Game Theory Captures a Nobel

By PETER PASSELL

The 1994 Nobel Memorial Prize in Economic Science, a $930,000 award to be divided among three pioneers in the field of game theory, celebrates achievements in building the foundations for analyzing interactions among businesses, nations and even biological species.

But just as important, the prize awarded to John F. Nash of Princeton University, John C. Harsanyi of the University of California at Berkeley and Reinhard Selten of the University of Bonn acknowledges a sea change in economics that has occurred in the last two decades.

Economics has been a discipline dominated by the concept of perfect competition — competition among so many participants that no single buyer or seller need worry about the responses of others.

And perfect competition has proved to be a powerful idea, one that both predicted how free-market economies would evolve and that gave policy makers a reliable compass for figuring how best to encourage growth as well as a fair division of the economic pie.

But in a world of hostile takeovers, trade wars, and big government, classical economics is giving way to game theory, an approach that focuses on the give and take among "players." While classical economics works for the international market in wheat with thousands of buyers and sellers, it takes game theory to try to figure out how Safeway will change the price of English muffins if the A.& P. marks down bagels.

Game theory "opens up terrain for systematic thinking that was previously closed," said Paul Krugman of Stanford University, who has applied game theory to international trade.

John von Neumann and Oskar Morgenstern, economists at Princeton, invented the field. Their book published in 1944, "The Theory of Games and Economic Behavior," was the first to delve deeply into the likely consequences of strategic interactions, where all the actors must consider the potential for reaction. Both men are dead, and, therefore, not eligible for a Nobel prize.

The Real World of Game Theory

Game theory will undergo a practical demonstration in December when the Federal Communications Commission begins to auction radio licenses for new wirelesss personal communications services.

The F.C.C.'s goal is to raise the maximum amount of money, at least $10 billion, and will be using game theory to reach that target.

Game theory focuses on how "players" in economic "games" behave when to reach their goals, they have to predict how their opponents will react to their moves. The concepts developed by the Nobel prize winners were used by other game theorists to devise the auction rules. — EDMUND ANDREWS
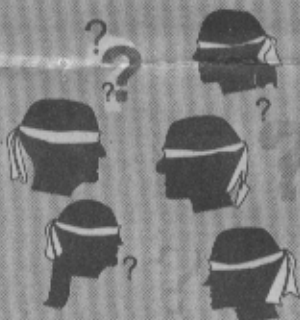
Coping With the Winner's Curse

Like poker, auctions are a 'game of incomplete information.' Bidders have to speculate about both the value of the good being sold and their opponents' strategies. The great fear is the 'winner's curse' of paying too much. But if all bidders are overly cautious as a result, the auctioneer runs the risk that the bids will be below the value of the good being sold.
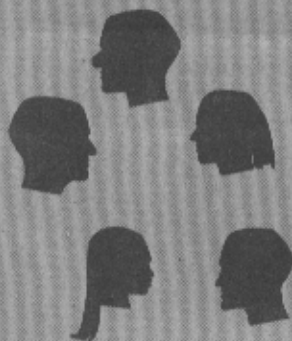
Maximizing Information

Game theory says bidders become more confident with more information, so the F.C.C. has designed the auctions to be as open as possible. Unlike most auctions, where goods are sold one after the other, bidding for all the F.C.C. licenses will occur simultaneously. By seeing how other licenses are being valued, and how their opponents are bidding, bidders can react without fear of paying too much. In such a case, the F.C.C. hopes, the proceeds will meet its goal.

The give and take of economics is seen in the work of three winners.

John Nash, who received a Ph.D. from Princeton in 1950, is widely credited with laying out the formal mathematical principles of "games" — think of them as rivalries — in which everyone knows what everyone else knows and everyone behaves in his own self-interest.

"Nash is the point of departure" for all modern game theory, argues Avinash Dixit, an economist at Princeton and a co-author of "Thinking Strategically," the first guidepost for predicting the consequences of rivalries.

One glaring limitation of Dr. Nash's work is the assumption about perfect knowledge of rivals' motives and resources. Compaq does not know exactly what Apple is prepared to invest to build a better laptop computer. For that matter it does not even know whether other companies are preparing to jump into the market, and under what circumstances. And here the work of John Harsanyi, a Hungarian-born mathematical economist, filled the theoretical breech in the late 1960's.

"Harsanyi gave shape to the fog in real-world games," said Barry Nalebuff of School of Organization and Management at Yale. In the Harsanyi world, nothing need be known for certain as long as it is predictable in terms of chance. Thus when Compaq and Apple are figuring pricing strategies, they need only assign probabilities to the other's uncertain responses and counter-responses.

Another limitation to the Nash approach is that it did not offer insight into what would happen if more than one ending to the game was possible, even if the players acted consistently and in their own best interests. It does not stretch the imagination, for example, to think of the outbreak of World War I as only one of many plausible consequences to the diplomatic and military maneuvering in August 1914.

The German economist Reinhard Selten enriched the Nash model in

Game Theory Brings a Nobel Prize to 3 Scholars

1965 by offering theories for discriminating between game outcomes that are reasonable and unreasonable. The mathematics is quite complex, but some of the underlying ideas are intuitive. For example, an outcome dependent on someone taking an unreasonable threat seriously (as in "buy my rug for $200 or I will kill your first-born child") may be discarded.

All this may seem as abstract and impractical as the theory of perfect competition — and for many years it was dismissed as just that. Nonetheless by the 1970's many economists were turning to game theory for inspiration, if only because they lacked answers to questions that turned on strategic behavior.

Thomas Schelling, an economist now at the University of Maryland who is in a class by himself in applied game theory, decades ago introduced ideas like the strategic value of brinkmanship. Indeed, some think he ranks with Dr. Nash as a founder of the field.

The great bulk of work by economists in game theory has been in an area where its insights had been most sorely missed: the organization of industry.

Robin Wells, an economist at the Stanford Business School, offers an example. Intel, the microprocessor giant, gave up an effective monopoly on the 86-series chip by allowing Advanced Micro Devices to share the technology. Intel, it seems, decided that computer makers would not lock themselves into a new microprocessor technology unless they were protected from future price-gouging by a monopolist. So by licensing another manufacturer, Intel successfully increased the demand for its own product.

Here, game theory explained corporate behavior that made no sense in nonstrategic terms. Game theorists have also been hired to create corporate strategy from scratch, most notably in the case of the Federal Communications Commission's auction of bands on the radio spectrum for use in wireless communications. "Every major bidder hired academic game theorists as consultants," said Andrew Schotter, an economist at New York University.

In the view of Mr. Schotter, however, the main value of game theory in formulating corporate strategy is more modest: getting executives to

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think carefully about response and counter-response in the marketplace. The purer gold, Mr. Schotter believes, will be mined by "institution builders" who must make rules to induce cooperative behavior. Corporations, for example, need to create incentives to minimize the conflict between their own interests and those of their employees.

What works in the private sector might work in the public sector: The F.C.C. did, in fact, hire game theorists to set the rules for the spectrum auction. And the potential is far broader — changing the tax code to induce voluntary compliance, for example, or designing monetary policy to gain the most credibility for the Federal Reserve as an inflation fighter with the least risk of setting off a recession.

Game theory may not be as intellectually elegant as the model of pure competition found in every introductory textbook. Indeed, it is more a matrix for viewing the world than a full-blown theory. But Andrew Schotter believes the Nobel committee's decision to honor three founders was prescient. "Game theory," he says, "is the wave of the future."

3 Economists Share a Prize for Insights Into

John F. Nash

John F. Nash, by most accounts the rock on which the mathematics of game theory was built, was born in Bluefield, W. Va., in 1928. He went to college at the Carnegie Institute of Technology, now Carnegie-Mellon University, in Pittsburgh, switching from chemical engineering to mathematics after his freshman year in 1945.

His ascent into the academic elite was rapid. After receiving both a bachelor's and master's degree from Carnegie in 1948, he completed a Ph.D. in mathematics at Princeton University in just two more years. His Ph.D. thesis, "Non-cooperative Games," which was published in the journal Annals of Mathematics, laid out the framework for much of modern game theory.

Mr. Nash went to the Massachusetts Institute of Technology as an instructor in 1951, later being promoted to associate professor. Struck down by mental illness in the late 1950's, he resigned from M.I.T. and since then has spent most of his years at Princeton. For a time he was a visiting scholar at the Institute for Advanced Study there. For most of the last quarter-century, he has

William E. Sauro/The New York Times

been associated with Princeton as a "visiting research collaborator" without formal obligations to the institution.

He is said to lead a quiet life in the Princeton community, nurtured by friends and associates on the faculty. In deference to his wish for privacy, no details of his family life have been made available.

John C. Harsanyi

Born May 29, 1920, in Budapest, John C. Harsanyi has spent virtually his entire career at the Haas School of Business at the University of California at Berkeley. He was appointed a visiting professor there in 1964 and a professor in 1965.

A leading scholar of game theory, ethics and social choice, Dr. Harsanyi is Flood Research Professor in Business Administration, emeritus, and professor of economics, emeritus, at Berkeley.

"In more than four decades of scholarship, John Harsanyi has probed the idea of rationality in human affairs," wrote Raymond E. Miles, the business school dean when Dr. Harsanyi retired in 1990.

"His work centers on two difficult puzzles. The first is the formal study of what it means for rational persons to take ethical positions or make moral judgments, and how a society of rational but distinct individuals can properly choose among the alternatives it faces," Dr. Miles wrote.

"The second has been game theory," he continued, "that is to say the rigorous formulation of appropriate behavior for rational persons who are in conflict with other rational persons. Professor Harsanyi's contributions to both puzzles have been absolutely fundamental."

Dr. Harsanyi's work on ethics and social choice showed that once a culture adopts utilitarianism — the 19th-century notion that one person's satisfaction can be measured against another's — then it has an array of powerful tools to use in
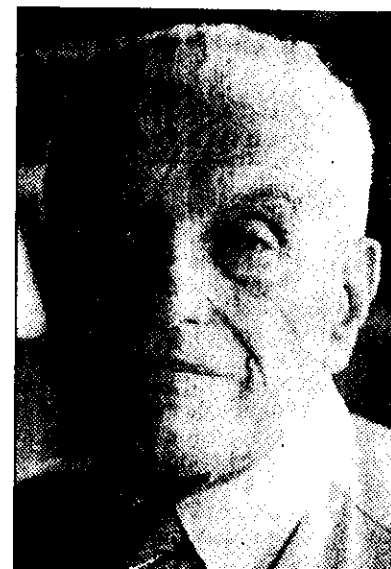
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choosing among alternative policies, laws and institutions.

Game theory has become the central tool for precise modeling of conflicts of company against company, subordinate against superior, interest group against interest group or nation against nation.

Dr. Harsanyi received his doctorate from the University of Budapest in 1947 and emigrated to Australia in 1950, where he received his M.A. degree from Sidney University in 1953. He came to the United States in 1956 as a Rockefeller Fellow at Stanford University, and became a research associate with the Cowles Foundation at Yale University in 1957, and received his Ph.D. from Stanford University in 1959. He and his wife, Anne, have a son.

How Rivalries Function

Reinhard Selten

FRANKFURT, Oct. 11 — Reinhard Selten says that he plays no sports, except perhaps hiking, "if one can say that is a sport."

He lives outside Bonn in an area called the Seven Mountains and says he hikes deep into the hills for three to five hours each Saturday.

"It's very productive scientifically; I often get some very good ideas for my research while hiking," said the 64-year-old professor of economics at the University of Bonn, who was one of three economists awarded the Nobel Memorial Prize in Economic Science. They were honored for their research on game theory, which looks at games like poker and chess and applies the strategies learned to business situations.

Though Professor Selten is not widely known in Germany outside of academia, he became a national hero today, because he is the first German to win the Nobel economics prize since the award began in 1969.

"But while I may be well known today — next week, they probably won't remember my name," he said in a telephone interview today.

The son of a bookseller, he was born in Breslau in 1930 and has been a professor at the Free University of Berlin, the University of Bielefeld and since 1984 at the University of Bonn. He spent two years as a visiting professor at the business school of the University of California at Berkeley in the late 1960's. He is also a mathematician by training.

In addition to speaking German,

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French and English, he says he also speaks Esperanto, an artificial language invented in the 19th century and intended to be a universal language. He describes himself as an idealist and a member of the Esperanto movement.

Professor Selten said he first became interested in game theory in the late 1940's, when he read an article about it in Fortune magazine.

"I was always interested in politics and psychology, learning beyond just the natural sciences, and this enabled me to expand economic thinking to include these areas," he said.

Critical to game theory is contemplating what an opponent — be it a chess or poker player or a competing business executive — might be planning, thus better enabling one to plan one's own strategy.

Professor Selten admitted that using game theory does not always produce correct results, a problem endemic to much of economics.

At a conference in 1976, he and other researchers studied the Middle East, using game theory to try to predict developments. One prediction was that there would be no revolution in Iran.

"So we missed maybe the most important event in the Middle East," he said. But he quickly added that a failed prediction does not mean a futile exercise.

"It's like playing chess," he said. "You have to think hard about what you think your opponent will do, and then you plan your own strategy based on that. You may not always be right, but such thinking probably makes you play better and keeps you from making as many dumb moves."