Rolling the Dice in the Corridors of Power: William Nordhaus's Impacts on Climate Change Policy

Faculty Research Working Paper Series

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July 2020

RWP20-022

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Prepared for

Climate Change Economics

July 10, 2020

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ABSTRACT

The seminal contributions of William Nordhaus to scholarship on the long-run macroeconomics of global climate change are clear. Much more challenging to identify are the impacts of Nordhaus and his research on public policy in this domain. We examine three conceptually distinct pathways for that influence: his personal participation in the policy world; his research's direct contribution to the formulation and evaluation of public policy; and his research's indirect role informing public policy. Many of the themes that emerge in this assessment of the contributions of one of the most important economists to have worked in the domain of climate change analysis apply more broadly to the roles played by other leading economists in this and other policy domains.

Key Words: climate change policy, environmental economics, social cost of carbon, carbon tax, climate club, national income accounts

JEL Classification Codes: Q54, Q58, Q40, Q48

ROLLING THE DICE IN THE CORRIDORS OF POWER: WILLIAM NORDHAUS'S IMPACTS ON CLIMATE CHANGE POLICY

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1. Introduction

The core contributions of William Nordhaus to academic economics were summarized by the citation of his 2018 Nobel Prize for "for integrating climate change into long-run macroeconomic analysis" (Nobel Foundation 2018). But beyond those academic macroeconomic insights, Nordhaus has had significant influence on U.S. and international public policies to address climate change. Identifying those contributions is more challenging, partly because such influences are more subtle. That is our purpose in this essay – to identify how Professor Nordhaus and his research have affected the path of climate change policy in the United States and around the world.

1.1 *The Use of Analysis in Policy Formulation*

Because academic influences on policy can be subtle, they are easily missed. For many years, economists and others have taken note of the influence – or lack thereof – of economic analysis on real world policy making. The upshot of much of that work was summarized by Thomas Schelling when he surveyed potential influences across a range of policy areas – including abortion, crime, environment, health care, illegal drugs, national defense, and race relations – and observed "how little difference economic analysis appears to make in most important policies" (Schelling 1997). However, economics and economists can be influential without leaving a trail of evidence. Sometimes, economists' greatest influence in government is by stopping bad ideas, as opposed to successfully promoting good ones (Schultze 1996). But, within the environmental policy realm, a case can be made that the influence of economics, even if relatively modest, has at least increased – with fits and starts – over the past four decades (Hahn 2000; Schmalensee and Stavins 2019).

A useful metaphor about the use of analysis in the process of policy formulation, which we learned from our colleague, Dutch Leonard, is of a "light bulb versus a rock."[2] Does the analysis provide illumination about a proposed policy, and thereby persuade policy makers to pursue said policy on its merits? Or does the analysis function as ammunition in a policy battle, used by those

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[2] For an examination of how an economic analysis, even if imperfect, can shine a light on climate change policy, see: Aldy 2004.

who already support a given policy (on its merits or for other reasons)? Evidence from the Council of Economic Advisers suggests that the use of macroeconomic analysis frequently fits the "light bulb" function (Schultze 1996; Stein 1996), whereas microeconomic analysis is more likely to function as a "rock" (Schelling 1997; Schultze 1996).

Over time, Congressional testimony by academic economists has increasingly come to fit within the category of ammunition, whether for members of a Congressional committee who are already supporters or are already opponents of specific legislation (Devins 2005). Likewise, administrations frequently contact academic economists when a new legislative proposal or administrative action is about to be rolled out, in order to develop a list of "objective academics" who can serve as validators when contacted by the press. Similarly, many academic economists have received press inquiries, wherein it becomes clear that the reporter wants a statement of validation for a particular point of view, not an objective assessment.

1.2 *Three Pathways of Impacts on Climate Change Policy*

In reflecting on how economists have had impacts on the formulation of public policies, we identify three distinct pathways. First, there is *direct participation in the policy world*, such as via full-time government service or part-time service on a government committee. In the case of Bill Nordhaus, we review, in part 2 of this article, three engagements that fall into this first pathway: (1) Member, Council of Economic Advisers, 1977-1979; (2) Chairman, National Academy of Sciences (NAS) Panel on Integrated Environmental and Economic Accounting, 1996-1999; and (3) Chairman, NAS Committee on the Effects of Provisions in the Internal Revenue Code on Greenhouse Gas Emissions, 2011-2013.

The second of the three pathways is that of *directly influencing the formulation of public policies*, a pathway we believe to be considerably less frequent than commonly assumed. We find one significant example of this in the case of Nordhaus, and examine it in part 3 of the article: the explicit use of the Dynamic Integrated Climate-Economy (DICE) model by an interagency working group in the Obama administration which developed quantitative estimates of the "social cost of carbon" (Interagency Working Group on Social Cost of Carbon, United States Government 2010, 2013, 2015, 2016).

The third and final pathway is by far the most common, and we characterize this pathway as *indirectly informing public policy*. This category turns out to be in some ways the most challenging to assess, because here the picture is clouded by the first half of the well-known proverb that "success has many fathers, but failure is an orphan." Subject to that caveat, in part 4 of the article, we examine six distinct ways in which William Nordhaus's economic research has indirectly informed climate change policy.

In the fifth and final part of the article, we identify themes that emerge from this investigation – both generally and specific to climate change policy. This leads us to conclude with an appeal for modesty in thinking about the influence of economists on climate change policy.

2. Participation in the Policy World

An economist can share his or her views on policy without filter or interpretation by personally participating in policy debates. "Being in the room where it happened." "Holding the pen." "Clearing on the memo." These phrases represent ways that direct participation in the policy process can enable an economist's voice to be heard and influence an outcome. Our first example of Nordhaus's participation in the policy world – as a Member of the Council of Economic Advisers – is being part of the process, while the second example – chairing National Academy of Sciences panels – is providing advice to the process.

2.1 Council of Economic Advisers

On March 18, 1977, the U.S. Senate confirmed William Nordhaus as a Member of the Council of Economic Advisers (CEA), which is comprised of a Chair and two Members, and advises the President on domestic and international economic policy. In contrast with other agencies and departments of the Federal government, which may have their own interests and agendas, the CEA has "the luxury of trying to discern what is in the best interest of the country and of providing that analysis and advice directly to the President" (Feldstein 1992, p. 1224).

As a Member of the three-person council, Nordhaus's portfolio was necessarily broad, as noted in the 1979 Economic Report of the President: "Mr. Nordhaus has supervised international economic analysis and microeconomic analysis, including analysis of policies in such areas as energy, agriculture, social welfare, and oversight of regulatory reform activities" (United States 1979, p. 173). This service predated meaningful U.S. or international concern about climate change, but years later, Nordhaus's efforts on regulatory reform and oversight were of significance in the climate policy realm.

In 1977, while Nordhaus was a Member of CEA, President Carter created the Regulatory Analysis Review Group (RARG) and charged CEA with its leadership (Litan and Nordhaus 1983). The RARG could review analyses of regulations and make recommendations to regulatory agencies. Agency rules – as opposed to analyses – were not subject to RARG review, however, and recommendations were not binding on regulators. Not surprisingly, CEA advocated for more rigorous analyses of the benefits and costs of regulations (Sabin 2016).

The next year, President Carter issued Executive Order 12044 "Improving Government Regulations," which established the objective that regulations "shall achieve legislative goals effectively and efficiently."[3] The executive order required regulatory agencies to explain the need for their regulations; consider the direct and indirect effects; evaluate potential alternatives; solicit and respond to public comments; communicate rules in plain language; estimate reporting and record-keeping burdens; and develop a plan for retrospective evaluations. However, the executive order did not formally require benefit-cost analysis, and it failed to institutionalize a centralized authority responsible for implementing it. Nevertheless, in advocating for analyses of the benefits and costs of regulations, Carter's executive order and his CEA set the stage for subsequent administrations to require such assessments from their regulatory agencies, beginning with

[3] Refer to section 1, https://www.foreffectivegov.org/sites/default/files/regs/library/eo12044.pdf.

President Reagan's Executive Order 12291 and President Clinton's Executive Order 112866 (Litan and Nordhaus 1983; Smith 1984; Arrow et al. 1996).[4]

In Carter's CEA, Nordhaus expressed concern about the potential inflationary impacts of regulations and advocated for a regulatory budget (Sabin 2016). This has long been a controversial proposal to impose a social cost budget on regulations akin to a spending budget on government appropriations. Of course, limiting the aggregate costs of regulations, without consideration of their societal benefits, undermines the role of benefit-cost analysis in identifying policy options that increase social welfare. A memorandum from CEA Chair Charles Schultze to President Carter in advance of the 1979 State of the Union address followed up on a meeting of the President, Vice President, Schultze, and Nordhaus on establishing rational regulatory priorities (Schultze 1979). The CEA Chair acknowledged disagreement among White House staff regarding the idea of a regulatory budget. In his State of the Union address, Carter avoided the issue altogether.[5]

All in all, Carter's CEA and Nordhaus's service as a Member thereof had profound long-term effects on public policy – in the climate domain and many others – by initiating thinking that led directly to the use of Regulatory Impact Analyses (RIAs) of all major Federal regulatory proposals. By the year 2000, 20 of 28 countries in the Organization for Economic Development and Cooperation had implemented requirements for such RIAs (OECD 2002).

2.2 *National Academy of Sciences*

In 1979, Nordhaus departed CEA after two years of service, the norm for CEA members. But he continued to inform the policy process through another vehicle for academic experts: committees convened by the National Academies. Soon after leaving government, Nordhaus served on an early *ad hoc* committee of the National Academies focused on the economic and social aspects of climate change (National Research Council 1980), more than a decade before the Rio de Janeiro conference that produced the United Nations Framework Convention on Climate Change.

For the next two decades, Nordhaus focused mainly on his academic work, with direct and indirect climate policy implications, as we discuss in sections 3 and 4. But in 1998, Nordhaus returned to direct engagement with the policy world, co-chairing an NAS committee convened to study ways of accounting for natural resources and the environment in the National Income and Product Accounts (Nordhaus and Kokkelenberg 1999). The National Academies published the committee's report as *Nature's Numbers*. The report examined the history of national accounting and augmented accounting, suggesting that it is important to retain conventional, core accounts, but to develop additional, supplemental accounts that capture the output and value of non-market

[4] The emerging role of the social cost of carbon (SCC) in monetizing the benefits of reducing carbon dioxide (CO_2) emissions in recent regulations – addressed in section 3, below – reflects this legacy of promoting the explicit consideration of the benefits and costs of proposed regulatory actions.

[5] Executive Order 12291 issued by President Reagan in 1981 included a reference to a regulatory budget, but the Reagan Administration did not pursue it. In 2017, President Trump issued Executive Order 13771, "Reducing Regulation and Controlling Regulatory Costs," which called for regulatory cost budgets, and effectively slowed the development and promulgation of new regulations, including those that may address climate change.

natural services, even if defining the scope and measurement of those augmented accounts presents challenges.

In their assessment of the valuation literature, the committee noted the opportunities and methods for accounting for climate change benefits in valuing carbon sequestration through forestry activities – an issue relevant to a variety of land use policies targeting climate change, such as multilateral programs that promote reduced deforestation and increased afforestation in developing countries and tree-planting efforts in domestic policy. They also noted how Clean Air Act benefit-cost analyses had failed to monetize the benefits of reducing carbon dioxide emissions, an issue addressed subsequently through the application of the social cost of carbon (which we address in the next section). The report included guidelines for accounting for nonrenewable and renewable natural resources and environmental pollution.

In 2013, the National Academies published the report of another Nordhaus-chaired committee, *Effects of US Tax Policy on Greenhouse Gas Emissions*, convened at the request of the Department of the Treasury (Nordhaus *et al*. 2013). This study identified the tax provisions with the greatest effect on emissions that contribute to global climate change. It focused on energy-related tax expenditures and excise taxes, biofuels provisions, and broad-based tax expenditures. The committee recognized the limitations of existing models and scholarship, and made recommendations for future research to fill these gaps. In addition, the report highlighted the inefficiencies in the existing tax code in terms of its impacts on carbon dioxide emissions, both through fossil fuel provisions that may increase emissions as well as the high costs per ton of emissions reduced through some renewable energy and energy efficiency tax provisions.

In both cases, the Nordhaus-led committees made recommendations to improve public policy to better account for the adverse impacts of pollution. Indeed, each reflected well-understood insights from economics about how appropriately pricing pollution could alter behavior and investment and thereby increase social welfare. For a variety of political reasons, the committees' recommendations to account for the natural environment in Federal statistics, as well to reform the tax code, were not adopted.[6]

3. Direct Influence on Public Policy

In addition to service in government positions at CEA and on NAS committees, Nordhaus carried out some of his most influential work while back at Yale. Economists' voices can carry through to public policy when their research directly informs key elements of its design, evaluation, or implementation. This has been true in one important case with Nordhaus's research, the use of his path-breaking integrated assessment model of climate change by government analysts for the purpose of developing empirical estimates of the marginal damages of a unit of CO_2 emissions, the so-called social cost of carbon (SCC).

[6] Muller et al. (2011) illustrate an application of environmental accounting within a national income accounting framework, consistent with the *Nature's Numbers* recommendations. Their application focuses on local air pollution and carbon dioxide damages, but they acknowledge that no government statistical agency had explicitly linked such damages to specific industries.

3.1 *The DICE Model and the Social Cost of Carbon*

Integrated Assessment Models (IAMs) combine scientific relationships about emission flows, atmospheric pollutant stocks, temperature impacts, with key economic relationships to summarize the effects of climate change on human welfare. The first to incorporate economics in a systematic way was Nordhaus's DICE model, which has played a critical role in both scholarly and policy endeavors by characterizing the implications of a changing climate.

Consideration of the SCC, the estimated economic damage due to the emission of one ton of CO_2 into the atmosphere in a specific year, originated in Nordhaus's scholarship in 1982 (National Academy of Sciences 2017). While this work – and many subsequent papers – came well before meaningful policy debates about mitigating carbon dioxide (CO_2) and other greenhouse gases, these early models provided a foundation for quantitative assessment when those debates turned to real policy options.

The social cost of carbon can be used as an element in the design of climate change policy, such as in setting the tax rate for a carbon tax or informing the development of a cap-and-trade program. Also, government analysts can employ the social cost of carbon in their benefit-cost analyses of regulatory proposals that are expected to reduce CO_2 emissions (Nordhaus 2013). This latter application of the SCC has been the norm in U.S. energy and climate policy for more than a decade.

3.2 *The Social Cost of Carbon Arrives in Government*

In 2008, a Federal court required the Department of Transportation to revise a fuel economy regulation because it was "arbitrary and capricious" by failing to monetize the benefits of reducing CO_2 emissions.[7] This created demand for SCC estimates. It is common for regulatory agencies to include non-monetized benefit categories in their RIAs (Aldy *et al*. 2020), but the existence of numerical estimates (using DICE model calculations) precluded efforts to avoid monetizing CO_2 emission reduction benefits for major energy and climate regulations. Some of the initial efforts by the Department of Transportation to include SCCs relied on syntheses of the literature by Richard Tol (2005, 2008), which were influenced by Nordhaus SCC estimates from several years.

In 2009, the Obama Administration formed an Interagency Working Group on the Social Cost of Carbon (IWGSCC) to review the scientific literature on climate change damages and provide guidance for monetizing such damages in RIAs (IWGSCC 2010). Federal agencies began to use a preliminary set of SCC estimates based on an interim review of the literature, with explicit discussion of Nordhaus's DICE model as a key input to this work, along with two other IAMs – the FUND model (Tol 1997) and the PAGE model (Hope, Anderson, and Wenman 1993).[8]

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[7] Center for Biological Diversity v. National Highway Traffic Safety Administration, U.S. Court of Appeals, Ninth Circuit, 538 F.3d 1172 (9th Cir. 2008).

[8] See, for example, the Department of Energy final rulemaking "Energy Conservation Program: Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines" (74 Federal Register 44914, August 31, 2009), which references both Nordhaus's work and the interim guidance from the interagency working group.

The IWGSCC (2010) issued guidance to agencies on the social cost of carbon, based on modeling runs conducted by government staff with the three IAMs. In this initial report and in subsequent technical updates (2013, 2015, 2016), the working group generated hundreds of thousands of SCC estimates, using a range of discount rates, estimates of future economic growth, population growth estimates, and climate sensitivity assumptions. The primary SCC for Regulatory Impact Analyses reflected the mean SCC across these models and modeling assumptions (with a 3 percent discount rate).

In 2010, the IWGSCC's primary SCC estimate for 2015 was \$28 per ton of CO_2.[9] As the modelers updated their models, the government updated its SCC estimates. In 2013, the working group adjusted the SCC to \$45 per ton CO_2, with a modest revision down to \$43 per ton in 2015 and 2016. Nordhaus's own updated estimates of the SCC increased in similar fashion.[10]

The SCC has been used to monetize damages across three presidential administrations, but has it had a significant impact? Hahn and Ritz (2015) reviewed more than 50 regulations over 2008-2013 with monetized benefits associated with reducing CO_2 emissions, based on the SCC. Although monetized emission reduction benefits comprised a significant fraction of total monetized benefits for some rules, overall there was little evidence that inclusion of such monetized benefits changed the sign of net social benefits, and, in only a few cases did including the SCC affect the choice among regulatory alternatives. On the other hand, Pizer *et al.* (2014) demonstrated that the choice of SCC can influence whether the monetized benefits of reducing CO_2 emissions under the (then-proposed) Clean Power Plan would exceed the estimated costs of regulation. If assessments of future CO_2 regulations are based solely on the targeted pollutant benefits, that is, not including any co-benefits of reducing local air pollution, then the rule would deliver positive net social benefits only if the carbon reduction benefits estimated with the SCC exceed the monetized costs (Aldy *et al.* 2020).[11]

Although the Federal government has turned away from considering a global SCC, various state governments have drawn on the work of the IWGSCC to inform the design and evaluation of various state-level energy and climate change policies (Paul *et al*. 2017). In addition, the SCC has played a meaningful role in the International Monetary Fund's (IMF) recent efforts to highlight and discourage fossil fuel subsidies around the world (Coady *et al*. 2015, 2019). In its 2019 analysis, the IMF employed an SCC estimate of \$40/tCO_2, citing Nordhaus (2017) and the IWGSCC (2016), to monetize climate change externalities from fossil fuel use. Thus, the SCC – used under various Federal regulatory authorities, state planning and regulatory actions, and IMF

[9] All SCC estimates in this section are for a unit of CO_2 emissions in 2015, converted to 2018 dollars.

[10] Nordhaus (2008) reported a SCC estimate of \$14 per ton of CO2 for the year 2015, with Nordhaus (2014) increasing it to \$23, followed by Nordhaus's (2017, 2019a) estimate of about \$35 per ton of CO_2.

[11] In 2017, President Trump disbanded the Interagency Working Group with Executive Order 13868, "Promoting Energy Independence and Economic Growth" (82 Federal Register 16093, March 31, 2017). Since then, relevant regulatory agencies have continued to employ SCC estimates, but based on 3% and 7% discount rates, and focused exclusively on domestic benefits of reducing carbon dioxide emissions, resulting in empirical estimates in the range of \$1 to \$3 per ton of CO_2 emissions (Schmalensee and Stavins 2019).

policy guidance and evaluation – emerged as a focal point in a decentralized, patchwork approach to climate policy.

4. Indirectly Informing Public Policy

The third pathway is indirect and often subtle, but is, in general, the most common way academic research influences public policy. We examine six ways in which Nordhaus's economic research has indirectly informed climate change policy:[12] (1) investigations of the balance between economic growth and climate protection; (2) applications and extensions of the DICE model, both by Nordhaus and others; (3) identification of the dynamically efficient time path for global greenhouse gas (GHG) emissions; (4) promotion of cost-effective GHG emissions mitigation, particularly through carbon taxes; (5) recommendation of alternative approaches to international cooperation on climate change, in particular the use of international clubs of countries; and (6) participation in policy-relevant intellectual debates.

4.1 *Balance of Economic Growth and Climate Protection*

Two scientific realities of global climate change lead to important economic implications. First, greenhouse gases mix in the atmosphere, and so the location of emissions has no effect on impacts, rendering climate change a global commons problem. Hence, any jurisdiction taking action incurs the costs of its actions, but the climate benefits are distributed globally. Therefore, for virtually any jurisdiction, the climate benefits it reaps from its actions will be less than the costs it incurs (despite the fact that the global benefits may be greater – possibly much greater – than the global costs).

Second, greenhouse gases accumulate in the atmosphere (for more than 100 years in the case of carbon dioxide), and the climate impacts are a function of the stock (atmospheric concentration), not the flow (emissions). As a result, the most severe consequences of climate change will be in the long term. However, climate change policies and their attendant costs of mitigation will be up front. This combination of up-front costs and long-delayed benefits presents great political challenges.

Together, the global commons nature of the problem plus its long time horizon make climate change a difficult political challenge, and explain why there are concerns in many countries that ambitious short-term climate policy actions could undermine economic growth. Indeed, Nordhaus was the first to suggest that instead of investing in early abatement strategies, it would be more efficient to invest in conventional capital, and then use the additional resources in the future to invest heavily in climate capital (Nordhaus 1977), presumably both for mitigation and adaptation. The same analytical framework, but with updated estimates of relevant parameters, has gradually led Nordhaus to endorse much more ambitious time paths of emissions reductions (Nordhaus 2019a).

[12] Our focus here is on how specific elements of Nordhaus's research have indirectly informed climate change policy. Some of these were likely linked with Nordhaus's decades of teaching Yale undergraduate and graduate students, as well as his authoring several books for general educated audiences (1994, 2008, 2013).

4.2 *Applications and Extensions of the DICE Model*

The DICE model, first described by Nordhaus in a *Science* article in 1992, appears to have been the first integrated assessment model (IAM) to combine basic climate science, biophysical impacts, and economics so that the benefits and costs of alternative time paths of climate change could be compared.[13] In the subsequent Regional Integrated Climate-Economy (RICE) model, Nordhaus and co-authors incorporated geographically specific information on emissions, damages, production, and consumption to compare alternative approaches to climate change policy, including market-based, cooperative, and noncooperative approaches (Nordhaus and Yang 1996).

Importantly, because Nordhaus made the DICE/RICE models publicly available (in GAMS code), other researchers were able to use and/or extend the models for their own analyses. As described in detail in part 3 of this article, the DICE model – together with the FUND and PAGE models – have been used to estimate the social cost of carbon (Interagency Working Group on Social Cost of Carbon 2010, 2013, 2015, and 2016).

4.3 *The Dynamically Efficient Time Path of Global GHG Emissions*

Economists have long used the Kaldor-Hicks criterion (Hicks 1939; Kaldor 1939) to identify the most efficient policy to achieve some public purpose, by estimating the expected net present value (NPV) of alternative policies, with different time paths of actions and consequences. From early on, Nordhaus applied this thinking to identify preferred time paths of emissions (and emissions abatement), thereby distinguishing between an economically optimal path and one centered on possibly *ad hoc* quantity targets specified in terms of emissions, GHG concentrations, or temperatures (1977).

Nordhaus then used this standard to maximize the discounted net present value of utility, subject to a resource constraint, adding equations to represent activities that generate emissions into the atmosphere. He found that it was only in later time periods that it would be optimal to modify the energy system. In the short term, the optimal carbon price is low, but increases to a very high level by the end of the 21st century. He concluded, at the time, that the efficient program "requires little change in the energy allocation for 20 to 40 years" (1977). More recently, Nordhaus's analyses have led to much more ambitious time paths of recommended emissions reductions (2015, 2019a).

4.4 *Cost-Effective GHG Emissions Mitigation*

For 100 years, since Pigou (1920), economists have endorsed the use of pollution taxes to address environmental problems. Earlier than others, Nordhaus advocated for pricing instruments to address climate change in the form of carbon taxes (Nordhaus 1977). In order to correct for climate externalities of GHG emissions, he emphasized the need for control strategies which were

[13] At about the same time, William Cline (1992) published his work with his independent global macroeconomic model, from which he recommended much more aggressive policy action. The early work of both Nordhaus and Cline demonstrate that "ideas matter" in focusing attention by scholars and the public, and that diffusion from ideas to policy actions can take decades or longer (Hahn and Stavins 1992).

both feasible scientifically and possible to decentralize, leading to the notion of a tax on the carbon content of fossil fuels. The importance of carbon taxes remained central to Nordhaus's work on climate change for over four decades (Nordhaus 2007b, 2013, 2019a).

Countries around the world – including nearly all of the industrialized countries and large emerging economies – have launched or are in the process of launching national policies aimed at reducing their emissions of GHGs. Of the 169 Parties to the Paris climate agreement that have submitted specific pledges (known as Nationally Determined Contributions or NDCs), more than half refer to the use of carbon pricing in their NDCs. To date, some 51 carbon-pricing policies have been implemented or are scheduled for implementation worldwide, including 26 carbon taxes and 25 emissions trading systems (Stavins 2020). Together, these carbon-pricing initiatives will cover about 20% of global GHG emissions (World Bank Group 2019).

4.5 *Alternative Approaches to International Cooperation*

In the nearly three decades since the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 in Rio de Janeiro, Brazil (United Nations 1992), Nordhaus has consistently been critical of the approaches taken to international cooperation under the United Nations, including both the top-down approach of the Kyoto Protocol (United Nations 1997; Nordhaus and Boyer 1999), and the more recent bottom-up or hybrid approach of the Paris Agreement (United Nations 2015; Nordhaus 2020). Following work by Barrett (2003), Victor (2006), and others, Nordhaus used the DICE model to examine an alternative, largely voluntary international regime – a climate club (Nordhaus 2015).

Nordhaus has become the most prominent analyst and spokesman on behalf of the club approach, in which the club's members (countries) agree to harmonize emissions reductions using a carbon price, keep the revenue raised for themselves, and penalize non-participants by imposing a uniform tariff on all imports from non-participants. Carbon tariffs would be incentive compatible, rewarding the punisher, and incentivizing participation. Although potentially promising as a next step if the United Nations negotiations fail to produce meaningful progress, the analysis indicates that a tariff sufficient to stabilize the climate would lead to the collapse of the club (Barrett 2018). This approach has not received serious attention in international climate negotiations, but it remains among the most prominent alternative approaches to the United Nations scheme. Whether the climate club idea, in general, and Nordhaus's analysis and advocacy, in particular, will eventually be influential and affect the direction of international policy is anyone's guess.

4.6 *Policy-Relevant Intellectual Debates*

Two major debates among economists in which William Nordhaus had prominent roles stand out in terms of their policy relevance. One was about the role catastrophic risk plays in assessments of climate change policies. The other concerns the low discount rates used by Nicholas Stern in his analysis of optimal policy.

Beginning ten years ago, Martin Weitzman carried out theoretical analysis of how positive biophysical feedback loops could lead to uncertainty about the future damages of climate change that would be best characterized by a probability distribution of damages with fat tails, such as a Pareto distribution, rather than a conventional Gaussian (normal) distribution (Weitzman 2009,

2011). The result is greater weight being given to catastrophic (but relatively small probability) outcomes, such as in net present value analyses of alternative climate change policies. In the extreme, Weitzman's "Dismal Theorem" indicates that under specific structures of uncertainty and preferences, the expected value of losses would be infinite, and so standard economic (NPV) analysis simply would not apply.

Nordhaus (2011; and Pindyck 2011) pushed back against these findings, in part by indicating that the conditions of uncertainty and risk-aversion under which Dismal Theorem is derived are very limited, as well as by noting the absence of any policy interventions in Weitzman's analysis. Nordhaus suggested that policy interventions, such as geoengineering, that can truncate a fat tail merit serious consideration. In a recent paper, Nordhaus applies his thinking to account for a catastrophic event by incorporating the melting of the Greenland ice sheet in the calculation of the social cost of carbon (Nordhaus 2019b). He finds that the risk of disintegration of the ice sheet adds less than 5 percent to the estimated social cost of carbon, because the damages would occur much later than many other damages already incorporated in the estimated social cost.

The other climate-related intellectual debate in which Nordhaus has been a major participant involves the discount rate employed in the Stern Review (Stern 2007; Nordhaus 2007a), the prominent analysis of climate change and related public policy carried out for the government of the United Kingdom. Nordhaus's critique of that report centers on its use of a near-zero social rate of time preference, which Nordhaus maintains would mean that the savings rate would have been much greater than it has been historically. Capital markets, he argues, reflect how societies have chosen to distribute consumption across time, and on that and other bases, claims that Stern has underestimated the appropriate social discount rate. He notes that if transfers were allowed, using Stern's policy prescriptions would actually make the world worse off, yielding in net present value terms, negative net benefits. He also points out that with such a high value of future consumption, we would need to be willing to trade off a large fraction of today's consumption for only a small fraction of potential consumption in the distant future.

5. Conclusions

The seminal contributions of William Nordhaus to fundamental scholarship on the long-run macroeconomics of global climate change are abundantly clear. More challenging to identify are the impacts of Nordhaus and his research on public policy in this domain. In the short term, at least, more easily digestible symbols – for example, targets of 2°C maximum temperature change by 2100 or net zero emissions in 2050 – sometimes matter more for public policy than even the best, most rigorous scholarly research. This is hardly unique to this case, however. Many of the themes that emerge in our analysis are common to the roles played by other leading economists in this policy domain, and perhaps in some other policy domains as well.

The limited influence of economic analysis on real world policy making has long been noted, although within the realm of environmental policy, such influence has increased over recent decades. Whether as a light bulb or a rock, the work of economists such as Bill Nordhaus can affect policy making via three distinct pathways: personal participation in the policy world; directly influencing the formulation of public policies; and indirectly informing public policy.

In general, personal involvement in the policy world – in Nordhaus's case decades ago at the Council of Economic Advisers and the National Academy of Sciences – typically provides the most transparent evidentiary trail. Although even here, it is clouded by the passage of time. Some of Nordhaus's most important contributions to climate change policy from this period – such as his support at President Carter's CEA of the use of benefit-cost analysis to assess proposed government regulations – came to fruition only years later, beginning in the Reagan administration, with the first formal requirements for Regulatory Impact Analysis.

A second pathway, which many economists seem to think is important and even quite common, is that of directly influencing the formulation of public policies. When and if this occurs, the evidence ought to be abundant and compelling. So it is with the use of Nordhaus's DICE model as one of three IAMs employed by the Obama administration to estimate empirically the Social Cost of Carbon. That the SCC has itself been used repeatedly for benefit calculations in RIAs demonstrates this direct connection of Nordhaus's research and the formulation of public policies. However, it should not be surprising that we find only one example of this second pathway, because this pathway – we believe – is a rare one in the work of any environmental economist.

We find that the third pathway – indirectly informing public policy – is the most important one through which Nordhaus's work has had impacts on public policy. Reflecting on the work of other scholars suggests that this is broadly the case for academic economic research influencing public policy, at least in the environmental realm. But here the evidence can be difficult to discern, partly because "success has many fathers."

Reflecting on these three pathways reminds us of Josef Schumpeter's trichotomy of the process of technological change (Schumpeter 1942). Schumpeter distinguished three steps in the process by which a new, superior technology permeates the marketplace. *Invention* constitutes the first development of a new product or process. In the policy context, think of a new economic theory or method, such as Nordhaus's DICE model. Most inventions never develop into an *innovation* (accomplished only when the new product/process is commercialized, that is, moves from the laboratory to the showroom floor). And most academic research, no matter how path-breaking it may be as pure scholarship, never makes its way into influence in the real world of public policy. Last in Schumpeter's three stages of technological change is diffusion, the process of gradual adoption of a product or process. Here the analogy to the policy world is clearest, where some academic economists may work full or part time within government, directly pressing for the adoption of some specific policy, whether the policy idea is attributed to them or others.

William Nordhaus is perhaps the most important economist to have ever worked on climate change and climate change policy. If we are correct that his influence in the policy world has been as subtle and often as indirect as we have indicated, then perhaps we all should be left with a sense of greatly enhanced modesty regarding our own contributions to public policy. Our assessment in this article of the policy impacts of one of the most important economists to have ever worked in the environmental domain prompts us to issue an appeal to our colleagues in the profession for greater moderation overall when making claims about academic research influencing policy developments, whether specifically for climate change or more broadly in the realm of environmental, energy, and natural resource policy.

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