists there is sharp disagreement over its meaning and potential usefulness. There are those who believe that the goal of game theory is ultimately to provide a good prediction of behavior in strategic situations and even if we are not "there" (yet) we will get "there" once we have enriched the models with additional parameters and come up with better ways of measuring the considerations of real players. I am not sure on what this vision is based. Most situations can be analyzed in a number of ways, which usually yield contradictory "predictions." Furthermore, we need also to deal with the fundamental difficulty of predicting behavior in the social sciences, where prediction itself is part of the game and forecasters are themselves players.

Then there are those who believe in the power of game theory to improve performance in real-life strategic interactions. I have never been persuaded that there is a solid foundation for this belief. The fact that academics have a vested interest in it makes it even less credible. There seems to be some regularity in strategic behavior which becomes apparent in game theoretical experiments. It is gratifying to sometimes find similar distributions of modes of behavior across societies. But are these regularities related to the classical predictions of game theory?

Others (including myself) think that the object of game theory is primarily to study the considerations used in decision making in interactive situations. It identifies patterns of reasoning and investigates their implications on decision making in strategic situations. According to this opinion, game theory does not have normative implications and its empirical significance is very limited. Game theory is viewed as a cousin of logic. Logic does not allow us to screen out true statements from false ones and does not help us distinguish right from wrong. Game theory does not tell us which action is preferable or predict what other people will do. If game theory is nevertheless useful or practical, it is only indirectly so. In any case, the burden of proof is on those who use game theory to make policy recommendations, not on those who doubt the practical value of game theory in the first place.

And, by the way, I sometimes wonder why people are so obsessed in looking for "usefulness" in economics generally and in game theory in particular. Should academic research be judged by its usefulness?

Game theory is responsible for some new terms in our language. For example, the wide use of the term "zero-sum game" is attributed to the influence of game theory, although it is often used by speakers simply to demonstrate their level of sophistication (or lack thereof . . .). game theory popularized the term "Prisoner's Dilemma," which is widely used in the popular press and by politicians. However, it is used to express a rather trivial idea: that there are situations in which selfish behavior can ultimately hurt all participants.

I view economics (and even more generally, all social sciences) as culture. It is a collection of terms, considerations, models, and theories used by people who think about economic interactions. Game theory changed the culture of economics. Most contemporary economists use game theory as an essential tool for transferring their assumptions about a situation into outcomes. Game theory has essentially become a toolbox from which economists select, often mechanically, the tools for transforming assumptions into predictions.

Personally, I am not sure that game theory "improves the world." Overall, economics, and game theory in particular, is not just a description of human behavior. When we teach game theory we may be affecting the way people think and behave in economic and strategic interactions. Is it impossible that the study of game theoretical considerations in economics makes people more manipulative or more selfish?

Game theory's appeal is also a result of its language. Terms such as "strategy" and "solution" were not intended to be arbitrary names for mathematical concepts. Are they used in an appropriate fashion? This is not an easy question to answer since we do not possess objective tools for judging the interpretation of a formal notion in game theory (or more generally in the social sciences). The evaluation of the connection between a formal model and its interpretation relies entirely on common sense. For example, my own view is that the key term "strategy" is used most often in a way which is difficult to reconcile with its natural interpretation as a "course of action." The use of the term "solution" in game theory may create expectations that game theory can provide solutions to real world problems. In fact, a solution in game theory is no more than a systematic principle for analyzing classes of games; game theory encompasses many different solution concepts which yield conflicting predictions. The ambiguity of the language used in game theory is problematic and potentially misleading. Have we traded the ambiguity of words in the natural language for the confusing interpretations of formal concepts?

This book was a landmark in the transition of economics into a mathematical discipline. The advantage of making economics more mathematical is that it introduces order, precision, and a sense of objectivity into what

would otherwise be considered a vague social science. But of course there are also disadvantages. The heavy use of mathematics limits the number of people who are able to comprehend the material. There is sometimes a feeling that there exists a small sect of "high priests" who have mastered the material while the rest are left to wonder whether mathematical sophistication is being used to hide assumptions and pull a rabbit out of a hat. Does game theory require such a high level of mathematics? In the future will revolutionary ideas be stated in mathematical terms or will part of the revolution be the return to everyday language?

As to the state of the theory, it is my impression that the well of game theory is relatively dry. This is in spite of its success and probably because of it. Game theory has become a primary tool in the economist's toolbox. However, the last decade has seen few new ideas in game theory. Thus, the stage is set for a new unconventional work which will shake economics like this one did sixty years ago. Of course, original ideas cannot simply be ordered. Nevertheless, it is the responsibility of the profession to create an environment that will attract unconventional individuals with a broad educational base and the mental approach which can generate innovative ideas. The playing of games is dependent on abilities that game theory does not capture well, such as memory, the ability to process information and the quality of associations. The assimilation of these concepts constitutes one of the main challenges for the future. Will we see a new concept added to those of competitive equilibrium and Nash equilibrium as an additional pillar of economic thought?

Finally, I can not help noticing that the book was written during the Second World War and published in 1944, a year of loss and tragedy. This coincidence and the role later played by certain institutions (which had been involved in security matters) in the development of game theory led some people to the ridiculous conclusion that "game theory is a plot." I often find myself wondering how such intellectual progress could have been made during a period of such turbulent events. Perhaps we feel more of an urgency to understand the world when things are unstable. In any case, we should feel privileged that we can play games not only as children but also as academics—but we need to keep in mind that the challenges facing the world today are far too complex to be captured by any matrix game.