Short on Chander, 'Game Theory and Climate Change'

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In his 2018 monograph, *Game Theory and Climate Change*, Parkash Chander describes a mathematical model of international economic relations and shows how to use game theory to predict its consequences for multilateral negotiations over greenhouse gas emissions. The text is intended to introduce the model framework as much as make an argument about climate change, but the basic question driving the study is this: how can the international community develop concrete, effective policies that will address the climate crisis when there is no global authority that can coerce governments to limit carbon emissions? Chander argues in great detail that sovereign states, if they are rational economic actors, will form a coalition committed to keeping carbon emissions at specific levels as long as there is a system in place to transfer wealth from states that must invest the least in drawing down their own emissions to those states that will have to pay the most to restructure their economies. In Chander's model, a free market for carbon credits can provide transfers such that every state winds up better off than they were prior to forming the coalition.

Chander's book provides an excellent window into the ways economists think about things like carbon emissions, especially for readers willing to work through the formal mathematical arguments. It's a perspective that many H-Environment subscribers will find deeply unsatisfying at times--few historians would agree that states are even approximately "rational actors" as defined in economic theory, or that those states which have historically dominated others should receive financial compensation for retooling their extravagantly wealthy fossil economies--but it is also an extremely important one. To his credit, Chander acknowledges that issues of fairness must be addressed in negotiations, and he readily points out when the economic model fails to comprehend the behavior of real states in case studies. This book is significant because it begins with the statement of a utility function that each model actor seeks to maximize and then provides a series of arguments about the consequences of those competing priorities in increasingly complex and realistic contexts, always with an eye toward multilateral climate negotiations. For historians and other scholars in the humanities, the value of Chander's work is that it provides an example of how, in his words, the science of resource allocation can be applied to problems associated with climate change. This is a step-by-step application of one set of tools economists and policymakers regularly use to understand the consequences of their decisions and to predict the behavior of others in negotiation.

The book will primarily be useful for people with prior knowledge of either economic theory or of climate change as a problem for international relations. The explanation of the model takes the form of an advanced textbook in economics, but those familiar with mathematical modeling in other
contexts will find the technical chapters relatively accessible. Readers familiar with international climate agreements but who are unsure if the more detailed sections of the text will be of interest should begin with chapter 9, a stand-alone essay that uses the model framework derived in the previous chapters to analyze the Kyoto Protocol and the Paris Agreement. It will mark the places Chander's position departs from (or confirms) other literature on the subject more clearly than the first chapter, which is more focused on Chander's project. In chapter 10, Chander argues that if a free market in carbon credits is established then globalized free trade agreements do not interfere with agreements to reduce carbon emissions and therefore, if the model accurately predicts real behavior, institutions like the World Trade Organization (WTO) and the Conference of Parties can conduct negotiations on trade and climate change independently. The chapter is largely an aside in response to controversy about the fact that negotiations over the Paris Agreement concluded before parties could consider the outcome of a WTO meeting that began a few days later. Chander points out in the conclusion that his model is only an entry in an ongoing research effort to understand how economic actors can navigate the climate crisis, and he provides references to other work on the subject.

Chapters 2 and 3 lay out the basic model framework and the rationale for the rest of the study. The heart of the model is a utility function that balances a model actor's benefit from creating carbon emissions against the cost to that actor due to global emissions. The setup is notable because all calculations are in terms of carbon emissions rather than some measure of capital or financial resources. These model actors weigh the value of a fossil-fueled economy against the damage emissions will cause as the climate changes. Chander shows that under relatively flexible assumptions about the form of actors' utility functions, all actors' individual utility can be maximized if each actor balances their benefit from creating emissions against the total damage to all actors from global emissions rather than focusing on the damage they would incur alone. This result has two consequences. First, each model actor independently has reason to cooperate with all other actors to set emissions levels that limit damage to the global environment. Second, since the cooperative benefit is only realized when actors consider the global damage of emissions rather than their individual costs, the model community must transfer wealth between actors to provide initial incentives for individuals to change their emissions levels and achieve an ultimate payoff. In the next five chapters, Chander argues that there are strategies model actors can employ to create those incentives and establish a system of voluntary transfers that benefits everyone.

In chapters 4 through 8 Chander shows that by applying an argument in game theory (which he and previous coauthors have dubbed the "gamma core"), there exist voluntary exchange agreements that reach the simultaneous maximum of all actors' utility functions without reducing any individual's initial utility. There are three important features of Chander's approach here. First, unlike many arguments in game theory, it does not assume that all actors are identical. Given some assumptions about their form, utility functions can be different for each model actor, a feature that is obviously critical to simulate real-world negotiations between actors with vastly different experiences of climate change, for instance between small island states and the group of twenty. Second, negotiating coalitions in Chander's model assume that players outside the coalition will act to maximize their individual utility. This is contrary to many game-theoretic frameworks, which assume actors cooperating in a coalition either maximize the coalition's payoff no matter what strategy is taken by other players or that the coalition will act to maximize their minimum possible payoff. Chander's position amounts to assuming that a coalition of concerned actors initiates negotiations to
limit damage from climate change and that parties unwilling to join the coalition are primarily concerned about their local situation rather than the behavior of the coalition. Third and perhaps most important, Chander shows his arguments are valid for conditions that evolve over time. Subject to some restrictions, the modeler can maximize all actors' utility for all time if the utility functions are formulated such that the atmospheric carbon concentration or even the utility functions themselves are time-dependent. This is a requirement for any theory that can lead to useful long-term responses to the climate crisis, and one that is frequently not met in discussions about economic negotiations. The middle chapters of the book provide great insight into a problem that is often intimidating for those of us unfamiliar with economic theory, namely that even if parties could agree about what should be done in response to climate change, how could they craft a proposal that people initially resistant to taking action might adopt?

A central problem that arises repeatedly throughout the book is that there is no economic basis on which a market in carbon emissions can be first established. As Chander notes early on, even if everyone agreed to an overall framework in which states traded rights associated with emissions, the international community would still have to choose between two kinds of rights: either states have a right to be free from damage due to climate change or states have a right to exploit the environment. If states have the right to a safe environment, emitters have to pay to produce emissions. If states have a right to exploit the environment, those most affected by a changing climate will have to pay emitters to change their behavior. In both cases states trade permits to create pollution; the only question is who should hold more permits when the market first opens. In terms that highlight how controversial this problem will be, parties have to mutually agree about how wealth should be redistributed when a market in carbon emissions is created. This is ultimately a moral problem that states would have to solve prior to the negotiations Chander handles as problems in game theory (pp. 58-63). As far as the mathematical model is concerned, it does not matter which right is chosen or how it is initially distributed--Chander's setup results in a single, optimum set of emissions values for each set of utility functions actors might choose (subject to some constraints), and actors in the model can always negotiate contracts such that each actor has the right to produce their optimum amount of emissions. Chander's project is to show that in his model, those contracts leave everyone better off, or at least no worse than they were when the market opened regardless of initial distribution of emissions rights. Chander proves that there exist utility functions which generate that model world.

It is debatable whether utility functions that generate mutually beneficial agreements in the model could inform real choices that avert planetary catastrophe. As Chander shows in chapter 8, model actors profit from agreements that limit total atmospheric carbon concentration to some future value, but an emissions level that guarantees economic benefit in the model may not be one that real actors could survive. When a specific, sustainable limit to future carbon emissions is added as a constraint to the model, the set of utility functions that solve the model is dramatically reduced. The utility functions are supposed to represent the amount of wealth actors are willing to live with, so there may not be a set of utility functions that both solve the model and correspond to living standards real actors will accept. This is not necessarily a criticism of Chander's work. Mathematical modeling is always a balancing act between reasonable constraints and a solvable system of equations. Ultimately there is no reason to expect human problems are mathematically manageable, and in many cases mathematical models should be considered heuristic guides we can use to imagine possible worlds.
At times Chander repeats a commonplace among economists: that utility functions represent people's preferences. But Chander's innovative approach, in which actors' utility functions account for the damage they will suffer from environmental damage due to global emissions, means that utility functions in this model cannot be purely a matter of preference. Small island nations cannot represent the damage they will suffer from rising seas by choosing the amount they would be willing to pay to hold back the tide. The international community will either limit global warming or these islanders will cease to be national actors in a sense today's socioeconomic system can comprehend, and in fact we have probably already passed a point of no return for some island communities. States whose territory is at least existentially secure face a problem that differs in degree rather than kind. We have long known that harm from climate change may become so extreme that many states will no longer exist, at least not in the sense that they approximately represent groups of economic "rational actors," but we still live in a world where we might limit ourselves to extreme rather than cataclysmic harm. Work like Chander's is important precisely because it creates tools we can use to imagine the distance between our world and one in which powerful actors have committed to a response to climate change. Even if a reader is tempted to protest Chander's premises or the moves he makes, these studies are urgently necessary so that we might all think better about the choices we want to make in a warming world.


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