

The climate change game

Hopes are fading that a strong treaty will emerge from next month's negotiations in Copenhagen. Researchers who study cooperation, though, aren't surprised. **Mason Inman** reports.

Progress on forging a strong, global treaty to fight climate change has been painfully slow. But before deciding who is to blame, consider what happened when Manfred Milinski asked teams of university students to save the planet from a climate catastrophe. Milinski, director of the Max Planck Institute of Evolutionary Biology in Plön, Germany, wanted to see if the students could join together to tackle such a problem, which can only be solved through cooperation. And they had to do it on a shoestring budget of just 40 euros each.

The future of the climate wasn't actually in these students' hands — and it turns out this was a good thing. This was just an experiment, in a burgeoning field called behavioural economics. Studies such as this, and computer simulations from the related field of game theory, can be used to explore when people are likely to cooperate or stubbornly refuse to be a team player. And although these games are far removed from the messy world of politics, they provide insight into which strategies are likely to succeed in climate negotiations, where the future really is at stake.

The students in Milinski's experiment¹ were told that unless they contributed to a fund to cut emissions, the world would almost certainly suffer catastrophic climate change. "It was a scenario like in *The Day After Tomorrow*," says Milinski, referring to the disaster movie where sudden climate change causes the collapse of ice sheets, flooding New York City and triggering mass migration.

Each six-student team needed 120 euros in total to do the job, more than each student had in hand. The game included ten rounds, and in each round individual students had a chance to contribute a small amount, a generous amount, or nothing at all. If they succeeded, they got to keep any leftover cash. If they failed, though, the climate almost certainly went to hell, in which case they lost everything — both the collective fund and their personal stash.

"I thought they'd all reach the goal," Milinski says. "They could see very clearly where things were headed, and some people could contribute more to make



© STOCKPHOTO / LISE GAGNE

Climate negotiators heading to the UN talks in December are more prone to cooperation than most people, finds one study.

up the difference," he points out. But they surprised him. Even faced with the possibility of near-certain doom, only half of the 30 teams mustered enough funds. And in a variant of the experiment, where there was only a 50 per cent chance of climate doom, the outcome was even worse: Only one out of 10 teams succeeded at the task. "It's really frustrating," Milinski says.

WORLD LEADERS PRETEND

Milinski's experiment was simplistic. Sparing the real world from a dangerous climate change would never be all-or-nothing. But in other ways, the students' challenge was much easier than that faced by negotiators heading to Copenhagen this December, where they are tasked with reaching an effective, and equitable, treaty.

In Milinski's game, the students facing near-certain doom would have all been best off if they'd contributed half of their money — 20 euros — to the collective fund. That would have been just enough to prevent disaster, and would have maximized their winnings. If they failed to

cooperate, however, then they wound up with nothing — clearly a worse situation for each team member. And yet they still failed to cooperate much of the time.

In traditional economic terms, the students were not being "rational" — that is, maximizing their payoff in the short term. Game theory — a branch of applied mathematics used in the social sciences — specializes in analyzing the strategies that are played out in games such as Milinski's, to see whether they lead to cooperation or selfishness, and what the best outcome would be for each person or for the group. In Milinski's experiment, game theory predicts that rational players would usually go for the optimal, win-win solution.

But even when people aren't perfectly rational, in the economic sense, there's still logic to how they behave. Studies on cooperation show that when you throw a bunch of strangers together, "people mostly care about themselves, but they also care about others, and want to do things that are fair," says behavioural economist Olof Johansson-Stenman of the University of Gothenburg in Sweden.

“We care about poor people, about future generations, about fairness — that’s the good news from behavioral economics.”

Concerns about fairness have been prominent in climate haggling so far, with many developing countries arguing, for example, that it would be unjust to impose mandatory emissions targets on them, given that current warming is mostly the fault of richer nations. Wealthy nations, on the other hand, point to the rising emissions from emerging economies such as China, which is now the world’s chief generator of greenhouse gases. “These fairness arguments can be used for strategic purposes,” Johansson-Stenman says. “The reason they’re useful is because people care about fairness.”

But for these tactics to lead to happy outcomes, negotiators need tools to aid cooperation, and the students in Milinski’s class didn’t have any of these. They didn’t have any way of rewarding team members who helped out, nor could they punish the slackers who refused to pull their weight. And any reputation the students may have earned — either good or bad — didn’t stick with them outside the game. “The less-good news from behavioural economics,” as Johansson-Stenman puts it, is that “unless you have enforcement, people tend to gravitate toward what you’d predict from conventional game theory,” which is that people only cooperate if it’s in their own self-interest. In particular, if there’s no way to keep slackers in line, they can spoil the group’s goodwill. Others who would

normally be altruistic often stop caring as much about justice or equality, and become selfish².

Tackling climate change on the world stage is much tougher than getting Milinski’s six-member groups to work as teams. In Copenhagen, nearly 200 countries will be thrashing out an agreement, with a small team representing each country. Compared with the average person, climate negotiators and other officials involved in the talks are more concerned about equity, which can aid cooperation, according to one study³.

“For a strong, global agreement at Copenhagen, there’s no chance.”

Carlo Carraro

However, “most studies find that groups are less cooperative than individuals,” says Johansson-Stenman. This suggests that negotiating teams representing countries may act more like “rational” players in game theory. And unfortunately, compared with behavioral economics, game theory has some even worse news for those concerned about the chances of a deal being struck in December.

“For a strong, global agreement at Copenhagen, there’s no chance,” says Carlo Carraro, an environmental economist at the University of Venice in Italy, who has been using game theory

models for years to study climate treaties. The problem is that climate change is unlike any challenge humanity has faced before. We’ve mustered collective action to stop acid rain, heal the ozone layer and avert nuclear war, but reducing emissions is different. “Climate change is the hardest collective action problem,” says Scott Barrett, a natural resource economist at Columbia University, New York City, who uses game theory to analyse environmental treaties. “Nuclear war might be worse, but it’s easier to address.”

SWEETENING THE DEAL

But what makes climate change so complex a problem? One contributing factor is that emissions disperse quickly throughout the atmosphere. If one country cuts their greenhouse gas emissions, this benefit gets shared across billions of people. But suppose there’s a country — call it Slackistan — that is emitting loads of carbon dioxide, and doesn’t want to cut back. If Slackistan can somehow convince all the other countries to take action, but do nothing itself, it gets all of the benefits of a cooler climate with none of effort. In game theory lingo, that’s called free riding.

“What you want is a treaty that changes the incentives,” Barrett says. “A good treaty makes countries behave differently.” An effective global deal on climate change has to, therefore, use carrots or sticks to nudge countries away from the default strategy — that of Slackistan — and towards cooperation. Figuring out how to create these incentives is the key, many game theorists say, to breaking the current stalemate and to keeping a strong agreement running for many decades.

Yet, in the negotiations so far, Barrett complains, “the focus has been on targets and timetables”. Countries, environmental groups and aid organizations are arguing over how much richer countries should cut their emissions by 2050; whether it should be 50 per cent, 80 per cent or 90 per cent. And they’re weighing in on what kind of atmosphere we should want in the long run, whether to aim for stabilizing carbon dioxide concentrations at 550 parts per million (ppm), 450 ppm or even 350 ppm, compared with today’s value of 390 ppm. “I think this is absolutely the wrong way to go,” Barrett says. “As climatologists, it makes sense. As humans, it makes sense. But as [the basis for] an international agreement, it doesn’t make any sense.”

So how can the world design a more powerful climate treaty? Unfortunately, game theory predicts that it’s hard to



EPA/OLIVER BERG

UN climate chief Yvo de Boer shows his dismay at the slow progress of climate negotiations in Bangkok, September 2009.

get started, and stalemates are likely. Countries have made many pledges to cut greenhouse gases before, Barrett points out, starting with a 1988 conference in Toronto that called for 20 per cent cuts in CO₂ emissions by 2005, a target several European countries pledged to meet. But 2005 came and passed, and those countries never met the targets⁴. “No one’s willing to go very far unless the others are,” Barrett says, “and that’s just the first step.”

The key to getting the process moving, studies on cooperation suggest, is to work on the carrots and sticks. The Kyoto Protocol — a 1992 agreement aimed at reducing greenhouse gas emissions, effective from 2005 to 2012 — includes, for example, an incentive in the form of the Clean Development Mechanism. Through this arrangement, countries can buy carbon credits, which are meant to pay for emissions reductions in developing countries, and allow the richer countries to delay cutting their own emissions. Also, if countries miss their targets under Kyoto, they’re supposed to be penalized in the next agreement, and have to cut their emissions even more in the next phase, after 2012.

But so far the carrots have not been tasty enough, it seems, nor the sticks very menacing. While the Kyoto Protocol was originally set up to reduce greenhouse gas emissions across most developed countries by 2012 to 5 per cent below 1990 levels, these targets were softened in follow-up agreements. Furthermore, some countries — including Spain, Denmark, and Austria — are on track to overshoot their targets. Canada, for one, has increased its emissions by more than 30 per cent rather than decreasing them by 6 per cent, as they’d signed up to do.

The same could hold true for the Kyoto Protocol’s successor, according to a study Carraro and colleagues published in September⁵. They found that if countries form a global treaty, it could work — but it would be unstable, with many countries being tempted to free ride. And to hold this grand coalition together would take enormous transfers of money — on the order of hundreds of billions of dollars a year — from richer to poorer countries.

Such deal-sweeteners are essential to any climate deal, many economists say. If richer countries help poorer ones with low-emissions technologies, that could help entice developing countries to work on cutting their emissions. “I don’t expect China, India [and other developing countries] to commit to anything without some new institutions for financing energy investments in those countries by the

main developed countries,” says Thomas Schelling of the University of Maryland at College Park, who was corecipient of the 2005 Nobel prize for economics for his work on game theory.

GRAVITY SHIFT

Even with these incentives, however, in Carraro’s study the stable coalitions contained only a handful of countries. That’s because when coalitions add more members, the incentives shift. The more players in a group, the less each one matters for meeting the group’s goal. There’s also less pressure to avoid cheating in larger groups, so free riding looks more tempting. In their model, Carraro says, “we usually get seven or eight smaller coalitions, rather than one big coalition”.

“The games played in negotiations have unclear rules...so the complexity of the real situation is infinitely larger than what you can analyze with game theory.”

John Schellnhuber

In climate negotiations so far, both in Kyoto and in discussions leading up to Copenhagen, the big push has been to create an agreement that nearly every country will sign. “It’s a bit naive,” Carraro says. Game theory suggests this is not only a waste of time, but that it could actually be counter-productive.

Aside from the question of how stable this sort of treaty is, there’s also its effectiveness to worry about. To entice more countries to join an agreement, the requirements inevitably have to be watered down, Carraro argues. “The bigger the ambitions, the smaller the coalition that will join up,” he says. This also explains why the Kyoto Protocol was ratified by so many countries, he adds. It was “exactly because it wasn’t ambitious”.

Now, an increasing number of economists are calling for “bottom-up” approaches, involving agreements between smaller groups of countries. “I’m pretty sure it’s a mistake to try to get more than a dozen major parties to negotiate,” says Schelling. It would be better to stick to “the European Union, United States, Canada, Japan, Australia, Russia and maybe China, India, Brazil, and Indonesia”, he says.

Along these lines, groups such as the G8 and the Major Economies Forum

have been working toward agreement between their members, which include most of the richest countries and biggest emitters. In addition, China is working in coalition with the United States and separately with India to forge agreement on key issues ahead of the official UN talks. “The centre of gravity has shifted,” says economist Robert Stavins of Harvard University in Cambridge, Massachusetts. “There’s a lot more interest in bottom-up approaches.”

ENSURING COMPLIANCE

But for any kind of climate agreement, setting emissions targets won’t nearly be enough to ensure compliance. Most studies suggest that enforcement will be necessary to prevent free riding. The problem, says David Victor, an economist at the University of California in San Diego, who is outside of the game theory ilk, is that “governments don’t have much direct control over emissions”. Instead “you need to focus on things that governments actually control”, such as regulations or prices on carbon, he argues. “The more you drift away from that the harder it is to design the agreement. And since this is one of the hardest agreements to design, if it is to be effective, that’s a big problem.”

Victor’s concern points to a major obstacle to implementing these incentives: despite the fears of a few paranoid conspiracy theorists, there’s still no world government. So while it’s possible to dream up various rules and punishments for the Slackistans of the world, it’s not obvious how to carry these out. Some have suggested using trade sanctions — such as import tariffs on goods from countries that do not meet their emissions targets. Such border taxes are built in to the Waxman-Markey climate bill now under consideration by the US Senate, Barrett points out.

Whatever kinds of enforcements countries settle on, Barrett says, “it’s very important that the enforcement is legitimate, that it’s agreed to by all parties.” But punishments, decided by one country on its own, could backfire. “One thing you see again and again in experiments,” Barrett says, “is that if players think a punishment is unjust, they will rebel.” So after years of foot-dragging by the United States, he says, “Now we’re going to err, possibly, by moving too far ahead of other countries.”

But it’s hard to decide on punishments that seem fair to the group, and also that the enforcers feel is fair to inflict. Behavioural economics studies suggest it

Published online: 29 October 2009

doi: 10.1038/climate.2009.112

References:

1. Milinski, M. et al. *Proc. Natl. Acad. Sci. USA* **105**, 2291-2294 (2008).
2. Brekke, K. A. and Johansson-Stenman, O. "The Behavioral Economics of Climate Change" in *The Economics and Politics of Climate Change* (eds D. Helm and C. Hepburn) 107-122 (Oxford University Press, 2009).
3. Dannenberg, A. et al. *Inequity Aversion and Individual Behavior in Public Good Games: An Experimental Investigation* Discussion Paper 07-034 (Centre for European Economic Research, Mannheim, 2008); <http://ssrn.com/abstract=991555>
3. Barrett, S. *Environment and Statecraft: The Strategy of Environmental Treaty-Making* 366-368 (Oxford University Press, 2003).
4. Bosetti, V. et al. *The Incentives to Participate in, and the Stability of, International Climate Coalitions: A Game-theoretic Analysis Using the Witch Model* (Fondazione Eni Enrico Mattei Working Paper 64, 2009); <http://www.bepress.com/feem/paper325/>
5. Herrmann, B. et al. *Science* **319**, 1362-1367 (2008).
6. Rand, D. G. et al. *Science* **325**, 1272-1275 (2009).

Mason Inman is a freelance writer based in Karachi, Pakistan.

requires a balance between the enforcer's efforts and the sting of the penalties. Expressed as a ratio of efforts to penalties, "it has to be close to one-to-three or one-to-four," Milinski says. "If the ratio is one-to-two, it doesn't work." If enforcement is too much work, no one is likely to step up to be a vigilante. And if the crack of the whip is too sharp, that can lead to bitterness or even revolt⁶. However, Milinski says, "we think punishment would be used only as a last resort." In experiments, people are eager to use whatever kind of incentives they can to discourage free riders. And when they have the choice between punishments or rewards, they usually choose to lure their team mates with carrots, rather than drive them with sticks⁷.

"So far, most of these lessons are being ignored," Victor argues. "This is partly a sign that the architects of the agreements have not heeded the basic lessons of cooperation theory. But it's

mostly a sign that most governments don't want to spend very much money on the warming problem."

Others disagree that economists can explain this so simply. "The games played in negotiations have unclear rules, and no referee to ensure compliance, so the complexity of the real situation is infinitely larger than what you can analyse with game theory," says John Schelling, head of the Potsdam Institute on Climate Impacts Research in Germany, and climate advisor to the German government.

But even if the negotiations in Copenhagen fail to deliver on expectations, this isn't cause for despair, say game theorists like Carraro. Cooperation studies could still offer insight into how to make a treaty easier to agree on, and make it last. So while most of the students in Milinski's study failed at their allotted task, just by playing the game they could still help to avert a climate catastrophe after all.

nature
geoscience

Submit online now!



Chief Editor: Heike Langenberg PhD

Associate Editors: Ninad Bondre, PhD; Alicia Newton, PhD and Anna Armstrong, PhD

Nature Geoscience is an international forum for the timely publication of significant new research in the geosciences. This monthly journal is aimed at a broad interdisciplinary audience of scientists from all areas of the Earth and planetary sciences. *Nature Geoscience* is committed to publishing top-quality original research in the geosciences through a fair and rapid review process.

In addition to publishing primary research, the journal provides an overview of the most important developments in the Earth sciences through the publication of Review Articles, News and Views, Research Highlights, Commentaries and reviews of relevant books and arts events.

Nature Geoscience also provides Advance Online Publication (AOP) of research articles, which benefits authors with an earlier publication date and allows readers access to accepted papers before they appear in print.

Complete submission information is available at:

www.nature.com/ngeo/authors

General editorial inquiries and correspondence should be addressed to the Editor at: geoscience@nature.com

www.nature.com/naturegeoscience

nature publishing group 