A SOCIAL COST OF CARBON CONSISTENT WITH A NET-ZERO CLIMATE GOAL

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INTRODUCTION

The Biden administration has pledged to put the US on a path that will lead to net-zero annual emissions of greenhouse gases by 2050 or sooner. This goal is intended to be in line with the Paris Agreement's mandate to limit global temperature increase to well below 2°C and to pursue efforts to hold the rise to 1.5°C. Biden's goal is a landmark shift away from past US climate policy—from former President Trump's regime of climate denial to the smaller, sector-specific pledges offered during the Obama administration (The White House: President Barack Obama, 2016). Meeting this goal will require robust federal investment in climate action and a comprehensive policy toolkit including regulation (including financial), procurement and supply chain reforms, green banks, etc. that meet the scale and urgency of the climate crisis. In addition to driving a much-needed reduction in greenhouse gas emissions, such climate investments could also catalyze a "green boom" that would unleash new economic growth, spark new industries, "crowd in" private investment, and create millions of jobs.

Crucial in developing, evaluating, and ultimately passing climate policy is a sound and strong "shadow price" of carbon—that is, the price the federal government uses internally to carry out cost-benefit analyses and guide climate policy decisions (Burke et al., 2019). In the US, this price is estimated using the social cost of carbon (SCC), the dollar value of the total climate damages incurred from emitting each additional metric ton of carbon dioxide. However, thus far the SCC has been estimated using Integrated Assessment Models (IAMs) that do not consider the global cost of reaching any particular temperature or emissions target and rely on assumptions that, when altered, provide widely varied estimates. The output of these models alone cannot be relied upon to produce reliable estimates of the SCC that are in line with international temperature targets or domestic emissions targets. The interim values produced by the Interagency Working Group (IAWG) on the SCC range from $62 by 2030 to $85 in 2050 (assuming an average discount rate of 3 percent)—values far lower than those needed to limit warming to well below 2°C or reach net zero by 2050.

To ensure the value of the SCC is in line with internationally set targets, Stern and Stiglitz (2017, 2021) have outlined a *target-consistent approach* that aims to produce a price pathway that efficiently moves policy and economic activity toward a given target. Such a price pathway can be estimated by calculating the near-term marginal abatement cost (MAC)—that is, the cost to reduce an additional ton of emissions through actual public and private sector actions that can be taken over the next decade, when such actions are taken on sufficient scale to achieve the agreed upon targets. Not only is this approach designed to deliver on climate goals but it is also simpler to model and estimate and more robust relative to assumptions, overcoming key flaws in the IAM approach. Ultimately, if the IAM approach could be modified to correctly estimate the SCC (i.e., the true damage caused by each additional ton of emissions, incorporating, for instance, risk and distributive effects and policies that were "optimal") then the values produced should align with estimates of the MAC for a level of warming at which the costs of action and the costs of residual impacts are approximately equal.[1] As a first step toward this outcome, there is an implementable modification to the IAM approach that can embed the target-consistent approach. A constraint can be imposed on the intertemporal maximization problem that underpins an IAM's mechanics, restricting greenhouse gas concentrations from rising above the level associated with a particular temperature goal in the model. This alteration does not deal with all the methodological flaws inherent in the IAM approach—they are indeed deep and serious (see Stern and Stiglitz [2021], and below)—but does ensure that the SCC values estimated for use in policymaking do, in fact, move us closer toward the Paris Agreement and domestic emissions targets.

The international community has balanced the risks of increased climate change with the reasonable costs of containing it, and has agreed on keeping temperature change to well below 2°C. Having made that commitment, the task at hand is how to efficiently implement it, which includes a derivation of the SCC that reflects the targets that have been set. This brief will review the history of the SCC in US policymaking and outline the shortcomings in the current approach to pricing carbon. It will then describe the previously outlined alternative approach to determining *a target-consistent* SCC and argue that policymakers and the IAWG should use estimates from this modeling approach to benchmark SCC estimates produced by an IAM approach.

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[1] In imperfect economies, optimization would not necessarily have the SCC exactly equal to the MAC, but there would be a close link.

THE SOCIAL COST OF CARBON IN US CLIMATE POLICY

In the US, the social cost of carbon was first introduced as an input of a cost-benefit analysis in 2008 following a legal case filed by the Center for Biological Diversity (CBD) against the National Highway Traffic Safety Administration. The CBD argued that fuel economy standards did not take into account future costs due to climate change and that policymakers thus implicitly valued climate damages at zero dollars.[2] The US Court of Appeals for the Ninth Circuit ruled in favor of the CBD, and as a result established a legal requirement that the US government account for the costs associated with greenhouse gas emissions in its cost-benefit analyses (Environmental Defense Fund, n.d.). The SCC was the first attempt to integrate climate impacts into federal cost-benefit analysis and marked a crucial step toward embedding the impact of emissions in federal policymaking.

In response to the ruling, the Obama administration established the Interagency Working Group (IAWG) on the Social Cost of Greenhouse Gasses, which calculated the value of the SCC for emissions for every year between 2020 and 2050. The last estimate, published in 2016, estimated the SCC to be $50 in 2030 and $69 in 2050 (in 2007 dollars and assuming a 3 percent discount rate) based on the average output of three models (IAWG, 2016). These SCC values were then used to carry out cost-benefit analyses—including, for instance, a cost-benefit analysis to approve the Clean Power Plan (CPP). Then, in 2017, the Trump administration hugely diminished the SCC to $8 in 2030 (in 2018 dollars) by excluding international impacts caused by US emissions from the estimate. The Trump administration used this new figure when replacing the CPP with Trump's Affordable Clean Energy rule (GAO, 2020).

On his first day in office, President Biden signed an executive order to reinstate the IAWG and asked it to publish interim values of the SCC within 30 days and final values within a year.[3] He also set a domestic policy goal of reaching net-zero annual emissions of greenhouse gasses by 2050. On the same day, President Biden initiated the process for the United States to rejoin the Paris Agreement on climate change, taking on the commitment to limit warming to well below 2°C. In April 2021, the Biden administration committed the US to reduce its emissions by 50—52 percent by 2030 compared with 2005, in line with the 2050 target. This represents a stronger target than the pledge by the Obama administration to cut emissions by 26—28 percent by 2025 compared with 2005, and signals a positive shift in US climate policy. It also applies pressure on policymakers to develop an SCC that will be consistent with meeting this goal.

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[2] Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 508 F.3d 508 (9th Cir. 2007).

[3] "Executive Order 13990 of January 20th, 2021, Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis," *Federal Register* Vol. 18. No.14 (2021): 7037–7043.

Despite strengthened climate ambition reflected in Biden's pledge, on February 26, 2020 the IAWG published interim values of the SCC that reincorporated international climate impacts and roughly reinstated the estimates from the Obama administration: $62 in 2030 and $85 in 2050 in 2021 dollars. In making these calculations, it again assumed a 3 percent discount rate (IAWG, 2021). These prices are too low to be consistent with the aim of reaching net zero by 2050 and exemplify the danger of relying on Integrated Assessment Models to produce estimates of the SCC and of using an excessively high discount rate.

METHODOLOGICAL FLAWS OF THE INTEGRATED ASSESSMENT MODELS USED TO ESTIMATE THE SCC

The SCC produced by the IAWG has thus far been estimated using Integrated Assessment Models (IAMs). IAMs draw together concepts from climate science and economics into a single modeling framework. In the past, the SCC used for climate policy evaluation by US federal agencies has been estimated using a trio of standard IAMs: DICE (Dynamic Integrated Climate-Economy), FUND (Climate Framework for Uncertainty, Negotiation, and Distribution) and PAGE (Policy Analysis of the Greenhouse Effect).

The basic premise underpinning the IAM is that the monetized value of the damages caused by climate change can be compared with the costs associated with actions to mitigate greenhouse gas emissions to determine the "optimal" level of climate policy. IAMs use a damage function to translate the state of the climate, usually represented by temperature, into the aggregate economic impacts of that state of the climate, and to calculate the SCC. The abatement function in an IAM links the cost of actions to mitigate greenhouse gas emissions to economic output and emissions reductions. However, underlying these models is a questionable description of the economy, one which typically ignores market failures and/or assumes that the government can and does correct market failures and that it can and does undertake active redistributive policies, including to offset intra- and intergenerational impacts of climate change. These models also typically ignore or do not adequately treat risk and the endogeneity of preferences and technology—both of which can be affected by policy. And, since IAMs are mainly equilibrium models, they pay little attention to the dynamics and dislocation involved in major change. Even within the flawed framework, when more reasonable damage functions are introduced or even a limited account of distributive impacts and risk is made, the models produce very wide ranges of estimates, making the models of limited value in calculating the appropriate SCC. The standard "meta-analysis" approach—taking an average of the estimates produced by different IAM studies—is clearly inappropriate, especially when many of the earlier estimates took *no* account of risk or distributive effects.

In this section, we call attention to five aspects of the IAMs that contribute to generating a low SCC value (corresponding to the fact that the standard IAMs suggest accepting a temperature increase of 3.5 to 4°C, which is far beyond the level that the international community has determined to be acceptable).

Flaw 1: Inadequate Treatment of Risk and Uncertainty

The standard IAMs do not account for the extreme risks of inaction. These models also cannot deal with the unknown unknowns of climate change and never will be able to, even if the models are improved. There is real uncertainty about the consequences—climatic and economic—of different temperature increases; about how much temperatures may increase as a result of different emissions paths; and about the extent of the effects that increases in greenhouse gas concentrations could potentially generate, including transformations of lives and livelihoods across the world, major migrations and population displacements, and widespread loss of life. Furthermore, the extreme damages that are possible if climate change is not managed are difficult to model and to quantify because they result from physical processes that are not well understood. Examples include feedback loops that accelerate climate change, such as permafrost thaw and forest die-off; extreme heat waves, droughts, and associated wildfires; sea level rise and coastal erosion and its impact on infrastructure; and cascading ecosystem losses (DeFries et al., 2019). There are also likely to be additional risks that scientists have not yet anticipated: We are experiencing climate change that is unprecedented in human history; we know that the underlying physical processes are complex and highly non-linear, so we cannot simply extrapolate from the effects of the limited changes experienced so far. Indeed, the Intergovernmental Panel on Climate Change (IPCC) (2018, 2021) has noted the sharp increase in risk associated with an increase in temperature from 1.5°C to 2°C. If the scientific community is correct about this, we can only surmise the magnitude of the increase in risk going from 2°C to 3°C.[4] What's more, the uncertainty increases over time, as climate change proceeds and climate science is better able to recognize the great dangers of instabilities and tipping points.

[4] For example, the last time the world was at 3°C warmer than pre-industrial temperature, around 3 million years ago, sea levels were 10–20 meters higher.

The combination of unknown likelihoods of extreme events and potentially disastrous outcomes should provide a strong motivation for precautionary action on climate change as insurance against those disasters. However, the standard IAMs do not allow for the nature and scale of the risks of inaction on climate change to be accounted for. Indeed, as Stern and Stiglitz (2022) point out, the IAM framework, with its simple welfare approach based on the aggregation of utilities, cannot accommodate the high levels of uncertainty and extreme risk associated with climate change—this is the critical flaw of the IAM framework.

Still, the international community arrived at the consensus that temperature changes should be limited to 1.5°C to 2°C because they believed higher temperature increases posed unacceptable risks that could be avoided at an acceptable cost. This was done knowing the results of the IAMs. The IAMs focused on intertemporal tradeoffs (although as we note below, they even got that wrong), but the international community rightly focused on risk.[5]

Flaw 2: Growth is Exogenous

The standard IAMs represent the relationship between global temperature increase and economic activity using a damage function, which is an equation that translates the impact of a temperature change due to an increase in the atmospheric concentration of CO_2 into effects on human welfare, expressed as an equivalent change in economic output (often measured as a percentage of global GDP). In most IAMs, this damage function assumes that the growth rate of GDP is exogenous, meaning that it is predetermined and constant, and therefore is not responsive to damages from climate nor policy actions taken to mitigate climate change (Stern, 2013).

Given the likely destructive effects associated with temperature rise beyond 2°C—loss of life, destruction of capital, collapses in biodiversity, mass migration and conflict (Stern, 2013)—this assumption appears untenable. Emerging empirical evidence demonstrates impacts of both short- and longer-run temperature changes on economic growth (Burke et al., 2015; Deryugina & Hsiang, 2017; Burke & Tanutama, 2019; Colacito et al., 2019; Henseler & Schumacher, 2019; Kahn et al., 2019; Kumar & Khanna, 2019; Kalkuhl & Wenz, 2020). Because growth effects, even small ones, generate large climate damages over time, models that leave these effects out—because they don't account for lasting damage to capital stocks, to productivity, and to growth—are deeply misleading. The exogenous growth assumption embodied in the damage functions of the standard IAMs leads to gross underestimation

[5] Intertemporal issues matter, of course, but the IAMs have been grossly deficient in their portrayal of risk.

of the SCC. Weakly managed climate change could indeed lead to the destruction of living standards across many parts of the world—the opposite of growth.

The approach in most IAMs also overlooks the growth opportunities offered by taking action to address climate change. Faster innovation in new, clean technologies could usher in a new era of high productivity growth (with growth measured correctly—focusing on standards of living—not narrowly on the output of material goods). We've already seen enormous reductions in the costs of renewable energy, despite very limited government support (as well as continued support for fossil fuels).

The transition to zero carbon would offer new job opportunities and could also help lower unemployment and inequality over the coming decades as the global economy undergoes a number of other difficult transitions, including those associated with both automation and recovery from the COVID-19 pandemic. And climate action can enhance well-being, broadly defined, both through changing consumption patterns and through avoiding huge risks to lives and livelihoods. In practice, the flawed assumption that the growth rate is fixed misleads policymakers about the benefits of economic support for the transformative policies necessary to unleash these new drivers of growth.[6]

Flaw 3: An Excessively High Discount Rate of 3 to 7 percent

Because the impacts of climate change will be experienced long into the future, the SCC must reflect not only the value of immediate damages caused by an additional ton of CO_2 today but also the value of all its future benefits and costs, in today's dollars. The underlying assumption of the standard IAMs is that future generations will be richer, and further that they matter less than current generations, whether richer or not. $1 today is therefore assumed to be worth more than $1 in the future, and thus in order to evaluate any additional costs in the future relative to additional costs now, IAMs "discount" the future. The Obama-era estimates of the SCC and the interim estimates proposed during the Biden administration (IAWG, 2021) used a discount rate of 3 percent for the central estimates, meaning that future costs are valued at 3 percent less per year than they would be today. In practice, this means that $100 of damages 100 years in the future would not justify spending more than $5.20 today to avoid those damages. The Trump administration adopted a discount rate of 7 percent, implying that $100 in climate damages 100 years in the future would not justify spending more than 10 cents today.

[6] Some variants of IAMs (Grubb et al., 2021) do accept that technology is endogenous, but assume that the pace of innovation has already been optimized. Such an approach flies in the face of the well documented market failures in innovation.

Discounting calculations depend on both the valuation of a future life relative to one now, and economic conditions in the future relative to now. There is no defensible ethical argument for discounting in the valuation of a future life relative to a life now, where it is otherwise similar to one now,[7] other than the possibility of extinction of the human race in the future due to reasons other than climate change (Stern, 2014; Chichilnisky et al., 2020). That probability may itself be affected by climate policies. Undervaluing a life in the future should be considered "discrimination by date of birth" (Stern & Stiglitz, 2021). An alternative reason for discounting future benefits or costs would be to account for the increase in future incomes that could result from advances in technology and capital accumulation.[8] However, median per capita real income in the US has been increasing by far less than 1 percent per year. With many approaches to utility functions, this would imply a discount rate of less than 1 percent—even ignoring the possibility of very low future income resulting from badly managed climate change. If the compounding nature of climate impacts results in falling living standards, then the discount rate could even be negative. This is especially so if we properly account for risk—for the fact that those eventualities where climate change is worst are those in which future incomes will be lowest and the value of a "marginal" dollar the highest.

The real interest rate for capital is often cited as justification for the choice of the discount rate used in the standard IAMs. But this indicator, which measures the marginal rate of transformation between today and tomorrow (available in capital markets), does not reflect social values—how society is willing to trade off income of this generation with that of future generations—and is not equipped to capture decisions that will have *intergenerational* impacts. Further, capital markets are full of imperfections and risk, and the link between an individual's marginal rate of transformation on these markets and the marginal rate of substitution is far from clear.

When considering climate policy, we are addressing a difficult intergenerational ethical issue, of the sort that we normally, as a society, do not address. But even if one accepts the market rate of interest as an indicator of how we *should* value future impacts (a serious mistake, as argued), the discount rates generated in the IAMs are far too high: The real interest rate (accounting for inflation) is very low—in recent years negative, and over the long run around 1 to 1.5 percent—and thus provides no justification for discount rates as high as 3 percent. Some advocates of using higher interest rates point to the higher average return to capital; but some of these returns are monopoly profits—not the returns to capital—and some of the higher returns are a reflection of risk. But climate mitigation

[7] The ethical argument at this point does not focus on the possibility of rising living standards (that is examined below), but on the relative value of lives in the future.

[8] Various forms of capital would be relevant here.

entails a reduction in risk—it is a kind of insurance—and accordingly, the appropriate SCC discount rate should be *lower* than the "safe rate of interest."[9] The use of a higher discount rate is another manifestation of the failure of the IAMs to take adequate account of risk.

The discount rates used in standard IAMs both undervalue damages inflicted on future generations and inhibit actions that could be taken now to prevent future losses.

Flaw 4: Inadequate Treatment of Differential Impacts of Climate Change among Different Segments of the Population

Climate change has very unequal impacts: The poorest people are likely to be hit earliest and hardest; they live in more vulnerable areas, are less-well insured, and have lower ability to cope with climate impacts. This is the case both within and across countries.[10] Moreover, those least responsible for emissions are among those most adversely affected by climate change. In the US, low-income, Black, and Indigenous people bear the brunt of climate change (Holmberg, 2017). As a highly relevant illustration of the regressivity or discriminatory effects of environmental damage, on average, non-Hispanic white people in the US experience a "pollution advantage," experiencing 17 percent less air pollution than they create, whilst Hispanic and Black people experience "56% and 63% excess exposure, respectively, relative to the exposure caused by their consumption" (Tessum et al., 2019). Research also shows that climate change increases pre-existing inequalities in the US because the damages associated with rising temperatures are largest in regions that are already poorer on average (Hsiang et al., 2017).

The standard IAMs deal with globally or regionally averaged economic variables and thus mask many or most of the inequalities of climate impacts. They also fail to recognize that there are limits on the abilities of governments to implement redistributive policies that would counteract the unequal impacts of climate change. Ignoring the disproportionate impacts experienced by the poorest individuals results in a lower SCC and biases against climate action.[11]

Flaw 5: Ignoring Market Failures Other than Climate

Markets are rife with imperfections that are highly relevant to climate change or climate action, but the standard IAM approach ignores these, treating greenhouse gas emissions as the only market externality to be dealt with. But several other market failures interact

[9] We should note that the concept of the "safe rate" in the context of existing markets is not clear.

[10] The gap between nations with the highest and lowest economic output per person has been estimated to be approximately 25 percent larger than it would have been without climate change (Diffenbaugh & Burke, 2019).

[11] Those IAMs that make some account of distributive effects generate a much higher SCC.

with climate change and therefore should be included in any model designed to guide climate policy decisions. These include: an inadequate treatment of risk and uncertainty pertaining to climate impacts (as outlined in the first flaw, above); the public good nature of research and development; imperfections in information around new technologies, the carbon content of products, or the climate impact on assets; the necessary cooperation of multiple supporting networks and systems, including public transport, recycling and re-use facilities, and grid structure and operations to bring renewable energy sources online; and, importantly, the co-benefits of climate policy beyond market rewards, including reducing air pollution, which kills many millions a year around the world. Taking actions (such as better disclosure requirements) that reduce the market failures which have particularly large effects on climate may secondarily improve overall economic efficiency. The result of ignoring these market failures is that the costs of responding to climate change are again overestimated and the SCC is underestimated. And they lead to the overlooking of key aspects of climate policy.

Flaw 6: IAM Estimates of the SCC Are Enormously Sensitive to Modeling Assumptions

Recent work to improve estimates of the SCC has involved updating the assumptions embodied in the standard IAMs outlined above (Dietz & Stern, 2015; Moore et al., 2017; Schumacher, 2018; Anthoff & Emmerling, 2019; Ueckerdt et al., 2019; Glanemann et al., 2020; Hänsel et al., 2020). The results generated by these models have proven to be enormously sensitive to the assumptions they make. For example, modifying the damage function in FUND to account for developments in the scientific literature more than doubles the estimated SCC (Moore et al., 2017), and updating the parameters in DICE to incorporate the latest findings on economic damage functions, the latest climate science, and expert recommendations on social discount rates can bring the optimal temperature trajectory recommended by the model in line with the Paris Agreement (Hänsel et al., 2020). Further, when temperature is allowed to impact growth in DICE, the policy recommendations are altered significantly (Moyer et al., 2014; Dietz & Stern, 2015; Moore & Diaz, 2015).

The result of this sensitivity to various assumptions is a wide range of "potentially defensible" SCC estimates. Meta-analysis from Wang et al. (2019) finds that recent SCC estimates range from under US$0 per metric ton of CO2 to over US$2,000 per metric ton (Kaufman et al., 2020). Importantly, as IAM methodologies are updated to incorporate the latest climate science, additional uncertain elements that were left out of previous models will be introduced, further widening the range of SCC estimates (Kaufman et al., 2020).

Even though improvements to the IAMs have produced more reasonable estimates of the SCC, this sensitivity to updated assumptions and the resulting wide range of estimates indicate the results of IAMs are not robust and cannot be relied upon alone to provide a sound estimate of the SCC.

With national emissions targets and international temperature targets in place, it is essential that the value of the SCC used in policymaking be in line with those targets and incentivize behavior that can result in their being met. An alternative approach proposes starting from the Paris Agreement temperature target or a net-zero emissions target and developing a target-consistent SCC that allows those goals to be met cost effectively.[12]

A TARGET-CONSISTENT SOCIAL COST OF CARBON

Given the extent of the flaws in the IAM methodology, an alternative approach to guide climate policy is needed to ensure that the SCC value used is in line with agreed upon targets. The solution set out in Stern et al. (2017) and Stern & Stiglitz (2021) focuses on determining the most cost-effective way to reach an agreed upon goal, such as a temperature limit for global warming: a target-consistent SCC (see also Kaufman et al., 2020).

Under this approach to determine a target-consistent SCC, it is taken as given that the objective of the Paris Agreement to limit global warming to well below 2°C and the Biden administration's commitment to the US reaching net-zero emissions by 2050 should be met. The costs associated with abating greenhouse gas emissions can then be used to inform the calculation of a time path of carbon prices that reflects the least-cost pathway to meeting these goals. Multiple lines of evidence should be used to guide the calculation of this price trajectory, for example, technological roadmaps that reveal the "switching prices" needed to make low-carbon technologies competitive with their fossil fuel-based counterparts; national modeling exercises that provide estimates of the shadow price of carbon required to deliver decarbonization in a given economy; and global energy-economy models that produce global scenarios of future socioeconomic and technological development that are consistent with different global temperature targets (Stern et al., 2017). Each of these sources of information has strengths and weaknesses, but used in conjunction they can complement one another to build a better understanding. This holistic approach to determining price is superior, both in its logic (given the agreed objective) and in its robustness, to relying solely on the IAMs to inform the SCC.

[12] Such an approach has the further advantage of not being as sensitive to concerns about whether the SCC should include climate damages experienced outside the US.

The target-consistent approach provides a framework for moving toward agreed upon goals in the most cost-effective way, without imposing unacceptable risks on future generations, and tackles some of the key challenges faced by the IAM approach. Whereas estimating the SCC using IAMs requires identifying and quantifying all damages caused by rising temperatures worldwide over long time horizons, estimating the target-consistent price involves dealing with the costs associated with abating greenhouse gas emissions using mostly known technologies, domestically, and over a specified time horizon—and in the case of a net zero by 2050 target, the next three decades. Because the target-consistent approach entails more focused analysis of specified technologies and bounded time horizons, estimates of a target-consistent price are likely to be less sensitive to changes in model assumptions.

The 2017 High-Level Commission on Carbon Prices, the Stern-Stiglitz Commission (Stern et al., 2017), followed the target-consistent approach and calculated the carbon price paths that would provide the necessary incentives to induce the changes in investment, production, and consumption patterns needed to achieve the temperature targets of the Paris Agreement at the time. The Commission concluded that the explicit target-consistent price level should be US$50—US$100/tCO_2 by 2030, and, importantly, should be supported by policy measures beyond carbon pricing. This target-consistent price level was higher than the $50/t$CO_2$ (in 2007 prices, $60 in 2018 prices) SCC estimated by the Obama administration (with the central 3 percent discount rate). But since 2017, ambition has been strengthening, with targets now set for 1.5°C (rather than "well below 2 degrees Celsius") and net-zero emissions by 2050, while emissions have continued to rise. Therefore, the upper end of the US$50—100/t$CO_2$ range for the target-consistent price level in 2030 estimated by the 2017 Commission should now be interpreted as a minimum. Kaufman et al. (2020) have produced estimates of carbon price pathways using what they call a Near Term to Net-Zero (NT2NZ) approach. Their estimates of the NT2NZ price of carbon are higher, as they reflect the most recent climate target of net zero by 2050. They estimate a price of carbon of US$77—US$124/tCO_2 in 2030.

Implementing a Target-Consistent Social Cost of Carbon

In the US, Executive Order 12866 and OMB (Office of Management and Budget) Circular A-4 mandate cost-benefit analysis of major proposed regulations by federal government agencies. It has been questioned whether the target-consistent approach would meet these legal requirements because it is based on an assessment of the costs of achieving a temperature target rather than the monetized benefits of a regulation. However, an answer to that question could be that the estimates of the target-consistent prices based on MACs give us a route to the SCC because the policy decision on the targets would have explicitly or implicitly compared benefits and costs. We should also note that there is a long-standing and well-founded approach to project appraisal in imperfect economies (see e.g., the literature associated with Little and Mirrlees, 1974), which bases the system of shadow prices for cost-benefit analysis on producer prices rather than consumer prices.

If legal challenges prove insurmountable, policymakers can, as a first approximation, embed the target-consistent approach in the IAM approach by imposing a constraint on the IAM's underlying intertemporal maximization problem that restricts greenhouse gas concentrations from rising above the level associated with a particular temperature goal in the model. This alteration can be justified as a way of dealing with the overwhelming risk of climate change, but of course does not deal with all the methodological flaws inherent in the IAM approach. It does, however, move the SCC values estimated for use in policymaking toward those that could be consistent with the Paris Agreement and domestic targets. At the very least, policymakers should develop an estimate of the target-consistent price path of carbon and use these values as benchmarks to vet IAM estimates of the SCC. This way, the IAWG can check that SCC values are in line with temperature and greenhouse gas emission targets while also being in compliance with Executive Order 12886.

CONCLUSION

The standard IAM approach to estimating the SCC is insufficient to deliver the climate targets set in the Paris Agreement and by the Biden administration. A target-consistent approach that develops a price path consistent with international and domestic temperature targets will better serve federal climate policymaking. The Interagency Working Group should update its modeling approach accordingly to produce target-consistent estimates of the SCC. If estimates of the SCC using the IAM approach must be employed, they should be calculated using an IAM that embeds the target-consistent approach or is benchmarked against estimates calculated using the target-consistent approach described in the previous section, to enable the SCC values used in policymaking to move us toward the Paris Agreement and domestic targets. Further, any IAM used must address the flaws discussed above. Indeed, addressing just a few of them would likely result in an SCC estimate that is broadly consistent with that of the target-consistent approach (even without imposing the target constraint). Most importantly, it is essential to deal adequately, or at least far better, with discounting, risk (including the risk of large damages), and distributive effects.

At the same time, policymakers should push for a full suite of progressive climate policies that meet the scale of the climate crisis and stand to usher in the pro-growth economic transformation we need. These include standards, regulations, support for R&D, and climate investments. The risks attributable to inaction on climate, while unknowable to an extent, are potentially immense and increase significantly over time.

Thus, in addition to advocating for employing a target-consistent social cost of carbon in policymaking and regulatory review, the federal government and policymakers should feel empowered to utilize all the policy levers and mechanisms at their disposal to meet pledged decarbonization goals. Market mechanisms alone, while crucial, are not nearly enough to tackle the challenge at hand. The economic transformation necessary to reach net-zero emissions by 2050 will require regulations, including financial, that wind down the fossil fuel industry and improve the disclosure of climate risk, green procurement, green lending, research and development, and changes in the design of our cities, our energy systems, agriculture, our transportation systems, and much more. Not only will this suite of policy actions mitigate the impacts of climate change, they will also usher in economic growth and, if done in the right way, improve another growing and profound threat: inequality.

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