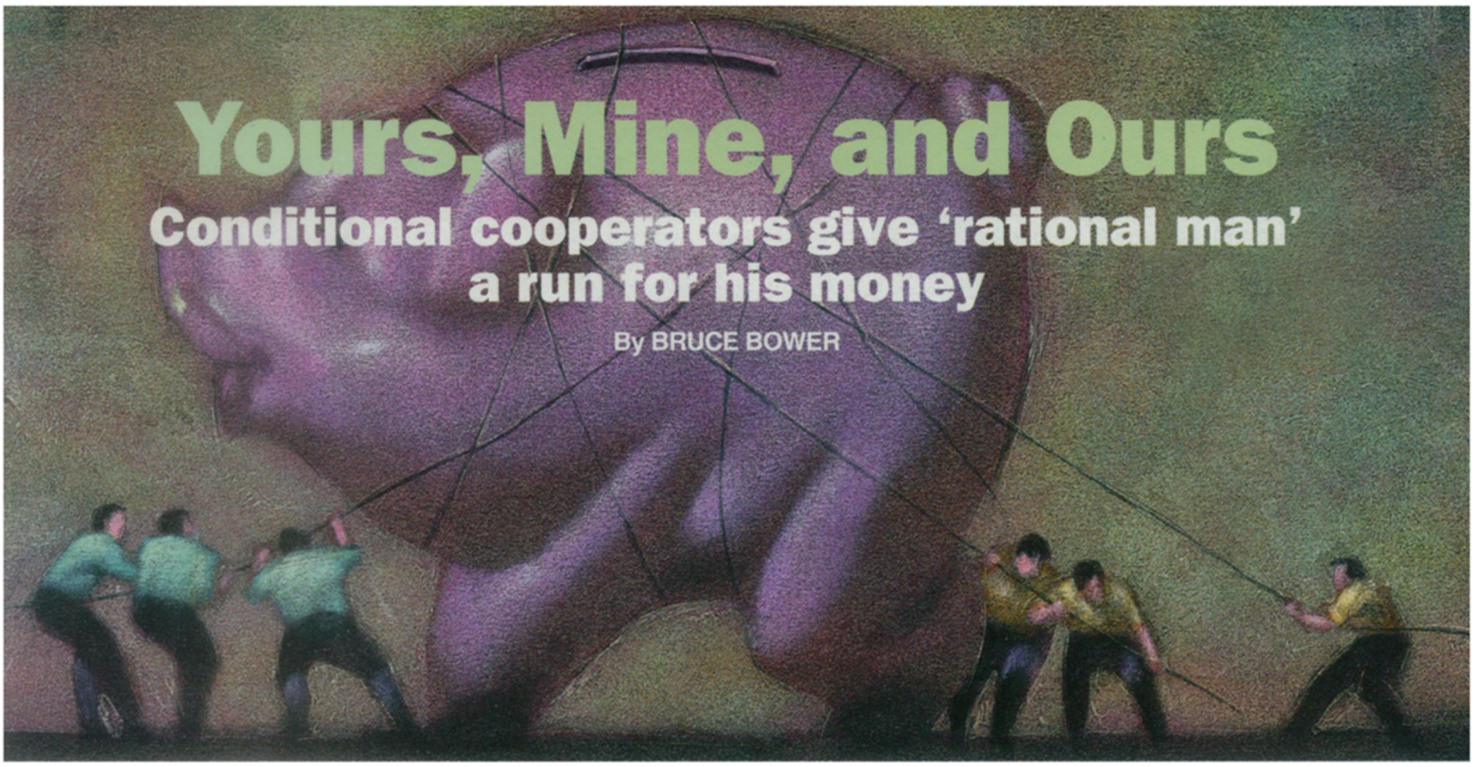


Yours, Mine, and Ours

Conditional cooperators give 'rational man' a run for his money

By BRUCE BOWER

Notions of fairness and morality seem about as welcome in economic theory as a Communist firebrand lecturing frenzied traders at the New York Stock Exchange. Economists have long constructed mathematical models of bargaining tactics favored by a theoretical "rational man," who tries to slice off as big a piece of the monetary pie for himself as possible. Armed with researcher-supplied knowledge about the costs and benefits of various strategic moves, this hypothetical striver shreds the competition with no regrets.

Rational man heeds a blunt motto: "I got mine, and I'll get yours, too, if you give me half a chance."

Yes, such folks exist, though few of them have as much time and knowledge as researchers have heaped on rational man. But researchers face a much deeper challenge than how best to model the calculations of selfish hedonists. A substantial minority of economists and other social scientists now questions the bedrock assumption that self-interest provides the sole, or even the best, explanation for the ways in which people divvy up goods and services.

Selfishness resides within an ambivalent human nature that also promotes allegiance to the moral codes of religious sects, ethnic organizations, workers' unions, and myriad other social groups, these scientists contend. As a result, loyalties that extend far beyond self and family routinely complicate economic decisions.

In new social situations, most individuals try to cooperate and share, according to this view. Those who don't had better beware: Cooperators dispense harsh punishments to people perceived as cheats, liars, or freeloaders. Shared beliefs about what makes for a fair division of some commodity orchestrate decisions about who gets how much of the stuff. Populationwide precepts of fairness apply both to meting out the spoils of hunting in foraging bands and to allocating U.S. tax dollars for welfare benefits.

Moreover, these researchers argue, the repeated interactions of people living in groups may give rise to large-scale effects, such as the formation of upper and lower classes, that reshape the economic landscape.

"An important shifting of the ground in theoretical economics is taking place," says economist H. Peyton Young of the Brookings Institution in Washington, D.C. "There's a greater willingness to consider social forces and interactions as essential for understanding how goods are distributed, but this work still lies outside the mainstream."

One branch of standard economic theory devises experimental situations in which pairs of individuals work out a mutually acceptable agreement to split up a sum of money or some other valued item. Experimenters assume that each volunteer scrutinizes the pros and cons of an agreement so as to reap as many personal benefits as possible.

Yet in the last 2 decades, researchers have noted that cooperation blooms in experiments known as public goods games. In these, members of a small group are kept unaware of each other's choice of either cooperating on a common task—and thus gaining a modest individual payoff—or acting selfishly. A lone selfish player enjoys a larger benefit than cooperators, but if all players act selfishly, each receives the lowest possible payoff.

Participants tend to cooperate in the early stages of these games. In one example, volunteers receive money in their private accounts, and most initially choose to contribute it to a public account, thereby gaining modest financial rewards. In later stages of the game, after isolated players have withheld contributions to obtain bigger personal payoffs, donations to the public account dwindle and financial returns plummet for everyone. Public-spirited contributors apparently retaliate against exploiters in the only way available to them—by withdrawing their contributions, even knowing that they will probably end up with less money than if they gritted their teeth and continued to pay into the public fund.

A related strain of experiments, known as ultimatum games, illustrates the pivotal role that concepts of fairness play in such bargaining decisions, assert Samuel Bowles and Herbert Gintis, both economists at the University of Massachusetts, in Amherst.

Ultimatum games allocate a sum of money to two players. The first player, or proposer, offers part of the total to the other player, or responder. If the responder takes the offer, each player receives the agreed-upon amounts; if the responder rejects the offer, both players get nothing.

Standard economic theory predicts that self-interested proposers will make meager offers, which self-interested responders will accept with a resigned conviction that it's better to leave with a pittance than with nothing. Yet in studies conduct-

ed in Korea, Israel, the United States, and several other countries, proposers usually begin by tendering from 30 percent to 40 percent of the total. Most responders find such proposals acceptable but reject offers below 20 percent.

In high-stakes ultimatum games, such as a study in which pairs of Indonesian volunteers received sums equivalent to 3 months' salary, most proposers offer 50 percent of the total, which responders overwhelmingly accept.

Proposers commonly explain their behavior to researchers by saying that they fear responders will view a low offer as unfair and reject it as a way of punishing the proposer's greediness, even if the responder ends up with nothing. Responders justify their rejections in largely the same way.

Even minimal social contact alters players' approaches to ultimatum games. For instance, generosity and cooperation rise further among participants who first talk to one another for a few minutes or have a chance to learn of common interests.

Cultural differences in expectations about fairness and punishment affect behavior in ultimatum games, holds anthropologist Robert Boyd of the University of California, Los Angeles. Under Boyd's direction, UCLA anthropologist Joe Henrich administered a version of the ultimatum game to unrelated members of a Machiguenga community in the forests of southeastern Peru. The Machiguenga live in relatively isolated family units and subsist on slash-and-burn farming, hunting, gathering, and fishing.

In this population, proposers prove much stingier, and responders more tolerant, than their counterparts in industrialized societies, Henrich reports in an upcoming HUMAN ECOLOGY. Most initial Machiguenga offers range from 15 percent to 25 percent of what represents for them a large sum of money. Nearly all offers meet with acceptance, including those that fall below 15 percent.

Traditionally nomadic people such as the Machiguenga, who exchange goods primarily in families and extended kin groups, experience little obligation to concoct or follow rules of fair behavior with strangers, Boyd theorizes. In contrast, he maintains, fairness sentiments saturate the give-and-take in sedentary societies, where people belong to large, economically interdependent groups.

Boyd hopes to see this theory tested in ultimatum experiments with people from diverse cultures. He, Bowles, Gintis, and Young all participate in an interdisciplinary group of social scientists interested in the formation of economic preferences. It convenes a few times each year under the auspices of the MacArthur Foundation in Chicago and plans to commission six to eight ultimatum experiments in different parts of the world.

In the United States, an underlying tendency to temper public cooperation with retaliation against those seen as cheaters may explain much about attitudes toward specific welfare programs, Bowles and Gintis argue. Programs viewed as rewarding people regardless of whether or how much they contribute to society, such as some welfare measures for the poor, attract fierce resentment. Those that serve recipients generally viewed as meriting paybacks for past efforts, such as Social Security and Medicare, enjoy broader blocks of support.

The reasons for these contrasting expectations about fair exchange remain unclear. Consider that in Western societies, highly trained individuals often willingly accept princely sums of money and are widely viewed as deserving them, whereas successful hunters in many foraging groups feel compelled to distribute meat to all of their comrades in roughly equal portions.

For the past 20 years, anthropologists have emphasized self-interested motives among hunters to explain their meat-sharing proclivities. In 1987, UCLA's Nicholas Blurton-Jones proposed that scroungers with no meat are more willing to fight for a portion of a carcass than

the hunter is willing to defend that portion of his kill. When all group members have equal shares, motivations to fight for the available meat even out and yield social calm, he suggested.

A related theory holds that hunters who dole out large parts of their kills to comrades receive preferential treatment from them in future social disputes or reorganizations, as when a band splits up.

However, it's more reasonable to assume that hunters share meat primarily to help their group or tribe, not themselves, contends evolutionary biologist David Sloan Wilson of the State University of New York in Binghamton. In the February CURRENT ANTHROPOLOGY, Wilson presents a mathematical model of forager meat distribution based on the existence of group norms both for sharing with those seen as doing their best to provide public goods and for punishing freeloaders.

Wilson's conviction that people have evolved genetic traits geared toward the interests of groups, not individuals, incites much debate (SN: 11/18/95, p. 328).

However this controversy plays out, the group affiliations of bargaining partners may greatly influence economic decisions, says Boyd. Further studies should explore the strategies of ultimatum game players who are told that their partners have different ethnic or cultural backgrounds, he says.

Such social identities define people and how they should behave, both among themselves and toward outsiders, hold Brookings economists George A. Akerlof and Rachel E. Kranton. Those rare figures who manage to harness the power of widely shared identities can shake an economy to its roots, Akerlof argued at a Brookings symposium in February.

As a case in point, he notes that throughout the 1920s, residents of India assented to a British salt tax. But in 1930, Mohandas Gandhi triggered an 18-year civil disobedience campaign against British rule by marching to the sea and extracting a pinch of salt from seawater. His highly publicized, symbolic act of defiance against the foreign tax coalesced Indian national identity and sparked years of nonviolent attempts to halt salt manufacturing, distribution, and sales, Akerlof argues.

Preliminary computer simulations suggest that social divisions or classes—fonts of shared identity—can arise when individuals pursue economic exchanges based on simple and essentially meaningless group distinctions, Young says.

He teamed up with Brookings colleagues Robert L. Axtell and Joshua M. Epstein, who had previously created an economic model describing large-scale interactions (SN: 11/23/96, p. 332). The three researchers developed a computer model in which a population of "agents" repeatedly forms pairs to split up a numerical sum. Each agent offers to take either three-quarters, one-half, or one-quarter of the total. If the offers of both players in a pair add up to more than what's available, each gets nothing; otherwise, they get what they ask for. Thus, a demand for three-quarters of the pot combined with a demand for half of it adds up to zilch for both players, whereas demands for half and half or one-half and one-quarter result in corresponding payoffs.

The researchers divided agents into two color-coded groups, blue and yellow. After starting with randomly assigned preferences for making demands, ranging from low to high, each agent recorded in its memory its last 20 exchanges with blue and yellow agents. This information guided the simulated bargainers in forming new demand strategies.

After several hundred interactions, blue and yellow agents began to make highly consistent demands, based on their partners' color. Given one random starting point, same-color agents regularly sought half-and-half arrangements, but in mixed pairs, yellow agents routinely

demanded three-quarters and blue agents one-quarter of the total.

At the end of a trial that began with a different array of random strategies, yellows shared the pot evenly among themselves, while individual blues made either consistently high or low demands of fellow blues, often yielding little or nothing from their exchanges. In mixed pairs, yellows routinely made high demands that were balanced out by low demands from blues.

Overall, this situation appears comparable to "a divided blue underclass oppressed by a unified yellow elite," Young theorized at the recent symposium. He plans to study how the social order of simulated groups might change after, say, a few renegade blue agents hike their demands in interactions with yellow agents.

The idea that collective preferences and moral codes form as individuals adjust their decisions to others' behavior is not new, but until recently it has been relegated to the fringes of economics research, remarks Joseph Harrington, an economist at Johns Hopkins University in Baltimore, Md.

"Now there seem to be a lot more open minds toward alternative economic theories," he says. □

Physics

From a meeting in Los Angeles of the American Physical Society

Chemistry smooths silicon surface

To the naked eye, a silicon wafer looks as shiny as a mirror, but under a microscope, its surface resembles the pitted, cratered landscape of the moon. Treating the wafer with ammonium fluoride can smooth out that roughness, leaving the surface perfectly flat, says Melissa A. Hines of Cornell University.

In the multistep chip-manufacturing process, "half of the stages involve cleaning the wafer off," says Hines. She and her colleagues are trying to understand why some chemicals used for cleaning leave the surface flat, while others damage it.

Ammonium fluoride, an acid, etches away jagged kinks on one face of the crystal, "unzipping" lines of atoms from the edges of the overlapping silicon layers. Within a minute, the layers smooth out, forming large, flat steps only one atom high.

Steps only four atoms high would halve the mobility of electrons in very thin components, says Hines, so atomic-level control can improve silicon's performance. By 2010, scientists will want to pack billions of transistors one-fourth the size of current ones onto a computer chip, says Yves J. Chabal of Bell Labs Lucent Technologies in Murray Hill, N.J.

Hines and her colleagues hope to apply their technique to other faces of silicon crystals, including the one used as the foundation of computer chips. —*C.W.*

Silk foam eases structure studies

Shi-Juang He and her colleagues at the University of Massachusetts at Amherst have found a new way to study the structure of silk. By blowing bubbles of nitrogen gas into a solution of silk proteins, they generate a foam that they examine using electron diffraction. This technique, says He, provides insight into a form of silk whose structure has remained elusive despite nearly 50 years of study.

Silk fiber starts out as a liquid solution of protein in the gland of the silkworm. The worm spins out a thin strand of the solution, which dries into a strong, crystalline fiber. Scientists would like to know how silk solidifies from the poorly understood wet form stored inside the gland to the well-characterized fiber.

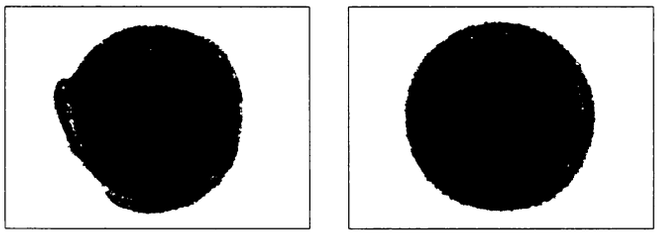
From their studies, the Amherst researchers propose that the protein in the silkworm gland has a repeating sequence of six amino acids. —*C.W.*

Electrons swirl into crystal array

Spinning a cloud of electrons within a superconducting magnet creates groups of whirlpools that "cool" into geometric patterns, says C. Fred Driscoll of the University of California, San Diego in La Jolla. He and his colleagues use this system to study turbulence, the seemingly random churning that occurs in fluids ranging from storm winds to cups of coffee.

However, "these whirlpools are not random at all," Driscoll notes. Through experiments and computer simulations, the San Diego team is trying to determine how and why these patterns of vortices form. —*C.W.*

Driscoll/UCSD



A spinning electron cloud (left) freezes into a pattern of whirlpools (right).