

The *hard* sciences

In at least one respect, the social, economic, political, and behavioral sciences truly are the “hard” sciences. A problem that is unique to these areas of research is that the subjects of the study (human beings) can *read*. Because of this, developing a theory to understand and predict an election outcome or a stock market crash is fundamentally more difficult than the problem of predicting a chemical reaction or an earthquake.

In the case of the chemical reaction or the earthquake, the publication of the theory will not have any effect on the prediction. In the case of the election outcome or the stock market crash, if the prediction is public, and the theory is convincing, individuals may have incentives to take advantage of their knowledge of the theory to alter their behavior. Thus, if individuals believe a prediction that a stock market crash is imminent, they may decide to sell off declining stocks before the crash, implying that the crash will occur earlier than predicted. So the original prediction will be wrong. Any good theory of behavior in the social sciences must work even when the participants know the theory, that is, *the theory must survive its own publication*. This characteristic of a theory is captured mathematically by concepts of game theoretic equilibrium such as the Nash equilibrium [the general existence of which was first established in these pages 49 years ago (1)] for noncooperative games, and the core for cooperative games. The necessity of a theory to be *publication-proof* helps explain why game theoretic models have become central to the study of social science.

The second Special Feature, on the social sciences, is presented in this issue as part of the National Academies of Sciences’ continuing initiative to promote the physical sciences, social and behavioral sciences, and mathematics through its house journal, PNAS. (The first Special Feature, on astronomy, can be found at www.pnas.org.) The six Perspective articles focus on a selection of currently active areas of research that either highlight some of the problems unique to the social sciences or illustrate the use of ideas in the social sciences that may be of particular interest to people outside the social sciences. As for all Special Features, we are continuing to encourage submission of original research that may be presented as part of the free web-based version of the Feature (see www.pnas.org).

The social sciences Special Feature includes several Perspective articles that illustrate the importance of game theory in current social science research. Feddersen and Pesendorfer (2) use the Nash theory of game theoretic equilibrium to derive nonobvious and testable predictions about jury behavior, which challenge the conventional wisdom that the requirement of unanimous verdicts helps protect innocent defendants. Durlauf (3) considers equilibrium behavior in a setting where individuals have preferences that are a function of the similarity of their behavior to others in a reference group (such as a peer group or social network) and a random error term. This yields a model that is amenable to the study of social and group interactions. In this stochastic setting, equilibrium includes the idea of *rational expectations*—on average, beliefs about the behavior of others must be correct. The Wooders paper (4) applies game theoretic reasoning in a cooperative game setting, providing conditions under which local public goods (such as police protection, public schools, or parks) should be provided efficiently. In addition to the Perspective articles, the regular research article by Banks (ref. 5; see issue 14, page 8295) uses game theory to explain when legislatures will adopt restrictive rules (rules that limit the number and type of amendments that can be offered to a piece of legislation), finding a relationship between the number of issues and the type of rule.

While game theoretic and rational choice models have pervaded much theoretical reasoning in the social sciences, experimental work has consistently shown limits to the applicability of

these models. Goeree and Holt (6) discuss these problems and show how the introduction of stochastic error into game theoretic models helps bring theory closer to experimental data. Camerer (7) summarizes some of the primary experimental limitations of rational choice and game theoretic models, and presents alternative models proposed by behavioral economists that account for these limitations.

The Perspective articles have also been selected to highlight potential areas of overlap between problems in the social sciences and other areas of science. Several articles illustrate ways in which ideas from other fields have been useful in the study of social science: Saari (8) applies ideas from mathematical chaos theory to voting and apportionment, providing the latest startling reminder in a long series of results (starting with Arrow’s impossibility theorem) showing how badly behaved social choice can be; Schuessler (9) considers connections between problems in tomography and the problem of ecological inference (the problem of making inferences about individuals from aggregate level data); Durlauf applies ideas from statistical mechanics to the study of social interactions; and Goeree and Holt apply ideas from statistical physics to evolution and learning in games.

While the Perspective articles focus primarily on theoretical or conceptual issues, the regular research articles appearing in this issue are all empirical or experimental. Gerber and Green (10) perform a field experiment to estimate the effects of canvassing on voter turnout. Fong and McCabe (11) present an experimental study of a phenomenon called “illusion of control” (the hypothesis that individuals value gambles more highly if they are involved in the process generating the gamble), finding, contrary to the accepted view in the literature, that involvement lowers rather than raises the valuation of a gamble. The field of *mechanism design* uses principles of game theory to design rules that will make systems with undesirable properties work better. Andreoni and Varian (12) conduct an experimental test of a mechanism for implementing efficient outcomes in a repeated prisoner’s dilemma, finding some support that the mechanism does lead to more efficient behavior.

The social, economic, and political sciences encompass a vast subject matter, and the Special Feature illustrates merely a sample (although a particularly exciting one) of the studies being carried out. Future Special Features will cover the cutting edge of research in all these areas. Through these Features (the next is on rapid climate change, see www.pnas.org), PNAS aims to provide a forum where research can be discussed, published, and made visible to a general scientific audience, fostering interest and interdisciplinary research in all areas of science, some of which have traditionally been very insular.

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