In Memoriam: Roy Radner

Roy Radner, Stern Professor of Business, Emeritus at New York University, passed away on October 6, 2022 at the age of ninety five. Economic theory lost one of the great conductors who had led so many of its orchestras over some fifty years.

Born in Chicago, Radner received his B.S. in Mathematics in 1950, and a Ph.D. in Mathematical Statistics in 1956 from the University of Chicago. His thesis supervisor was Leonard (Jimmie) Savage. He was influenced by Jacob Marschak, with whom he developed the theory of Teams early in his career. Subsequent to his appointments at the University of Chicago and Yale University, he had a distinguished career at the University of California, Berkeley from 1957. In 1979, he joined the Technical staff at Bell Laboratories, and later moved to New York University.

Blessed with originality and remarkable analytical power, Radner covered a vast terrain. He was at his peak as a mathematical economic theorist, and was able to change the direction and tenor of research on the theory of economic growth and planning, on existence and optimality of " general" equilibrium under uncertainty, and on applications of dynamic game theory to throw light on problems of industrial organization and environmental change. Never hesitant to challenge the mainstream, he explored implications of bounded rationality, formulated alternatives to models of maximizing behavior and investigated issues involving survival and extinction of species

The Arrow-Debreu model of uncertainty assuming *complete markets* for present and future contingent transactions is a landmark in microeconomics and finance. Subsequent research related to this model was initiated by Radner's seminal contributions, and over the next twenty years some of the best minds in mathematical economics introduced (1) differences in information available to different participants in the markets, (2) incompleteness of markets, and (3) sequential trading in a dynamic world. Considerations of these complications in turn led to new concepts of equilibrium and a better understanding of market failures. The existence of an equilibrium of plans, prices and price expectations (also known as a *Radner equilibrium*) and the nature of information revealed by equilibrium prices satisfying appropriate consistency properties (a *rational expectations equilibrium*) are now in the toolkit for micro-economists studying uncertainty and finance.

Radner made a number of subtle contributions to the literature on capital accumulation and long term planning, dealing with investment criteria, cost-benefit analysis and sustainability of a target consumption of a renewable resource. One remarkable contribution of Radner stood out. "Turnpike" theory, according to Samuelson, belonged to a "golden age of analytical economics". Samuelson had a conjecture on the structure of a class of optimal programs in closed multi-sector (von Neumann type) models, "but not until Radner (1961) was the conjecture elevated into a theorem". The originality of formulation and the sheer elegance of the proof of this theorem by his value loss method earned him rare acclaim as giants like Nikaido, Morishima, McKenzie and Gale followed

the exploration of turnpike properties of optimal programs in a wider class of models.

Always eager to explore new paradigms, Radner first published in game theory in 1980 (on approximate equilibrium) and, over the course of the next forty years, he and his associates investigated a wide range of theoretical issues and presented applications to dynamic economics (an example being the study of moral hazard, both in principal-agent and partnership settings). By the mid-1990s, however, his focus had shifted primarily to a range of questions on sustainable development like problems of the commons and climate change. He was an early convert to the existential importance of climate change (and in later years he was in despair of society's ability to address the problem at a meaningful level). As an economist he saw self-enforcing climate treaties as equilibria in well-defined dynamic games in which at least one of the variables - the stock of greenhouse gases - was very long-lived. Since there is neither a global government to optimize on this externality, nor a global court to uphold international laws on violation of responsible courses of action, Radner contributed to the debate on what it is that is incentive compatible for the nations of the world. A framework (now widely used) incorporating a commonly used scientific model of the evolution of greenhouse gases was developed. It was tractable enough to characterize long-lived equilibria.

Even within the realm of game theory, Radner was willing to explore the implications of less than full rationality; he studied themes as diverse as viscous demand - when consumers are slow to shift their buying habits, corruption that stifles investment in developing countries, the market selection hypothesis - that only profit maximizing firms "survive" in the long run ... and the list is long and fascinating. Perhaps the topic that stayed very close to Radner's heart through the last ten years of his life was a mathematically precise definition of bounded rationality. He often presented a paper titled "Bounded Rationality: In Search of a Definition" though we are less than sure whether he ever got around to finishing it!

His leadership in research was recognized with many honors: he was twice the recipient of a Guggenheim Fellowship, was a Fellow of the American Association for the Advancement of Science, a Distinguished Fellow of the American Economic Association, a Fellow and a former President of the Econometric Society, a Fellow of the Society for the Advancement of Economic Theory, and a Member of the National Academy of Sciences and the American Academy of Arts and Sciences.

Radner's death is mourned by his family members and close friends, his former students and research associates, and also by so many across the world to whom he has given much to think, enjoy and admire. The indelible imprints of his research will be inspiring generations of theorists to come.

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