The Climate Casino: Risk, Uncertainty, and Economics for a Warming World

William Nordhaus
(Yale University Press, 392 pp., $20.00)

Climate Shock: The Economic Consequences of a Hotter Planet

Gernot Wagner & Martin L. Weitzman
(Princeton University Press, 264 pp., $27.95)

by Yihan Cheng

Before It's Too Late to Act

William Nordhaus's *Climate Casino* and Gernot Wagner and Martin L. Weitzman's *Climate Shock* are two outstanding pieces of economic analysis that powerfully call for citizens and world leaders to take action on climate change. Both books address three overriding questions: first, they explain *why* climate change is a pressing issue for the international community; second, they discuss *when* environmental interventions should be pursued; third, they prescribe suggestions for *what* those interventions should be. The two works share a common perspective in their

approach to the first two issues, but they differ in addressing the third. While Nordhaus presents a comprehensive, accessible, and data-driven overview of global warming and the prospect of its reversal, Wagner and Weitzman focus on two particular issues – the uncertainty of climate-change forecasting and the dangers of planetary-scale geoengineering. The two texts also depart from one another when addressing a promising solution to global warming, namely carbon taxes. At 326 pages, Nordhaus's work is twice as long as Wagner and Weitzman's (not counting the notes in either case), but the latter's tidy summation of the relevant issues allows it to present a similar scope of arguments even while interspersing its prose with case studies and anecdotes.

In *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World* (2013), Nordhaus, a professor of economics at Yale, provides a comprehensive overview of climate change. The term "casino" is used to describe humankind's relationship with the environment. Human activities in the developing global economy, he argues, should be thought of as rolling the climate change dice, the results of which could be surprising and perilous. A signature theme of Nordhaus's book is its use of economic models to analyze environmental trajectories and their associated abatement costs. He cites these models as offering feasible and economically efficient carbon-pricing plans. Without resorting to technical jargon, he presents complex scientific studies and models in a way that is accessible to wider audiences. This text is appropriate for any reader interested in a broad perspective on the problems and interventions associated with global warming and environmental policy today.

As in Nordhaus's work, Wagner and Weitzman use *Climate Shock: The Economic Consequences of a Hotter Planet* (2015) to stress the importance of drawing public attention to climate change and bringing the world to action on the issue. The authors present carbon pricing as an essential component of any serious solution to global warming. Instead of categorizing topics in different sections of the book, they begin with an overview of climate change in the first chapter, which addresses its causes, impacts, and potential solutions. They leave readers with an impression that climate change is a global, long-term, irreversible, and uncertain phenomenon. In chapters two and three, the authors establish scientific approaches to relevant topics (e.g., climate sensitivity, carbon pricing, and externalities) and provide an overview of climate change backed with facts and statistics. By using a thin-tailed distribution to model the uncertain range of future climate-change outcomes, the authors show that the worst-case scenarios are more probable than we might think. In chapter four, the authors shed light on the worst-case climate change scenarios that threaten to destroy civilization. In facing such global catastrophes, they contend we should consider not solely cost-benefit analyses that ignore potential climate extremes, but also that we should not aimlessly throw money at solving the problem. Instead, a policy direction is needed to balance "overreaction" with "inexcusable inaction" to narrow the gap between our current efforts and our enormous needs (Wagner & Weitzman 2015, 83). Chapters five and six center on geoengineering, including its advantages, problems, and potential for use in the future applications. The authors, however, do not recommend this approach, which is so unpredictable that it could yield disastrous consequences that would be felt beyond our lifetimes. Although the authors are writing for a general audience, their analyses can

capture as much attention from policymakers as from the rest of us. The text's technical examples combined with a witty writing style helps draw critical attention to these complicated issues.

To begin, both texts establish that climate change is a pressing issue facing the international community. To illustrate this argument, the authors first establish that climate change is real. While some question whether the phenomenon exists, most scientists believe that it is an urgent problem and countries should take actions to reverse it immediately. A review of scientific studies of climate change shows that the greenhouse effect was first discovered in a lab in 1859, but it was not quantified until 1896. That same year, Wally Broecker coined the term "global warming." Eight decades later, in 1979, by introducing the concept of "climate sensitivity", Svante Arrhenius established a relationship between the doubling of the CO_2 concentration in the atmosphere and the doubling of the globe's average surface.

After establishing the reality of global warming, both texts assert that human activity is responsible for this phenomenon. Unlike past climate changes, as Nordhaus notes, modern climate change is largely human-caused. Studies show that the major contributors to global warming are CO_2 and greenhouse gas (GHG) emissions from burning fossil fuels, which come from human activities in industry, agriculture, and technology. These also happen to be the necessary components for developing economies and raising the global standard of living. A final introductory argument establishes the pressing nature of climate change and its perilous consequences on our lives. This threat, which is expressed in dire terms by both books, is meant to alert people, governments, and countries around the world that humans have caused global warming and that the issue demands immediate attention.

On the question of *when* climate change must be addressed, Nordhaus agrees with Wagner and Weitzman's assertion that pricing carbon emissions is not a matter of "if," but of "when." As the latter assert, climate change is bad, but not acting on it is even worse. Nordhaus's models illustrate that the longer we wait to address climate change, the higher the temperature of the globe and thus the higher the cost of mitigation. While both books present a general assumption that catastrophes likely won't play out today or tomorrow, the technological innovations of today must be designed to safeguard the future even though we will not reap the most immediate awards. If our generation believes it is the responsibility of future generations to address climate change, then we will be guilty of free riding on our children and grandchildren. In sum, our individual and social practices directly contribute to global warming, and we all have individual and social responsibilities to curb the emission and pollution of GHGs now.

The two texts highlight geoengineering and mitigation as two possible climate change interventions. Geoengineering refers mainly to two kinds of activities: reducing solar radiation or spewing reflective sulfuric acid vapor or artificial sulfur particles into high altitudes. Both books critique the approach as a futile and unsafe false panacea. Geoengineering may not seem prohibitively expensive at first, but it encompasses hidden costs because it lacks long-term effectiveness. As Wagner and Weitzman argue, reflective particles can cool the planet, but they do not reduce carbon emissions or CO_2

concentrations and they pose substantial risks to human health (Wagner and Weitzman 2015, 124). Finally, geoengineering, by curbing global mean temperature without reducing carbon emissions, threatens to deter people from altering their behavior in environmentally sustainable ways.

Wagner and Weitzman also argue that geoengineering represents an undesirable solution because it would require complex international treaties, which a single nation could block the progress of the world at large. Yet, the authors do not completely reject the approach. Instead, by comparing errors of commission and errors of omission (executing geoengineering approach when they know and when they do not know the harmful risks), they reason the latter is less dangerous than the former, particularly for politicians. When considering the possibility of the approach's implementation, they compare international negotiations with the United States' Congress, arguing that an international agreement on geoengineering would be more vexed than a deadlocked US Senate trying to find a 60:40 majority on a contentious issue. In contrast to Wagner and Weitzman's practical political argument, Nordhaus simply argues that geoengineering is a "salvage therapy" that one should use only after all else fails and safer solutions are no longer available (Nordhaus 2013, 155). As he writes, research into the potential risks and true social costs of geoengineering is necessary before pursuing any such tactic in climate change strategy.

When it comes to mitigation or reducing CO_2 emissions, as Nordhaus points out, population growth, improvements in living standards, and CO_2 concentrations are the three factors driving the increase in total yearly CO_2 emissions. He does not dwell on the first two factors. Instead, he contends that those who believe that only the first two issues can be reengineered by economic policy are rather likely mistaken. He argues that addressing the third approach by slowing CO_2 accumulation would be more effective and can be done at a modest cost if undertaken wisely and appropriately. However, most countries favor energy efficiency regulations to something much more extreme: banning or reducing the carbon-emitting resource of coal. This resistance is largely due to the fierce opposition from coal-producing regions and stakeholders (Nordhaus 2013, 273). Yet, it seems clear, as both texts argue, that reducing CO_2 emissions from burning coal is certainly a central component of any mission to affect climate change

Besides advocating for the decreased use of coal, both texts suggest using Arthur C. Pigou's approach of pricing every ton of carbon dioxide emitted according to the gas's social cost, which is the cost associated with the negative effect of climate change (the cost not expressed by the market price) to reduce CO_2 emissions. The Pigouvian approach can be implemented either through taxes or cap-and-trade systems, in which participants are assigned a maximum level of emissions but can trade permits with other market participants.

Although implementing a tax or a cap-and-trade system would achieve the same goal of raising carbon prices, the texts express varying degrees of support of cap and trade. Wagner and Weitzman argue that a cap-and-trade approach would lead to the entire system becoming discredited if the permit prices go through the roof or collapse. However, the authors ultimately conclude that they, along with most economists, would support cap-and-trade systems as long as the policy was well designed. Nordhaus, on

the other hand, suggests that some of these problems could be avoided if cap-and-trade were implemented alongside a carbon tax. He suggests that such "hybrid" approaches could be implemented by different nations based on their economic and political situations, rather than strictly based on the social costs as in Wagner and Weitzman's proposal.

Wagner and Weitzman's discussion of carbon taxes makes an important contribution through its suggestion that economists look beyond the most efficient solution for pricing emissions. Although the second-best or third-best equilibrium might be less than ideal, the scholars insist that imperfect policy barriers might demand an imperfect solution. This argument aligns with Nordhaus's suggestion that so-called second-best solutions, such as the CAFE (Corporate Average Fuel Economy) standard for fuel economy, can supplement and buttress carbon-price policies. Although regulatory policies like CAFÉ are more expensive and less effective than straightforward cap-and-trade/carbon-tax policies, countries prefer them because such policies are usually hidden from consumers and businesses can manipulate regulations to their advantages. These preferences are essentially why carbon-pricing policies face political, corporate, and even public resistance. However, relying solely on such easy-to-implement policies is not ideal, and, as Nordhaus points out, they are not a perfect solution. Hidden costs posed by policies like CAFE threaten to erode the trust between citizens and their governments. With this in mind, both texts note that it is time for businesses and citizens to become comfortable with new approaches like cap-and-trade or carbon taxing.

The two texts also address the question of how to set the price of emissions. A simple straightforward standard would set price per ton of usage equal to the cost associated with reducing carbon usage. It is more difficult to set a price for one ton of carbon emissions equal to the social cost. The best one can do is estimate. Nordhaus published the Dynamic Integrated Climate-Economy (DICE) model in early 1990s, which is one of the most influential models in projecting climate change. This model calculates the damages associated with temperature increases and derives optimal policy scenarios, which balance the present value of the cost and benefits of reducing climate damage. A more elaborate version, known as the Reginal Integrated Climate-Economy (RICE) model, demonstrates all costs and optimal scenarios within twelve major regions, such as the United States, China, and India. According to the DICE model, the estimated optimal social cost of a ton of CO_2 rose from $2 in 1992 to $20 in 2012. These numbers, however, are still well below both the average estimates of $25 per ton, and the "central" US government's estimate of $40 (Wagner & Weitzman 2015, 58). Nordhaus also presents the percentage of the cost that corresponds to certain proposed global temperature limits. For example, 190 nations agreed to keep the average temperature increase below 2°C (3.6°F) above pre-industrial levels at the 21st session of the Conference of the Parties to the United Nation Framework Convention on Climate Change. Nordhaus writes that achieving this goal would cost around 3 percent of national incomes, compared with the 2.9 percent of total income in the model's optimal scenario (where the minimum change would be at 2.3°C). A range of estimates provides an overview of possible climates that could come to be in the future.

Wagner and Weitzman acknowledge the important contributions of efforts at modeling the future of climate change. At the same time, however, they bring up important questions for readers, students, and policy makers. First, the authors point out that the DICE model relies on exponential extrapolations, meaning that 1°C (1.8°F) is worth 0.5 percent of global GDP, 2°C (3.6°F) costs around 1 percent, and 6°C (11°F) costs nearly 10 percent. Wagner and Weitzman assert that by the time change amounts to 6°C (11°F), the global economic output would be much larger than today's 7 trillion and therefore the expected cost would be higher. However, the problem is we don't know the right economic numbers, so the model becomes guesswork. In reality, the authors argue, many other predictions, such as a linear estimation, could change the model and thereby yield starkly different results. Second, Wagner and Weitzman question the use of damages as a percentage of output in any given year. Third, the type of underlying assumptions about climate damage also matters. The DICE model assumes damages as a simple fraction of GDP, and the estimate of damages goes hand-in-hand with the increase and decrease of total economic output. In this case, GDP and temperature become interchangeable. Both cases incur a similar problem that "If more GDP implies higher damages, increases in GDP would still be better off, because 1°C (1.8°F) of damage can always be offset by 1 percent of GDP".

In spite of these inadequacies, this model is still a useful tool for policy building. However, policymakers should avoid relying solely on cost-benefit analyses because of the uncertainties involved in such models. For example, we do not know the true range of costs of a temperature increase of only 1°C (1.8°F), nor do we know the difference necessary to maintain the global temperature within 2°C (3.6°F) or 1.5°C (2.7°F) above pre-industrial levels. That said, the modeled scenarios allow economists, scientists, policymakers, and students alike to operate according to the same policy perspective and make recommendations based on similar starting assumptions.

As part of this discussion the authors of both texts write that policy makers should also take the "discount rate" into consideration. The discount rate is, essentially, an interest rate that transfers the current purchasing power of assets to the future. It also allows us to compare our proposed investment returns on other investing opportunities that we cannot pursue if we invest in a given particular practice. Nordhaus proposes a 4 percent discount rate, which is a sharp contrast with Wagner and Weitzman's suggestion of 1 percent or 2 percent. Nordhaus's 4 percent discount rate derives from opportunity cost, which is the cost one has to give up to use this money in a certain way. In other words, if the 4 percent discount rate ensures our best use of money, we would gain at least as much in returns as we would if we used the money to invest in something else. Although this argument is reasonable, Wagner and Weitzman believe the discount rate ought to be lower than 4 percent, given that we don't know the correct discount rate. They suggest that small climate damages favor high discounting rates, whereas large damages imply a lower discount rate. Nordhaus points out that his relatively high discount rate should not encourage us to consume all our income and make no investment for our future generation.

As both books' authors imply, the situation becomes complicated when we scramble ethical factors, economic growth, and the discount rate together in policy proposals.

Nordhaus contends that societies have vast alternative investments in things like domestic services, education, healthcare, and investments abroad. Carbon reduction is only one of them. It would certainly not make any sense to pour money into a relatively less valuable investment. After all, future generations can benefit from our other investments, too. Nordhaus, however, does not address the question of whether economic growth can be compatible with climate change. Catastrophic events are rather unlikely to happen tomorrow, but no one knows if or when they will come. This uncertainty – as well as the threat of cataclysm – would render opportunity costs of investing in carbon reduction lower than they might otherwise appear.

The two texts specify how the free-riding problem hinders global policy actions. The principle of Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC), established in 1992, is an international accord that acknowledges the different capabilities and responsibilities of each country to address climate change. Since then, countries like China have gained new responsibilities in addressing the issue. However, developed and developing countries disagree on what "responsibilities" mean for any given nation at any given time (CBDR-RC 1992). Nordhaus argues that generational free-riding is a common problem, meaning there is a tendency for nations to push the costs of solving climate change onto future generations. To solve this challenge, Nordhaus suggests international climate change deals should be legally binding and climate-change treaties should push countries to live up to their obligations. However, "legally binding" has proven incredibly challenging due to issues of national sovereignty and general wariness of international meddling in domestic affairs. Wagner and Weitzman, on the other hand, believe carbon pricing can serve domestic environmental interests even without international accords. More specifically, they argue that reducing local air pollution can lower the number of deaths within a country. Consequently, a country may be motivated to introduce carbon pricing for its own domestic benefits, irrespective of worldwide considerations.

Together, both books share the same paradigm in examining the core problem driving climate change: the steady growth of the global population and sustained economic development represent a near-guarantee that we will experience increased CO2 and GHG emissions and higher global temperatures in the future. Global warming poses a tremendous threat to global ecosystems, human life, and environmental safety, and impacts adaptation costs as a result. Although there is considerable uncertainty involved in each step of any restorative process, policymakers have to make choices. A good first step would be to put a price on carbon emissions – both books strongly argue that a price on carbon would be the best option for the global economy, even though this may be politically difficult. The texts agree hat reducing carbon emissions does not preclude the implementation of other policies aimed at mitigating global warming. Taking the works together, one can achieve what Nordhaus describes when he writes, "By studying the subject at hand carefully, from our own perspective, and merging our observations with different ones, we can arrive at a more complete understanding" (Nordhaus 2013, 14). In sum, these texts comprise an intellectual groundwork necessary for understanding existing policy frameworks and incorporating strategies such as carbon taxes and cap and trade in the international fight against climate change.

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YIHAN CHENG is a first-year Master of Public Policy student at The George Washington University, with a concentration in global environmental policy, program evaluation & policy analysis. She interned as a policy analyst at the International Fund of China's Environment, where she researched environmental topics, developed training programs, and compiled notes for the Pre-COP21 Conference. These experiences advanced her understanding of global climate issues and shaped her desire to improve environmental policy programs and solutions.

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