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Justin Gundlach* and Michael A. Livermore†

In the United States the primary tool to value greenhouse gas emissions reductions in cost-benefit analysis is the social cost of carbon (SCC), which is a metric that estimates, in monetary terms, the damages associated with climate change. Recently, some prominent public policy experts and scholars have proposed that a "marginal abatement cost" (MAC) could be used as an alternative to the SCC. Indeed, some jurisdictions, such as the U.K., have integrated MAC-based approaches into climate policymaking. This article provides conceptual clarity about these metrics, focusing on how a MAC-based threshold could sensibly be used in climate policy, and explaining why it is not a substitute for the SCC. We relate the current conversation about valuing greenhouse gas emissions to the longstanding debate over the use of prices versus quantities in climate policy formulation and the more generic regulatory question of when it is appropriate to employ cost-benefit analysis versus cost-effectiveness analysis. In addition, we use illustrative hypothetical policy contexts to explain the roles that these tools should play.

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Introduction

There has long been a consensus among climate scientists that the release of greenhouse gases into the atmosphere imposes extremely serious risks on ecosystems and human societies. Beginning with the pioneering work of William Nordhaus and others in the 1990s, climate economists have engaged in a substantial research program to estimate climate-change related damages. Among the most important outputs of that research program are estimates of the "social cost of carbon" (SCC), which expresses, in monetary terms, the harm caused by the release of greenhouse gases.[1] Since the administration of President Barack Obama, the SCC has played an important role in cost-benefit analysis of federal regulations related to the anthropogenic causes of climate change. It has also become a standard feature of some types of environmental review and been taken up by a range of public and private actors who must make decisions in the face of climate change risks.

The SCC has its share of critics. Some have argued that climate change risks are simply too uncertain to quantify with precision,[2] or that the quantification of such risks, while useful, should be just one of several tools that policymakers use to inform their decisions with respect to climate impacts.[3] Others have called for giving greater attention to the distribution of climate impacts than the SCC provides.[4] There is also a host of disagreements even among those committed to an SCC framework. Important questions range from the appropriate way to model climate damages, to how future climate impacts should be discounted, to how best to address the geographic and generational distribution of climate harms.[5]

Recently, critics of the SCC have emphasized an approach to climate policymaking that begins with an emissions target and then seeks to achieve that target at the lowest cost possible. To determine whether any particular policy should be adopted, a cut-off level of costs is selected that is believed to be consistent with achieving the emissions target. This cut-off is expressed in terms of "marginal abatement costs" (MAC). Generally, the marginal abatement costs of a policy are the costs to reduce the last unit of pollution (which is the most expensive to abate) under the policy.[6] MACs differ across policies. Whether examined economy wide or within a narrower context, a MAC identifies the costs per unit of emissions reductions of the last unit of reductions achieved before an emissions

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[1] It is technically correct to refer to the "social cost of greenhouse gases," but here we use the term "social cost of carbon" or SCC as a shorthand both for the social cost of carbon dioxide and of other greenhouse gases, such as methane, nitrogen oxides, and hydrofluorocarbons.

[2] *E.g.*, John C. V. Pezzey, *Why the Social Cost of Carbon Will Always Be Disputed*, 10 WIREs CLIMATE CHANGE e558, *2 (2019).

[3] *E.g.*, Susan Rose-Ackerman, *The Limits of Cost/Benefit Analysis When Disasters Loom*, 7 GLOBAL POL'Y (Supp.) 56 (2016).

[4] *E.g.*, Eric A. Posner & Jonathan S. Masur, *Climate Regulation and the Limits of Cost-Benefit Analysis*, 99 CAL. L. REV. 1557, 1596–97 (2011).

[5] *See* NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE, VALUING CLIMATE DAMAGES: UPDATING ESTIMATION OF THE SOCIAL COST OF CARBON DIOXIDE (2017) (identifying subjects of debate and articulating responsive research agendas); *see also* Richard L. Revesz & Max Sarinsky, *The Social Cost of Greenhouse Gases: Legal, Economic, and Institutional Perspectives*, THIS VOLUME; Peter H. Howard & Jason Schwartz, *Valuing the Future: Legal and Economic Considerations for Updating Discount Rates*, THIS VOLUME.

[6] A marginal abatement cost curve traces the incremental costs of a suite of policies or other emissions-reducing interventions, ordered from the least costly to the most expensive. Assuming that the least expensive options are adopted first, the curve predicts a marginal cost for every potential amount of emissions reduction that is achieved.

reduction target is met. Under a cost-effectiveness framework, any policy with a cost below the cut-off is adopted, while policies with higher costs are avoided.[7]

The debate over the use of the SCC- versus a MAC-based price threshold recapitulates in different form longstanding debates over cost-benefit analysis versus cost-effectiveness analysis and emissions taxes versus caps. The failure to recognize the symmetry between these concepts has led to considerable confusion. The main purpose of this essay is to take a step back and explain how the current debate fits into a conversation about how best to make environmental policy that extends back to the dawn of the contemporary environmental movement. With this intellectual history in mind, it becomes much easier to take advantage of the substantial analytic discourse that has taken place in the intervening decades to understand the relevant tradeoffs involved.

It is also useful to keep in mind that different policy contexts may call for use of the SCC or a MAC-based threshold. An agency directed to take steps consistent with an explicit emissions target faces a different inquiry than one tasked with considering a wide range of economic and social factors while pursuing a particular regulatory mission. Once an agency's mandate is understood, then the appropriate analytic framework (cost-effectiveness versus cost-benefit) and associated metric (MAC-based versus SCC) is often quite obvious. Confusion emerges when these debates are had in the abstract, without reference to the context of the particular policy-making situation.

It bears noting that the SCC is one of many tools that can be used to make sense of and communicate climate change risks. Some of these tools are technical but many employ narrative and qualitative elements. The proper uses of the SCC are contextual; recognizing its value in one context does not imply that there are not other useful ways of explaining climate change risks in the broad context of political and social discourse.

This essay proceeds in three parts. The first summarizes the functions of cost-benefit analysis and cost-effectiveness analysis in the context of environmental policy and notes how they relate to the choice of regulatory instruments that prioritize either prices or quantities. The second part describes regulatory instruments developed for climate policy in particular and highlights the parallels between older debates over instrument choice in the environmental policy context including more recent debates focused on climate policy. This part also describes potential reasons for misalignment between the SCC and a MAC-based emissions value. The third part puts these concepts into regulatory context, considering how they manifest under different administrative legal requirements. This part also summarizes the present uses of the SCC by federal and state governments before illustrating with stylized examples how different uses can be more or less apt.

I. Making Environmental Policy

Climate policy is a relatively recent outgrowth of contemporary environmental policy, which in the United States dates to about 1970. The basic task of environmental policy is to govern human activities that create environmental harms. Environmental regulators face a host of complex questions, often revolving around the appropriate level of stringency to select, and the best mechanism for achieving pollution control.[8] The following discussion describes analytic techniques

[7] When evaluating the policies with co-benefits, then the appropriate consideration is net costs. For example, an energy efficiency mandate may result in fuel savings and emissions reductions. The cost of such a policy for purposes of a MAC analysis would be the costs of the technology, minus the relevant fuel savings.

[8] Michael A. Livermore & Richard L. Revesz, *Environmental Law and Economics*, *in* THE OXFORD HANDBOOK OF LAW AND ECONOMICS: VOLUME 2: PRIVATE AND COMMERCIAL LAW (Francesco Parisi, ed. 2017).

that can be used for making these decisions and a particularly important class of "instrument choice" options that are relevant for climate policy.

A. Analysis

Cost-benefit analysis is a decision-making rubric that seeks to illuminate how government decisions will affect the public. Grounded in the field of welfare economics,[9] cost-benefit analysis estimates the net benefits of a policy option by comparing its positive and negative effects.[10] A well-conducted cost-benefit analysis tallies all measurable effects, including those that are ancillary or indirect to the primary objective or concern of the decision at issue.[11] Monetizing as much of that tally as possible enables an apples-to-apples comparison of the welfare effects of a given proposal relative to alternatives, including inaction.[12] Supporters of the technique argue that it can improve government decision-making by imposing transparency, facilitating accountability, and improving the quality of agency deliberations and analysis.[13]

Cost-effectiveness analysis is another form of regulatory impact analysis that can add rigor and transparency to decisions about environmental policy.[14] Unlike cost-benefit analysis, cost-effectiveness analysis does not assess the value to society of a given objective in terms of public welfare.[15] Rather, it takes that decision's objective as given and "compare[s] a set of regulatory actions with the same primary outcome," assessing how efficiently each of those alternatives would accomplish that outcome.[16] Consistent with this distinction, the outputs of cost-effectiveness analysis include the monetized, incremental *costs* of achieving an objective, but not the comparably monetized incremental *benefits* of doing so.[17] Stated another way, cost-effectiveness analysis is half of

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[9] Robin W. Boadway, *The Welfare Foundations of Cost-Benefit Analysis*, 84 ECON. J. 926 (1974).

[10] MICHAEL GREENSTONE, TOWARD A CULTURE OF PERSISTENT REGULATORY EXPERIMENTATION AND EVALUATION, *in* NEW PERSPECTIVES ON REGULATION 111, 113 (D. Moss & J. Cisternino, eds. 2009) ("By converting all costs and benefits to the same unit, government can avoid irrational combinations of policies that fail to maximize our well-being. The costs and benefits for one person under one policy are treated no differently than the costs and benefits for another person under another policy.").

[11] Office of Mgmt. & Budget, Exec. Office of the President, Circular A-4: Regulatory Analysis 26 (2003) [hereafter Circular A-4]; *see also* DAVID PEARCE, OECD, COST-BENEFIT ANALYSIS AND THE ENVIRONMENT: RECENT DEVELOPMENTS 56 (2006) ("Any impact of the policy that affects individuals' well-being is therefore a proper impact for inclusion in the CBA.").

[12] Circular A-4, at 15–17.

[13] Caroline Cecot, *Deregulaotry Cost-Benefit Analysis*, 68 DUKE L.J. 1593, 1613–15 (2019); Caroline Cecot & W. Kip Viscusi, *Judicial Review of Agency Benefit-Cost Analysis*, 22 Geo. Mason L. Rev. 575, 592–605 (2015); RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY (2008).

[14] OECD, Regulatory Impact Analysis: A Tool for Policy Coherence 13 (2009); *see also* Circular A-4, *supra* note 11, at 9–14 (describing cost-effectiveness analysis and some of its applications); GERBERT ROMANI & GUSTA RENES, NETHERLANDS BUR. FOR ECON. POL'Y ANALYSIS & ENV'T ASSESSMENT AGENCY, GENERAL GUIDANCE FOR COST-BENEFIT ANALYSIS 40 (2013).

[15] ROMANI & RENES, *supra* note 14, at 40 (suggesting use of cost-effectiveness analysis when "the goal of the policy is not at issue and is not a subject of study.").

[16] Circular A-4, *supra* note 11, at 11; *see also* ROMANI & RENES, *supra* note 14, at 40 (emphasizing that the quality of cost-effectiveness analysis is enhanced by consistency of costs and performance measures (i.e., "effectiveness") across alternatives for comparison).

[17] Circular A-4, *supra* note 11, at 11 ("Cost-effectiveness analysis can provide a rigorous way to identify options that achieve the most effective use of the resources available without requiring monetization of all the relevant benefits or costs."). Importantly, the comparison is not just of costs, but net costs, so that two options that both satisfy a cost-effectiveness criterion can still be compared based on which of them would perform *more* cost-effectively than the other.

a cost-benefit analysis, with an exclusive focus on costs, and no express information about benefits—only an implicit assumption of their value, often in the form of a threshold.[18]

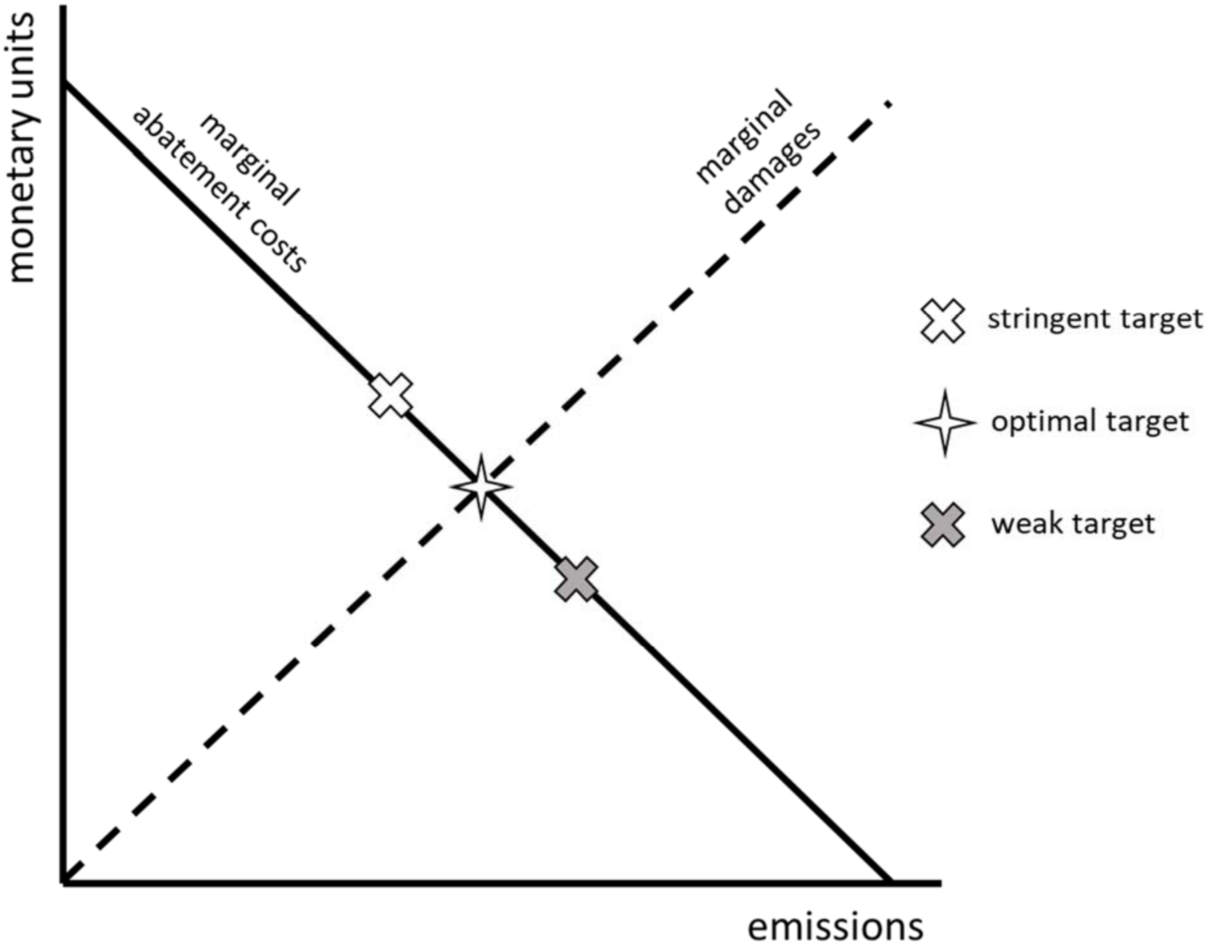

Figure 1

Figures 1 and 2 help illustrate the relationship between cost-effectiveness analysis and cost-benefit analysis, and how they are used in environmental policymaking. Both figures express environmental harms and the costs of abating emissions in monetary terms. The marginal cost of abatement is highest where emissions are lowest, because lower cost abatement strategies have already been deployed. The marginal cost of damages increases with emissions—i.e., as pollution increases, the incremental harm of each unit of pollution also increases.

An ideal cost-benefit analysis would be based on information on marginal damages and marginal abatement costs, both expressed in monetary units as a function of emissions. The benefit of emissions reduction is avoiding the harms expressed in the marginal damages curve, shown Figure 1 as the area under the "marginal damages" curve. Information on marginal abatement costs is

[18] In the environmental context, cost-effectiveness analysis is typically expressed in terms of cost per unit of emissions reduction. Cost-effectiveness analysis does not require a threshold to guide decision making about more and less cost-effective emissions reducing options, but thresholds are a conventional feature of such analysis. Any number of factors can serve as the basis for a threshold. *See infra* notes 66–76 and accompanying text.

expressed in terms of emissions reduced. As the stringency of policy increases—i.e. as more emissions are reduced—the monetary costs of each incremental unit of pollution reduction also increases. The goal of cost-benefit analysis is to maximize net benefits, which occurs at the point where marginal abatement costs and marginal damages are equal—the "optimal target" in Figure 1. If marginal damages are greater than marginal abatement costs, then net benefits can be increased by reducing emissions, since the cost of doing so is less than the value of the harm avoided. (See Figure 2, panel B.) If marginal damages are less than marginal abatement costs, the opposite is true: net benefits can be increased by reducing stringency, since the value of the harm avoided is less than the monetary cost of the last unit of emissions reduction. (See Figure 2, panel A.)

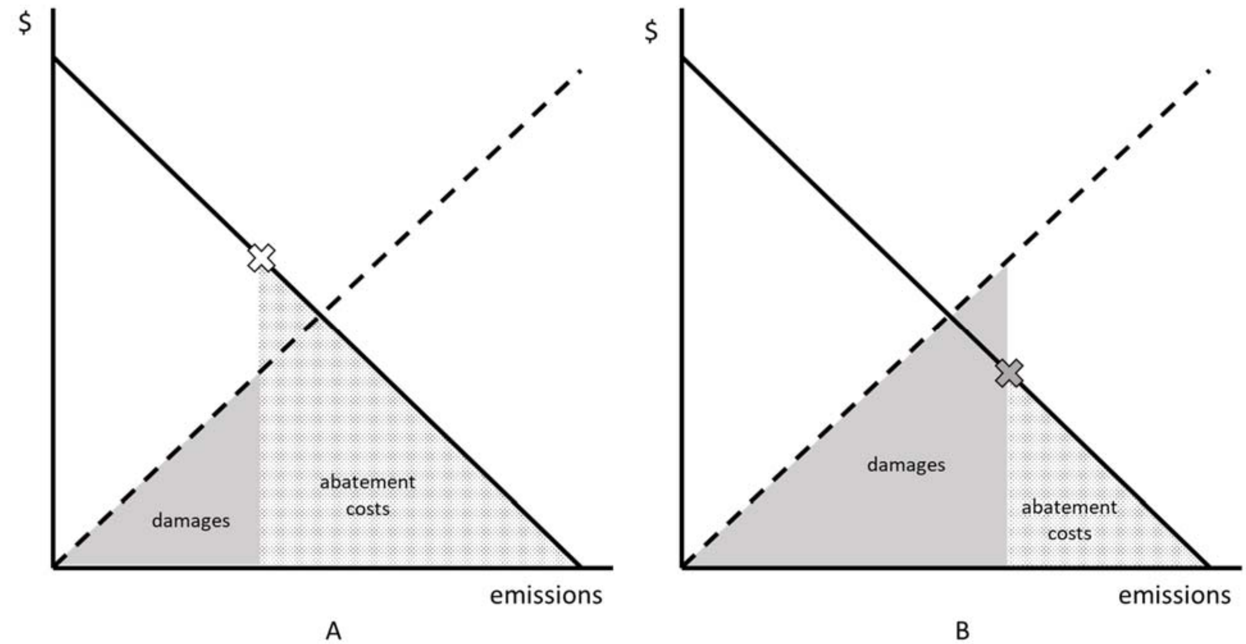

Figure 2

Cost-effectiveness analysis provides half of this picture. It is based entirely on the marginal abatement cost curve, and does not include any information on marginal damages. The social decision-maker can, for one reason or another, set a target, which will line up with a point on the marginal abatement curve. The target may be too stringent (Figure 2, panel A) or too weak (Figure 2, panel B); cost-effectiveness has nothing say on this question. Cost-effectiveness analysis can be useful however, in identifying more or less expensive ways to achieve a given pollution control goal.

By lining up the possible options in terms of their price per unit of emissions reduction, cost-effectiveness analysis guides policies toward the cheapest alternative. A thoroughgoing application of cost-effectiveness analysis results in the equalization of marginal abatement costs across the entire economy. This occurs because differential marginal abatement costs imply that some lower-cost alternatives are not being taken advantage of. If an optimal goal is set, then net benefits will be maximized if cost-effectiveness analysis is used.[19] Cost-effectiveness analysis can be used to evaluate command-and-control regulation,[20] but it could be used to set a price on emissions as well.[21]

An example can help make this a bit more concrete. Pursuant to the Clean Air Act, the Environmental Protection Agency (EPA) establishes National Ambient Air Quality Standards (NAAQS), which describe air quality targets for several major air pollutants, including particulate matter, sulfur dioxide, and nitrogen oxides. Once the NAAQS are set, states are charged with developing implementation plans that comprise a set of policies to attain and maintain these air quality targets. In developing their implementation plans, states have a number of different policy options.

In *American Trucking v. Whitman*, the Supreme Court held that EPA could not take costs into consideration when setting the NAAQS.[22] Accordingly, the agency focuses its analysis on the benefits of regulation, based on the risks posed to public health and welfare by different concentrations of regulated pollutants.[23] Nevertheless, the agency conducts, but does not formally consider in its decision, a cost-benefit analysis every time that it updates the NAAQS.[24] States can choose whether to conduct formal cost-effectiveness analyses to develop their implementation plans.[25] Nevertheless, the nature of the inquiry left to the states is an exercise in applied cost-effectiveness analysis of a sort.[26] That is, once EPA specifies the air quality targets a state must hit,

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[19] The optimal goal would equalize marginal costs and marginal benefits. Cost-effectiveness takes account of ancillary effects because the MAC curve is based on net costs.

[20] The term "command-and-control" encompasses pollution limits as well as technology and performance-based standards. It is distinct from market-based mechanisms that have dynamic elements and act through prices.

[21] It could also set a quantity, if the social decision maker sets a "per unit of emissions reduction cost" goal and then translates that into a quantity. This is akin to a regulatory budget approach.

[22] *Whitman v. Am. Trucking Ass'ns*, 531 U.S. 457 (2001). More specifically, the Court held that the agency could not use costs as a justification to reduce the stringency of the NAAQS from the health-based standard. Michael A. Livermore & Richard L. Revesz, *Rethinking Health Based Environmental Standards*, 89 N.Y.U. L. REV. 1184 (2014).

[23] *See, e.g.*, National Ambient Air Quality Standards for Ozone, 80 Fed. Reg. 65291 (Dec. 28, 2015); EPA, INTEGRATED SCIENCE ASSESSMENT, INTEGRATED SCIENCE ASSESSMENT (ISA) FOR OZONE AND RELATED PHOTOCHEMICAL OXIDANTS—FINAL REPORT (2013); *see also* JAMES E. MCCARTHY & KATE C. SHOUSE, CONG. RES. SERV., IMPLEMENTING EPA'S 2015 OZONE AIR QUALITY STANDARDS 6–12 (2018) (describing process of NAAQS review and revision). In the analysis used to set the NAAQS, the agency does not rely on monetized estimates for benefits and instead bases standards on its "public health policy judgement" informed by the recommendations of the Clean Air Science Advisory Committee. Livermore & Revesz, *supra* note 22, at 1214.

[24] *See* Livermore & Revesz, *supra* note 22, at 1239–46 (examining cost-benefit analyses of multiple NAAQS and finding that health-based NAAQS specification usually results in standards higher than those that would align marginal costs and benefits).

[25] The Clean Air Act does not require states to adopt a least cost approach, and EPA cannot consider "economic and technological infeasibility" as part of the approval process for state implementation plans. Union Electric v. Envtl. Prot. Agency, 427 U.S. 246, 256 (1976).

[26] *See, e.g.*, TEX. COMM'N ON ENV'T QUALITY, 2021 REGIONAL HAZE STATE IMPLEMENTATION PLAN REVISION 7-12 (adopted June 30, 2021) ("A cost threshold of $5,000 per ton for NOX and SO2 emissions reduced was used to further refine source selection within the initial list of sources selected for four-factor analysis. This allowed for the identification of sources to which potential control measures could be applied cost-effectively."); Alaska Dep't of Env't Conserv., Amendments to: State Air Quality Control Plan vol. II: III.D.7.7, at 7-37 to 7-38 (amendments adopted Nov. 18, 2020) ("[DEC's] evaluation considers technical feasibility, estimates of actual emissions reductions, and cost effectiveness for each technology or work practice identified."); Delaware 2012 SIP for 2008 8-hour Ozone NAAQS, https://regulations.delaware.gov/register/july2012/general/16%20DE%20Reg%20114%2007-01-12.htm (listing cost-effectiveness values in "potential additional control measures" column). A state is, of course, free to conduct a cost-benefit analysis as part of an inquiry into whether it should adopted emissions reductions beyond those needed to meet the NAAQS.

the state then determines the mix of measures it will undertake to hit them. Formal cost-effectiveness analysis can help guide the state toward the least expensive way to meet the target.

There are a few useful lessons to be drawn from the Clean Air Act example. One is that the law often determines the types of analyses that are appropriate for a regulator. *American Trucking* limits EPA's ability to consider costs, and so setting the NAAQS based on a full cost-benefit analysis is proscribed. However, under executive orders that have been in place since the Reagan era, agencies are generally required to conduct cost-benefit analyses of major rulemakings.[27] EPA threads this needle by setting the NAAQS based purely on health-based criteria, but then conducting a cost-benefit analysis for information purposes.[28] Because states are given no discretion with respect to the minimum air quality level they must achieve, they have no particular reason to carry out a full cost-benefit analysis.[29] Since their target is set by federal law, a cost-effectiveness analysis is all they need to optimize their policy choices.

A second lesson is that cost-benefit analysis is necessary to detect over- or under-regulation; cost-effectiveness analysis cannot be used for this task. In the case of the NAAQS, the litigants in *American Trucking* likely assumed that, were cost-benefit analysis to be used, it would lead to less stringent regulation, presumably because they believed that the identified marginal benefits would be less than the identified marginal costs. It turns out, however, that EPA's cost-blind, health-based approach has established standards that are inefficiently weak according to the agency's own cost-benefit analyses.[30] Looking at benefits in isolation (as EPA does when setting the NAAQS), or costs in isolation (as states do when setting their implementation plans) will never yield sufficient information to evaluate whether a given level of stringency is socially desirable.

A third lesson is that cost-benefit analysis and cost-effectiveness analysis can be used in tandem, especially in real-world decision-making contexts when different policy-makers are allocated different choices. In the NAAQS case, EPA is charged with setting uniform national standards that apply across the country. Even were it to use cost-benefit analysis when setting the standards, that analysis would be quite aggregated and coarse-grained because the agency would set the correct standard by focusing on average costs and benefits and ignoring local variations that tend to cancel out.

Because NAAQS are uniform across the country, there are different marginal abatement costs in different jurisdictions.[31] When developing their implementation plans states can attend to local variation in the costs of different approaches to achieving emissions reductions. States may also be better positioned to determine which approaches would yield greater indirect or ancillary benefits in addition to achieving regulatory compliance at lower or least cost.[32] For these reasons, an additional layer of cost-effectiveness analysis may be in order to help guide state decision makers. The national-

[27] Executive Orders 12866 and 13563 direct agencies to use cost-benefit analysis when justifying adoption of significant rules or decisions. 58 Fed. Reg. 51735 (1993); 76 Fed. Reg. 3821 (2011).
[28] Livermore & Revesz, *supra* note 22, at 1236–37 (identifying similar language in multiple EPA regulatory impact assessments).
[2929] A state may wish to carry out a cost-benefit analysis as part of its decision of whether to adopt additional emissions control measures that will lead to cleaner air than is required by the NAAQS.
[30] *Id.* at 1239–46.
[31] There is a tradeoff between setting uniform standards, and achieving lowest cost emissions reductions by equalizing marginal abatement costs. When jurisdictions are diverse, uniform standards will result in non-uniform marginal costs. This means that some lower-cost pollution reduction opportunities will not be utilized. But a regime that equalized marginal abatement costs—for equal a tax on emissions—would be unlikely to result in uniform levels of protection.
[32] States may also be attentive to the distribution of compliance costs.

level cost-benefit analysis carried out by EPA does not render state-level cost-effectiveness analyses redundant.

Cost-benefit analysis and cost-effectiveness analysis can also be used together in cases where not all benefits can be estimated accurately. A cost-benefit analysis approach could be used as much as possible to compare the benefits achieved by a regulation to the costs. Where there are important non-quantified benefits, then those costs that are not justified by the quantified benefits can be estimated in terms of the non-quantified benefits. With this kind of analysis in hand, professional judgement can be used to determine whether the rule passes a "breakeven" threshold where the marginal quantified and non-quantified benefits are likely to be greater than the marginal costs.

B. Instrument Choice

A social decision maker can take the information in a cost-benefit analysis and use it to evaluate different policy options. Two straightforward types of policies involve setting a quantity of emissions or a price on emissions. Setting the optimal price leads to the optimal quantity, and vice versa. A social decision maker could also use this information to set a net-benefit maximizing command-and-control style regulation.

Under conditions of perfect information and enforcement, price-based, quantity-based, and command-and-control regulations set according to comprehensive cost-benefit analysis will all lead to the same outcome of maximizing social well-being. In the real world, however, decision makers often face conditions of uncertainty, and this fact influences the regulatory instrument that is most likely to maximize net benefits. Generally, economists prefer market-based instruments (i.e. price- or quantity-based approaches) over command-and-control regulation, due to the greater information burdens that the latter approach places on regulators. A price on pollution or an emissions allowance system allows a regulator to focus on aggregate factors that affect marginal damages and marginal abatement costs across the economy when setting the price or quantity of allowances. Once the price is set or the allowance system established, individual firms can decide how to change their behavior accordingly. Command-and-control regulation places greater burdens on regulators, who must engage in more detailed and fine-grained rulemakings.

There is now a considerable literature on the relative merits of price-based and quantity-based mechanisms. The origin of this literature is economist Martin Weitzman's insight that "there is no *basic* or *universal* rationale for having a general predisposition toward one control mode or the other."[33] Rather, Weitzman argues, where abatement costs are uncertain, the suitability of one or the other approach depends on the relative elasticity (i.e. rate of increase) of marginal abatement costs and marginal damages.[34] Although Weitzman's model abstracted from the complexities of regulatory reality, it yielded insights that have since steered the literature and policy-makers alike.

Much subsequent work has extended Weitzman's initial analysis,[35] highlighting the potential relevance of various factors other than elasticities to how price- or quantity-oriented regulatory

[33] Martin L. Weitzman, *Prices vs. Quantities*, 41 REV. ECON. STUDIES 477, 479 (1974).
[34] *Id.* 485–87.
[35] *See* Torben K. Mideksa & Martin L. Weitzman, *Prices versus Quantities Across Jurisdictions*, J. ASS'N ENV'T & RESOURCE ECON 883 (2019) (collecting and categorizing selected analytical extensions and noting that "the results generally preserve the earlier insight that, all else held equal, flatter marginal benefits or steeper marginal costs tend to favor prices while steeper marginal benefits or flatter marginal costs tend to favor quantities."); David L. Kelly, *Price and Quantity Regulation in General Equilibrium*, 125 J. ECON. THEORY 36, 37 (2005) (listing theoretical and empirical extensions of Weitzman (1974)).

instruments will perform. These include risk aversion among regulated firms,[36] and dynamic factors such as the potential for policy changes over time.[37] A particularly important line of research explores how hybrid instruments that combine features of both price and quantity mechanisms can yield superior outcomes, given the challenges of adopting policy measures and setting parameters under uncertainty.[38]

From the perspective of a social decision maker, one of the most important features of the choice between price-based and quantity-based instruments in the relative allocation of risks over total emissions and market prices. Quantity-based instruments ensure that a given level of emissions reduction is achieved, but create uncertainty over prices. By contrast, price-based instruments create uncertainty over the total amount of emissions reductions that will be achieved, but facilitate greater certainty over prices. Hybrid approaches achieve a middle ground allocation of these two uncertainties, and for this reason have proven attractive to policy-makers. Consider the European Union's Emissions Trading Scheme and the Regional Greenhouse Gas Initiative in the eastern United States, cap-and-trade programs that set regional limits on aggregate emissions and compel qualifying emitters to purchase allowances for each unit of pollution they emit. Both of these programs revamped their original allowance-oriented designs to include mechanisms that ensure allowance prices and quantities neither drop to zero nor skyrocket suddenly.[39] These mechanisms limit volatility and facilitate business planning while also providing a measure of certainty concerning total emissions levels.[40]

Many jurisdictions are home to a mix of market-based and command-and-control regulatory mechanisms. In such jurisdictions, a cost-effectiveness analysis can borrow a price from a market-based regulatory scheme and use it to assess or recalibrate command-and-control measures that, for instance, address the same pollutant in a different sector. Transposing a price in this way can reveal inefficiencies and opportunities for more aggressive regulation.

II. The Case of Climate

The previous part provided a general overview of cost-benefit analysis and cost-effectiveness analysis, the associated metrics of marginal damages and marginal abatement costs, and how these analyses and metrics can be used to select between alternative regulatory instruments. This following part delves into climate policy more specifically.

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[36] David L. Kelly, *Price and Quantity Regulation in General Equilibrium*, 125 J. ECON. THEORY 36–60 (2005).

[37] Pizer and Prest, for instance, focus on uncertainty over time in a dynamic model to argue that a quantity-based regulatory instrument that allows for trading across time periods (e.g., "banking" of allowances) can be an efficient mechanisms for firms to hedge against foreseeable policy changes. William A. Pizer & Brian C. Prest, *Prices versus Quantities with Policy Updating*, 7 J. ASS'N ENV'T & RESOURCE ECON. 483, 484 (2020).

[38] *See, e.g.*, J. Mark Roberts & Michael Spence, *Effluent Charges and Licenses under Uncertainty*, 5 J. PUB. ECON. 193–208 (1976) (finding efficiency gains from supplementing a quantity-based regulatory measure with price-based components that hedge against misspecification of the quantity-based measure). *See also* Martin L. Weitzman, *Optimal Rewards for Economic Regulation*, 68 AM. ECON. REV. 683 (1978).

[39] European Commission, Climate Action: Market Stability Reserve, https://ec.europa.eu/clima/policies/ets/reform_en (accessed Aug. 23, 2021) (describing elements of mechanism and reasons for its adoption); Regional Greenhouse Gas Initiative, *Elements of RGGI*, https://www.rggi.org/program-overview-and-design/elements (accessed Aug. 23, 2021) (summarizing cost and emissions containment reserves); *see also* William Acworth, Katrin Schambil, & Tobias Bernstein, Market Stability Mechanisms in Emissions Trading Systems (2020) (describing emissions and price containment mechanisms generally, with specific reference to California, Quebec, and the EU).

[40] Richard Schmalensee & Robert N. Stavins, *The Design of Environmental Markets: What Have We Learned from Experience with Cap and Trade?*, 33 OX. REV. ECON. POL'Y 572, 578–79 (2017).

A. Marginal damages of greenhouse gas emissions, a.k.a. the Social Cost of Carbon

The SCC estimates in monetary terms the external cost imposed on society of emitting a marginal metric ton of carbon dioxide into the atmosphere.[41] The SCC is the main output of Integrated Assessment Models (IAMs), which seek to capture relevant features of the global climate and economy.[42] Academic researchers developed the first IAMs in the early 1990s to estimate global damages resulting from climate change.[43] These models and estimates have since been subjected to repeated rounds of peer review and updating.[44] National governments, starting with the UK, began making formal use of those estimates in the early 2000s.[45]

Federal agencies in the United States first used the SCC in cost-benefit analyses conducted to assess regulations following a 2008 decision by the U.S. Court of Appeals for the Ninth Circuit.[46] In that decision, the court remanded a rulemaking to the National Highway Transportation Safety Administration, which had acknowledged that its fuel economy rule would reduce carbon dioxide emissions but had failed to tally the benefits of those reductions so that they could be compared to

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[41] It is possible for cost-benefit analysis to be sensitive to the distribution of the allocation of cost and benefits. The technique of equity weighting, for example, places a higher dollar value on costs or benefits when they are experienced by less well-off members of society. *See generally* Matthew D. Alder, *Benefit-Cost Analysis and Distributional Weights: An Overview*, 10 REV. ENVTL. ECON & POLICY 264 (2016). In the context of climate change, equity weights can be incorporated into the construction of the social cost of carbon. Nicholas Stern et al., The Economics of Climate Change: The Stern Review 159 (2007); *see also* GAO, SOCIAL COST OF CARBON: IDENTIFYING A FEDERAL ENTITY TO ADDRESS THE NATIONAL ACADEMIES' RECOMMENDATIONS COULD STRENGTHEN REGULATORY ANALYSIS, GAO-20-254, at 65 (2020) ("The German Environment Agency developed the national government's most recent monetary estimates for carbon dioxide emissions using a social cost of carbon approach, which included equity weighting . . . ."); Tamma Carleton & Michael Greenstone, Updating the United States Government's Social Cost of Carbon 31 (Univ. Chicago Energy Pol'y Inst. Working Paper No. 2021-04, Jan. 2021) (recognizing that there is "a strong theoretical and empirical case for equity weighting" but not recommending it unless Circular A-4 is amended to permit it). The U.S. Intergovernmental Working Group considered use of equity weights but decided against this approach in 2016. Resources for the Future & N.Y. State Energy Res. & Dev. Auth'y, Estimating the Value of Carbon: Two Approaches 14 n19 (2020; updated 2021) (noting that federal SCC, on which New York based its SCC, does not incorporate equity weighting). The IWG's 2021 interim SCC, adopted in March 2021 is similar, but the final version adopted in 2022 could.

[42] For a summary description of how the SCC is estimated using IAMs, see Peter H. Howard, *The Social Cost of Carbon: Capturing the Costs of Future Climate Impacts in US Policy*, *in* MANAGING GLOBAL WARMING: AN INTERFACE OF TECHNOLOGY AND HUMAN ISSUES, 659, 662–75 (Trevor M. Letcher, ed. 2019).

[43] *See* Douglas J. Arent, Richard S.J. Tol et al., *Key Economic Sectors and Services – Supplementary Material*, *in* CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY. PART A: GLOBAL AND SECTORAL ASPECTS. CONTRIBUTION OF WORKING GROUP II TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, at SM10-4, tbl.SM10-1 (listing peer reviewed estimates of the welfare impact of climate change in terms of global GDP, starting in the early 1990s) (C.B. Field et al. eds. 2014).

[44] *See, e.g.*, William Nordhaus, *Evolution of Modeling of the Economics of Global Warming: Changes in the DICE Model, 1992–2017*, 148 CLIMATIC CHANGE 623 (2018) (describing process and substance of model updates).

[45] *See* Richard Clarkson & Kathryn Deyes, *Estimating the Social Cost of Carbon Emissions* 7–11 (Gov't Econ. Serv. Working Paper 140, 2002) (discussing damages- and cost-based approaches to emissions valuation and recommending that ministries use a particular range of shadow prices to develop or evaluate policies with effects on greenhouse gas emissions). In 2003, the UK Department for Environment, Food, and Rural Affairs commissioning a two-part Social Cost of Carbon Review, which was published in late 2005. *See* PAUL WATKISS ET AL., THE SOCIAL COSTS OF CARBON (SCC) REVIEW–METHODOLOGICAL APPROACHES FOR USING SCC ESTIMATES IN POLICY ASSESSMENT, FINAL REPORT (2005); THOMAS E. DOWNING ET AL., SOCIAL COST OF CARBON: A CLOSER LOOK AT UNCERTAINTY (2005).

[46] Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1188 fn.19 (9th Cir. 2008) (noting that Environmental Defense had discussed WATKISS ET AL., *supra* note 45, in its comments on the proposed rule). NHTSA only considered greenhouse gas emissions implications of its rule because of the Supreme Court's decision in Massachusetts v. EPA, 549 U.S. 497 (2007), which had rejected EPA's justification for refusing to regulate greenhouse gas emissions as "pollutants" under section 202 of the Clean Air Act.

the regulation's costs.[47] In 2009, the Obama Administration convened an Interagency Working Group on the Social Cost of Carbon to establish a monetized value of emissions for use across federal agencies.[48] The estimates it published in 2010—an instantiation of the SCC referred to here as the IWG SCC—drew on the three most widely cited IAMs.[49] The Group published revised estimates in 2013 based on updated versions of those models,[50] and in 2016 added estimates of the social cost of methane (SC-CH4) and nitrous oxide (SC-N2O).[51]

In January 2017, the National Academies of Sciences, Engineering, and Medicine published an examination of the IWG SCC as well as recommendations for how to update it so as to incorporate the findings of ongoing research.[52] Then, in March 2017, President Trump's Executive Order 13783 disbanded the Interagency Working Group and instructed agencies to monetize the effects of changes in greenhouse gas emissions in a way that would yield far lower values.[53]

President Biden's Administration then reversed this reversal with Executive Order 13990 in January 2021.[54] That order re-established the IWG and directed it to undertake several tasks, including: first, conduct an initial review of the Trump Administration's approach to the SCC and recommend an interim value for use by federal agencies by February 2021; and second, by early 2022, develop both "final" values for carbon, methane, and nitrous oxide, and, in line with the National Academies' recommendations, a process for regular review and updating of those values with due consideration for potentially catastrophic climate risks, environmental justice, and intergenerational equity.[55] The recommended interim valuation issued in February 2021 restored the estimates adopted in 2016, adjusted for inflation.[56] Recent research into climate damages and discount rates, among other things, suggests that the value recommended in 2022 will reflect adjustments that yield higher estimates of the SCC and other greenhouse gases.[57]

All applications of the IWG SCC by federal agencies involve monetizing the increase or decrease in greenhouse gas emissions that is expected to result from a decision or project for which the agency

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[47] *CBD v. NHTSA*, 538 F.3d at 1198 ("NHTSA fails to include in its analysis the benefit of carbon emissions reduction in either quantitative or qualitative form.").
[48] INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON (IWG), TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866, at 4 (2010).
[49] *Id.*
[50] INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON (IWG), TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2013).
[51] INTERAGENCY WORKING GROUP ON THE SOCIAL COST OF GREENHOUSE GASES, ADDENDUM TO TECHNICAL SUPPORT DOCUMENT ON SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866: APPLICATION OF THE METHODOLOGY TO ESTIMATE THE SOCIAL COST OF METHANE AND THE SOCIAL COST OF NITROUS OXIDE (2016).
[52] NATIONAL ACADEMIES, *supra* note 5.
[53] Exec. Order 13783 § 5, 82 Fed. Reg. 16093, 16095–96 (Mar. 28, 2017).
[54] Exec. Order 13990 § 5, 86 Fed. Reg. 7037, 7040 (Jan. 20, 2021).
[55] *Id.*
[56] INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON, METHANE, AND NITROUS OXIDE: INTERIM ESTIMATES UNDER EXECUTIVE ORDER 13990, at 5 (Feb. 2021) [hereafter 2021 TSD].
[57] *See* Peter H. Howard & Jason Schwartz, *Valuing the Future: Legal and Economic Considerations for Updating Discount Rates*, THIS VOLUME; Peter H. Howard & Derek Sylvan, *Wisdom of the Experts: Using Survey Responses to Address Positive and Normative Uncertainties in Climate-Economic Models*, 162 CLIMATIC CHANGE 213 (2020) (reviewing directions of research into key features of climate models and emissions valuation). *See also* N.Y. STATE DEP'T OF ENV'T CONSERV., ESTABLISHING A VALUE OF CARBON: GUIDELINES FOR USE BY STATE AGENCIES 4 (2020) (recommending that agencies apply a central value of $121/ton for CO2 and of $2,700/ton for CH4).

is in some way responsible. In addition to conducting the cost-benefit analyses required by executive orders and laws like the Energy Policy and Conservation Act,[58] agencies have also applied the IWG SCC when assessing environmental impacts pursuant to the National Environmental Policy Act (NEPA),[59] and to make procurement decisions and award grants.[60] These applications—especially those under NEPA—have been the subject of frequent litigation,[61] and courts have both upheld agencies' use of the IWG SCC[62] and, in some contexts, have directed agencies to use it.[63]

Several state governments have applied the IWG SCC to decisions or analyses.[64] In addition, New York adopted guidance in 2020 for its state agencies, recommending that they use a version of the IWG SCC that employs a lower discount rate for its central value (2%) than what the IWG SCC recommends (3%), which yields a higher estimate of value of carbon emissions.[65]

B. The Marginal Abatement Cost "Alternative"

Two recent papers criticize the SCC and argue for its displacement. One, Kaufman et al.'s *A Near-Term to Net-Zero Alternative to the Social Cost of Carbon*, argues that the SCC embodies too much uncertainty to be helpful for setting federal policy and proposes employing a target-based alternative instead.[66] This proposed alternative is meant to yield a carbon price to inform specification of a carbon tax through a repeating three-step process.

- First, set a date for the relevant jurisdiction to reach net-zero emissions; the authors assign this task, which involves "balance[ing] a range of factors," to "governing officials."[67]
- Second, specify "an emissions pathway" to that target date, meaning the rate (if linear) or rates (if curvilinear) at which policies and technologies will abate emissions up to the target date.[68]
- Third, estimate an emissions price based on the marginal cost of emissions abatement for the "near-term (the next decade, for example)" on the pathway to net-zero.[69]

Thus, while this approach fully specifies the rate of emissions abatement for each year leading up to the net-zero target, it only specifies the cost of achieving that abatement for the first few of those years. As noted above, the authors call for all three steps to be repeated "periodically" to ensure that its outputs reflect up-to-date inputs—ranging from political objectives, to policies' success at abating

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58 *E.g.*, Zero Zone, Inc. v. U.S. Dep't of Energy, 832 F.3d 654 (7th Cir. 2016).
59 *E.g.*, High Country Conservation Advocates v. U.S. Forest Serv., 52 F. Supp. 3d 1174, 1191 (D. Colo. 2014).
60 *See* 2021 TSD, *supra* note 56, at 12 n.12.
61 Zoe Palenik, *Note: The Social Cost of Carbon in the Courts*, 28 NYU ENVTL. L.J. 393 405 (2020).
62 Zero Zone, 832 F.3d at 677.
63 *See, e.g.*, Vecinos para el Bienestar de la Comunidad Costera v. FERC, 6 F.4th 1321 (D.C. Cir. 2021). Courts have also rejected arguments that agencies must apply the SCC. *See, e.g.*, EarthReports, Inc. v. FERC, 828 F.3d 949, 956 (D.C. Cir. 2016); Citizens for a Healthy Cmty. v. BLM, 377 F. Supp. 3d 1223, 1239–41 (D. Colo. 2019); WildEarth Guardians v. Zinke, 368 F. Supp. 3d 41, 77–79 (D.D.C. 2019).
64 *See* DENISE A. GRAB, ILIANA PAUL & KATE FRITZ, INST. FOR POL'Y INTEGRITY, OPPORTUNITIES FOR VALUING CLIMATE IMPACTS IN U.S. STATE ELECTRICITY POLICY 16 (2019).
65 New York State Dep't of Env't Conserv., Establishing a Value of Carbon: Guidance for State Agencies 18 (2020; updated 2021). Notably, that guidance was updated in 2021 to ensure methodological consistency with IWG SCC. *Id.* at 2.
66 Noah Kaufman et al., *A Near-Term to Net-Zero Alternative to the Social Cost of Carbon for Setting Carbon Prices*, 10 NATURE CLIMATE CHANGE 1010 (2020).
67 *Id.* at 1011.
68 *Id.*
69 *Id.*

emissions, to technological changes.[70] The authors' approach assumes a decision on the part of Congress or federal agencies to establish not only a net-zero target but to possibly also revisit and reestablish it periodically.

The second paper, *The Social Cost of Carbon, Risk, Distribution, Market Failures: An Alternative Approach*, by Nicholas Stern and Joseph Stiglitz, like Kaufman et al., criticizes the SCC and proposes a target-consistent alternative.[71] And, like Kaufman et al., Stern and Stiglitz's proposal assumes a form of emissions-reduction target. As they put it, by rejoining the Paris Agreement,[72] which embodies a 1.5°C or well below-2°C temperature target, "[c]onceptually, . . . a target has been adopted by the Biden Administration."[73] So, in their view, "the appropriate notion of the carbon price is one that would guide decisions to achieve that target."[74] Against this backdrop, Stern and Stiglitz propose two parallel analyses. The first assumes a 2° temperature constraint—that is, it assumes that global emissions will reach net zero by 2050, and that the result will be a stabilizing of global temperatures at 2° above pre-industrial levels—and estimates the marginal damages arising from that scenario.[75] The second involves comparing the costs of inaction and action in alternative scenarios, such as those that cause global temperatures to level off at 1.5° or 3° above pre-industrial levels. This pair of analyses is meant to identify the minimum carbon price required to steer society toward a 2° future while also revealing the consequences of stabilizing at other temperatures, both in terms of the carbon prices adopted and the economic consequences of mounting climate damage. As the authors put it, the idea is to "expos[e] explicitly the full consequences of different targets, including the risks which they entail," and to thereby inform and help to justify decisions about what target to select.[76]

Notably, what Stern and Stiglitz propose does not rely solely on a MAC-based analysis but also incorporates consideration for incremental climate damages. However, an emissions reduction target informs both of those elements, making their valuation of damages distinct from that of the SCC. The valuation Stern and Stiglitz propose can be thought of as an indicator of the minimum global and economy-wide carbon price required to keep to a pathway that stabilizes emissions at 2° above pre-industrial levels.[77]

The proposals in both Kaufman et al. and Stern and Stiglitz have been informed by experience with a target-based approach in the United Kingdom. In 2008, Britain's Climate Change Act established a schedule of binding "carbon budgets" that proceed toward a 2050 emissions reduction target in five-

[70] *Id.*
[71] Nicholas Stern & Joseph Stiglitz, The Social Cost of Carbon, Risk, Distribution, Market Failures: An Alternative Approach (NBER Working Paper No. 28472, 2021).
[72] The 2015 Paris Agreement was adopted at the 21st Conference of the Parties to the United Nations' Framework Convention on Climate Change. That agreement's basic goal is to "Hold[] the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;" Paris Agreement to the United Nations Framework Convention on Climate Change art. 2, Dec. 12, 2015, T.I.A.S. No. 16-1104. President Trump withdrew the United States from the Paris Agreement, effective November 2021. President Biden rejoined the agreement in January 2022.
[73] *Id.* at 2.
[74] *Id.*
[75] *Id.* at 59.
[76] *Id.* at 2–3.
[77] *Cf.* William Nordhaus, *Estimates of the Social Cost of Carbon: Concepts and Results from the DICE-2013R Model and Alternative Approaches*, 1 J. ASS'N ENV'T & RESOURCE ECONOMISTS 273 (2014) (calibrating IAM damage function to make 2° of warming optimal).

year increments.[78] In 2009, Britain switched from the SCC to a MAC-based approach to valuing emissions.[79] The resulting analysis yielded three sets of overarching values that, stitched together, serve as a shadow price for emissions from 2008 to 2050: a short term set of prices for 2008–2020, a long term set for 2030–2050, and a transitionary set to bridge the decade between. The short-term price is a hybrid of two prices, one for economic sectors subject to the European Union's Emissions Trading Scheme[80] and the other for "non-traded" sectors in which no market price was assigned to emissions.[81] The analysis underlying the long-term price assumes that, by 2030, there will be a binding global emissions reduction target and all significant emissions sources will operate subject to some form of cap or price.[82]

Policymakers use these prices to help assess options in various regulatory contexts.[83] Instructions for doing so are prescribed by the UK Treasury's Green Book and the supplement, *Valuation of Energy Use and Greenhouse Gas*.[84] Those instructions include a directive to assess cost-effectiveness by calculating "the average cost of saving each tonne of carbon dioxide (equivalent)."[85] This information can be used by policymakers to sort lower from higher-cost options, or to select all non-duplicative options under a cost-effectiveness threshold.

In contrast to the SCC, which reflects an emissions value based on global climate damages and abatement costs, any MAC-based threshold and related MAC curve are necessarily specific to a given jurisdiction, and possibly also specific to a sector within that jurisdiction. This has several implications, including that the MAC-based threshold derived from an analysis of one jurisdiction is likely to differ from that of another jurisdiction, in effect meaning that those jurisdictions assign different values to emissions. Because the same holds for economic sectors within a given jurisdiction, policymakers who rely on MAC-based thresholds for policy decisions can potentially assign different values to emissions just because they were emitted from a vehicle instead of a power

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[78] The 2008 Act directs the Climate Change Committee to recommend a five-year budget to Parliament, which can then codify that recommendation or seek revisions. In 2019, Parliament updated the original target of 80% reduction from 1990 levels to 100%. Climate Change Act 2008 (2050 Target Amendment) Order 2019/1056. Those budgets comprise sectoral targets, including for surface transportation, buildings, and electricity. *See, e.g.*, Climate Change Committee, Sixth Carbon Budget (2020) (discussing policies for each of 11 sectors).

[79] UK DEP'T OF ENERGY & CLIMATE CHANGE, CARBON VALUATION IN UK POLICY APPRAISAL: A REVISED APPROACH 2 (2009). This decision aimed to inform and support implementation of policies adopted pursuant to the emissions reduction targets established by the 2008 Act. *Id.* at 24–26.

[80] Following Brexit, in May 2021, the UK Emissions Trading Scheme replaced that of the EU for British covered entities. That change was largely formal; the schemes' parameters and prices are substantially similar. Dep't for Bus., Energy & Indust. Strategy, *Guidance: Participating in the UK ETS* (Aug. 2, 2021), https://www.gov.uk/government/publications/participating-in-the-uk-ets/participating-in-the-uk-ets.

[81] CARBON VALUATION IN UK POLICY APPRAISAL, *supra* note 79, at 28 ("This framework means that both the traded and non-traded sectors would be brought into line, in terms of the basis of assessment – both would be based on the necessary abatement costs required to meet targets.")

[82] The Department of Environment and Climate Change explained this shift from domestic to global scope as follows: "In the longer term, it is not appropriate to look at a UK-specific perspective alone. Climate change is a global problem that will require a global response. The long-term vision is of a world operating under a binding emissions cap, with that cap set with the objective of reaching a globally-agreed stabilization scenario." *Id.* at 32.

[83] HM TREASURY, VALUATION OF ENERGY USE AND GREENHOUSE GAS: SUPPLEMENTARY GUIDANCE TO THE HM TREASURY GREEN BOOK ON APPRAISAL AND EVALUATION IN CENTRAL GOVERNMENT 6 (2019) (indicating that steps for quantification and valuing of energy and greenhouse gas emissions should be applied at the policy, program, and project levels).

[84] HM TREASURY, THE GREEN BOOK (2019); HM TREASURY, GREENHOUSE GAS: SUPPLEMENTARY, *supra* note 83, at 16 Box 3.7 (presenting example of calculation of monetized emissions benefits in both traded and non-traded sectors resulting from energy efficiency program).

[85] HM TREASURY, GREENHOUSE GAS: SUPPLEMENTARY, *supra* note 83, at 25 para. 5.4, Box 5.1.

plant or cement production facility. Economists generally prefer pricing that is not confined to one jurisdiction or sector, but spans as much of the global economy as possible—economic principle holds that a global emissions price would be ideal. But generic greenhouse gas emissions pricing appears to be politically impossible at present, not just globally but within the U.S. and each of its states and territories. And so, the relative cost-effectiveness of abatement opportunities in U.S. jurisdictions generally does not determine their uptake.

C. Recapitulating an Old Debate

Debate over whether to look to the SCC or a MAC-based threshold for a superior estimate of the value of carbon is, fundamentally, a debate over whether to apply cost-benefit or cost-effectiveness analysis to the task of carbon valuation. This debate over how to value carbon also bears notable resemblance to the prices versus quantities debate described in Part I. In this subpart we describe these parallels before identifying several ways for the two carbon valuation tools to serve complementary rather than competing functions.

Cost-benefit analysis aims to maximize net social benefits by identifying where marginal costs come to equal marginal benefits, and the SCC allows one to identify where the marginal benefit of avoiding climate damage equals the marginal cost doing so. Assigning the price where those marginal values equal one another to each unit of greenhouse gas emissions could, in theory, steer society toward a stable climate. As for cost-effectiveness analysis, it ignores benefits and takes an objective as given rather than revealing which objective to pursue. A MAC-based threshold, similarly, ignores the benefits of avoiding climate damages and relies on an extrinsically specified emissions reduction target.[86]

Since the SCC and a MAC-based threshold are specific applications of cost-benefit and cost-effectiveness analysis to the climate context, the three lessons discussed above are applicable: First, the law often determines which emissions valuation tool regulators must use; second, a threshold derived from analysis of a MAC cannot detect over- or under-regulation in the way that the SCC can; and third, the SCC and MAC-based threshold can be complementary.

Like the prices versus quantities debate, a key point of focus in the debate over carbon valuation instruments is relative uncertainties. In the older debate, Weitzman distilled the question down to the relative elasticities of marginal damages and abatement costs under increasing regulatory stringency. In the climate context, key uncertainties include climate sensitivity to emissions (including tipping points)[87] and the potential for catastrophic damages on the one hand, and how quickly and well economies can adapt and develop new technologies on the other.[88]

A fully-fledged cost-benefit analysis of climate policies require the collation and analysis of information about global climate and economic damages on the one hand, and global emissions-avoiding policies and technologies—a MAC curve or something like it—on the other. Proponents of MAC-based threshold for emissions valuation often highlight the uncertainties and gaps in the

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[86] The process of setting a target presumably involved some assessment of benefits.

[87] Simon Dietz et al., *Economic Impacts of Tipping Points in the Climate System*, 118 PROC. NAT'L ACAD. SCIS. E2103081118, at *1 (2021); Carleton & Greenstone, *supra* note **Error! Bookmark not defined.**, at 37.

[88] For a fairly comprehensive description of the uncertainties embodied in each carbon valuation tool, see Lina Isacs et al., *Choosing a Monetary Value of Greenhouse Gases in Assessment Tools: A Comprehensive Review*, 127 J. CLEANER PRODUCTION 37 (2016). Memorably, Isacs et al. observe that: "the uncertainties around [the social cost of carbon] estimations are immense," but "[l]ike for [the social cost of carbon], many of the factors determining a MAC value are highly uncertain." *Id.* at 41–42.

damages-portion of this analysis,[89] and argue for dispensing with it.[90] Rather than attempt to derive a damages curve, they say, better to determine an emissions reduction target in some other way and deal just with the analysis needed to specify a MAC curve.

But MAC curves do not avoid uncertainties and are also not strictly necessary to value emissions using the SCC. MAC curves seek to estimate rates and costs of developing and deploying new technologies, patterns of technological change and adoption are notoriously hard to model accurately.[91] As for their necessity: the IWG SCC, for one, does not use a MAC curve to estimate costs.[92] Instead, it relies on a policy baseline and assumes that no policy or technology it is used to evaluate will shift the cost curve one way or the other.[93] SCC and MAC-based analysis are often presented as substitutes, but, like cost-benefit and cost-effectiveness analysis, they can sometimes be used in complementary ways. And, much as the prices versus quantities debate found at least partial resolution in the development of hybrid instruments, the debate over emissions valuation tools can find partial resolution through complementary applications of these emissions-valuation tools.

As discussed in Part I, under an economically efficient policy regime, the SCC and global MAC-based threshold will be the same. If these two estimates are not equal, then either the estimates are inaccurate in some way, or the policy regime is not efficient. For this reason, comparing the SCC to a MAC-based threshold can "stress test" both the figures themselves, and the policy regime under analysis. If the numbers do not align, analysts might pursue several potential avenues.

If the MAC-based threshold is higher than the SCC, possible explanations include the following:

> *The SCC is too low*. Concerns about whether the current SCC is inaccurately low may have motivated the approaches forwarded in Kaufman et al. and Stern and Stiglitz.[94] These concerns should be addressed in the process underway in the Biden Administration to update the SCC based on the latest research findings and recommendations of, among others, the National Academies of Sciences.[95] More generally, if confidence in a particular emissions reduction target and the MAC-based threshold oriented to that target is higher than confidence in the SCC, a discrepancy would indicate that the SCC underestimates the true damages associated with climate change.

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[89] John C. V. Pezzey, *Why the Social Cost of Carbon Will Always Be Disputed*, 10 WIRES CLIMATE CHANGE e558, *4 (2019) ("Many writers, including leading IAM authors, have noted the many types of damage, like biodiversity loss and ocean acidification, and the danger of triggering irreversible 'tipping elements' in the climate system that are omitted from or understated in such IAMs' damage functions.") (internal citations omitted); Peter H. Howard, *The Social Cost of Carbon: Capturing the Costs of Future Climate Impacts in US Policy*, *in* MANAGING GLOBAL WARMING: AN INTERFACE OF TECHNOLOGY AND HUMAN ISSUES, 659, 672–76 (Trevor M. Letcher, ed. 2019) (discussing included and excluded damages and the challenges of incorporating some types of damage); *see also* R. Daniel Bressler, *The Mortality Cost of Carbon*, 12 NATURE COMMUNICATIONS 4467 (2021) ("One source of climate damages not updated to the latest scientific understanding in IAMs is the effect of climate change on human mortality.").

[90] Richard A. Rosen & Edeltraud Guenther, *The Economics of Mitigating Climate Change: What Can We Know?*, 91 TECH. FORECASTING & SOCIAL CHANGE 93, 94 (2015) (". . . one of the previous damage functions incorporated into IAMs seem to have much basis in fact.").

[91] Isacs et al., *supra* note 88, at 42; *see also* Fabian Kesicki & Paul Ekins, *Marginal Abatement Cost Curves: A Call for Caution*, 12 CLIMATE POL'Y 219e236 (2011).

[92] 2021 TSD, *supra* note 56.

[93] *Id.*

[94] Kaufman et al., *supra* note 66; Stern & Stiglitz, *supra* note 71.

[95] Exec. Order 13990, 86 Fed. Reg. at 7041 (calling for update with reference to recommendations in the National Academies 2017 report on the SCC).

The target that orients the MAC is too ambitious. Emissions reduction targets are generally the result of a political process that distills a deadline from a mix of scientific, economic, and political information. A variety of situations might lead a given jurisdiction to adopt an overly ambitious target. For example, climate impacts there may be especially salient, leading to strong political outcry, or there may be powerful interest groups in the jurisdiction that will benefit from decarbonization policies.[96]

The MAC-based estimate is too high. Even if the target that orients the MAC analysis aligns with the SCC's emissions reduction pathway, the MAC-based *estimate* of emissions' value might still be off. This could owe to analytical error, due to the failure to predict technological changes that will lower abatement costs. Or, a jurisdiction may not actually adopt the lowest cost tools to reduce emissions, leading to a MAC that is inefficiently high.

The target has been selected to achieve distributional goals. Climate damages will not be borne equitably, either within or across countries. Generally speaking, poorer populations will almost certainly suffer more. At the same time, relatively well-off groups have contributed a larger share the to the current stock of greenhouse gases in the atmosphere. Recognizing this, a comparatively wealthy and high-emitting country might pursue a form of climate justice by selecting an earlier emissions abatement target than would be consistent with the SCC. Using the terminology of the Paris Agreement, this would be a way for that country to carry out its share of signatories' "common but differentiated responsibilities" consistent with its capacity and perhaps also its historical contribution to climate change. Such a decision would effectuate a wealth transfer to poorer populations and would do so without the transaction costs and potential for corruption that can encumber more direct efforts at international wealth redistribution.

If the MAC-based estimate is lower than the SCC, possible explanations include the following:

The SCC is too high. There are many critics of the SCC, but few of those who doubt the accuracy of its estimate of emissions' value have made persuasive arguments that the value is too high.[97] In fact, there is fairly wide agreement, including by the IWG itself,[98] that the IWG's current estimates are almost certainly significant underestimates. Nonetheless, one or more technical mistakes could, in principle, result in an overestimate of the value estimated by the SCC. A reexamination might review one or more of the tool's four modules (emissions and economic growth trajectories, climate sensitivity, damages, and discounting) or consider its treatment of uncertainty or equity.[99]

The emissions reduction target orienting the MAC is deliberately set to lag what would be consistent with the SCC. As noted above, emissions reduction targets are generally the result of a political process conducted within a particular jurisdiction. Numerous reasons might therefore be behind an emissions reduction target set below what corresponds to an SCC-consistent pathway. A jurisdiction may simply lack the political will to make the necessary investments

[96] Jurisdictions may bring other normative frameworks to bear other than economic efficiency. For example, a jurisdiction might decide to entirely decarbonize based on a view that any contribution whatsoever to global climate change is morally impermissible.
[97] Revesz & Sarinsky, *supra* note 5.
[98] 2021 TSD, *supra* note 56, at 4 ("the range of four interim SC-GHG estimates presented in this TSD likely underestimate societal damages from GHG emissions.").
[99] The National Academies 2017 report, *Valuing Climate Damages*, discusses each of these elements and their interactions. NATIONAL ACADEMIES, *supra* note 52. *See also* Carleton & Greenstone, *supra* note **Error! Bookmark not defined.**, at 8 (listing four modules and three "cross-cutting modeling decisions").

to achieve an efficient level of emissions reductions. This may be due to free rider problems, a relatively low level of exposure to climate risks, or a relatively high carbon-reduction burden. The obverse of the "climate justice" decision taken by a wealthy country, described above, may also be relevant. That is, a country that has historically had very low rates of emissions per capita might adopt a relatively late emissions reduction target and explain that decision in terms of the climate justice it believes it is due.

The MAC-based estimate is too low. Assuming the target that orients the MAC-based estimate is consistent with the SCC emissions pathway, then a low emissions valuation might owe to an analytical error that underestimates the cost of achieving the requisite emissions reductions—perhaps due to overly optimistic assumptions concerning technological development.

III. Climate Policy in Legal Context

In practice, the law often determines which carbon valuation tool is most appropriate to inform or justify regulators' decisions about climate policy design and implementation. This part first describes two basic ways in which the law might do this. It then describes more concretely how government agencies at the federal and state levels in the United States currently apply the SCC. Finally, building on those descriptions, it presents several stylized examples to illustrate different limits to the SCC's utility and so caution against some forms of misapplication.

A. The overarching legal context

Two ways in which the law might steer regulators to use either the SCC or a MAC-based value for greenhouse gas emissions are, first, through adoption of an economy-wide emissions reduction target; or, second, through requirements that apply generically to regulatory decisions, including those that carry out climate policies.

1. Jurisdictions that have adopted emissions reduction targets

In principle, a jurisdiction that adopts a legally binding emissions target to steer climate policy has only limited use for either climate-oriented cost-benefit analysis or the SCC.[100] The basic analytical question for a regulator charged with developing programs to hit that target, or for courts reviewing that regulator's decisions, is not whether those decisions' societal benefits justify their costs, but whether those decisions are less costly than alternatives. A challenge to an agency's proffered justification for imposing meaningful costs on stakeholders might fault the agency for failing to adequately explain its rejection of one or another less costly alternative. But it generally could not be faulted for choosing an approach that is net costly (as opposed to net beneficial) to society, so long as that approach is more cost-effective than alternatives.

That said, a legally binding target could be paired with a broader regulatory mandate, such that the target amounts to a *floor*, with a regulator free to depart in the direction of greater stringency when it is justified in doing so. Colorado anticipated this sort of possibility by pairing its emissions reduction target with a directive to agencies to be more ambitious if doing so would be "in the public

[100] Joseph E. Aldy, Giles Atkinson & Matthew J. Kotchen, *Environmental Benefit-Cost Analysis: A Comparative Analysis Between the United States and the United Kingdom*, 13 ANN. REV. RESOURCE ECON. _ (2021) (describing the United Kingdom's use of emissions reduction targets as resulting in "a role for economic analysis that is more about implementation than about setting the overall direction.").

interest."[101] Under this legal regime, regulators would use the higher of a MAC-based threshold (which ensures consistency with the target) and the SCC (which checks in additional emissions reductions would be cost-benefit justified).

2. Generic rules of regulatory decision-making

The administrative requirements that govern regulatory decisions often include prescribed forms of regulatory impact assessment. Use of either the SCC or a MAC-based threshold depends at least in part on compatibility with what administrative law requires of agencies. As discussed above, in the United States, longstanding executive orders generally require the use of cost-benefit analysis. In the United Kingdom, by contrast, some decisions are to be justified using cost-benefit analysis, others—such as decisions related to greenhouse gas emissions—with cost-effectiveness analysis.[102] Other jurisdictions, including most states in the United States, require fully articulated and supported reasons for a decision but do not necessarily always prescribe a particular mode of regulatory analysis.[103]

In the United States, Executive Orders 12866 and 13563 direct federal agencies to use cost-benefit analysis when justifying adoption of significant rules.[104] The Office of Management and Budget has elaborated on and clarified that directive with Circular A-4.[105] This directive to justify decisions in terms of net social benefits is not, on its own, legally enforceable, but it interacts with the Administrative Procedure Act. Under that Act, agencies have discretion over how to regulate within the confines of whatever statute empowers them to do so but they must provide a reasoned explanation of their policy decisions.[106] While courts reviewing an agency decision do not prescribe a particular rationale for arriving at and defending it, they do examine the quality and rationality of the agency's proffered justification.[107] So, when an agency justifies its decision using cost-benefit analysis, a reviewing court will insist that the analysis be complete and evenhanded.[108] Agency decisions whose effects include increases or reductions in greenhouse gas emissions are therefore

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[101] Colo. Rev. Stat. §§ 40-2-125.5(3)(a)(II) (directing utilities to generate electricity using only clean resources by 2050 "or sooner if practicable" if it is economically feasible and in the public interest to do so), (4)(d) (identifying factors indicative of what is in the public interest).
[102] Aldy, Atkinson & Kotchen, *supra* note 100, at _.
[103] JASON A. SCHWARTZ, INST. FOR POL'Y INTEGRITY, 52 EXPERIMENTS WITH REGULATORY REVIEW: THE POLITICAL AND ECONOMIC INPUTS INTO STATE RULEMAKING (2010).
[104] 58 Fed. Reg. 51735 (1993); 76 Fed. Reg. 3821 (2011).
[105] Circular A-4, *supra* note 11.
[106] 5 U.S.C. 553(e); Scenic Hudson Pres. Conf. v. Fed. Power Comm'n, 453 F.2d 463, 468 (2d Cir. 1971) ("Where the Commission has considered all relevant factors, and where the challenged findings, based on such full consideration, are supported by substantial evidence, we will not allow our personal views as to the desirability of the result reached by the Commission to influence us in our decision."), *cert. denied*, 407 U.S. 926 (1972).
[107] Dep't of Homeland Sec. v. Regents of the Univ. of Cal., 140 S. Ct. 1891, 1907 (2020) ("It is a 'foundational principle of administrative law' that judicial review of agency action" is based on "the grounds that the agency invoked when it took the action." (quoting Michigan v. EPA, 576 U.S. 743, 758 (2015)); *see also* SEC v. Chenery Corp., 318 U.S. 80, 88 (1943); *see also* Carolyn Cecot & W. Kip Viscusi, *Judicial Review of Agency Benefit-Cost Analysis*, 22 GEO. MASON L. REV. 575 (2015).
[108] *See,* e.g., Mozilla Corp. v. Fed. Commc'ns Comm'n, 940 F.3d 1, 71 (D.C. Cir. 2019) (discussing consistency of agency's approach with instruction in Circular A-4); Cooling Water Intake Structure Coal. v. EPA, 905 F.3d 49, 67 (2d Cir. 2018) ("[A]gencies are ordinarily required to consider the relative costs and benefits of a regulation as part of reasoned decisionmaking"); Nat'l Ass'n of Home Builders v. EPA, 682 F.3d 1032, 1036, 1040 (D.C. Cir. 2012) ("When an agency decides to rely on a cost-benefit analysis as part of its rulemaking, a serious flaw undermining that analysis can render the rule unreasonable."); City of Portland v. EPA, 507 F.3d 706, 713 (D.C. Cir. 2007) ("[W]e will [not] tolerate rules based on arbitrary and capricious cost-benefit analyses").

harder to justify if those emissions are ignored or are not valued in a way that enables—as the SCC does—comparison to other effects.

B. *Current applications of the SCC by federal and state agencies*

Government agencies at the federal and state levels use the SCC when assessing decisions that will reduce or increase emissions of carbon dioxide and other greenhouse gases.[109] Federal applications tend to be more uniform than state-level applications.

Federal agencies generally apply the SCC in three instances: cost-benefit analysis; review of environmental impacts pursuant to the National Environmental Policy Act (NEPA); and, in procurement and grantmaking decisions.

The first of these is the use of the SCC in regulatory cost-benefit analysis. The Interagency Working Group's SCC was developed specifically for use in cost-benefit analysis, and is applicable to analyses conducted pursuant to executive order or to statutes that direct an agency to specify a given regulatory standard. The latter sort of application was examined in *Zero Zone*, in which the Seventh Circuit rejected an industry challenge to the Department of Energy's updated energy efficiency standard for commercial refrigerators, adopted pursuant to the Energy Conservation Policy Act.[110] That act calls for such standards to achieve maximal energy efficiency within the bounds of what the agency determines to be "technologically feasible and economically justified."[111] The agency used the SCC to estimate the standard's benefits in order to inform its interpretation of "economically justified,"[112] a decision that the court upheld as reasonable.

The second type of application, environmental review of agency decisions, has been more contentious and less frequent to date.[113] Operationally, this application looks just like the monetization of benefits (or costs) that informs a cost-benefit analysis, but instead of the resulting monetary value always being netted against others, it often merely features in the list of impacts attributable to a given decision or project.[114] Notably, some agencies' applications of the SCC to environmental review more closely resemble cost-benefit analysis—the US Postal Service, for

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[109] With limited exceptions, localities generally do not employ formal carbon valuation metrics. *E.g.*, KING COUNTY OPERATIONAL COST OF CARBON 5–7 (2018), https://your.kingcounty.gov/dnrp/climate/documents/2018-KC-Operational-Cost-Carbon-Report.pdf (recommending use of the social cost of carbon for an electric bus fleet feasibility study and in capital project planning). The *Technical Manual* for compliance with New York City's environmental quality review requirements, for instance, explains how city agencies should quantify emissions and assess qualitative alignment of a project with the city's greenhouse gas emissions reduction goals. NEW YORK CITY, CEQR TECHNICAL MANUAL, ch. 18: Greenhouse Gas Emissions and Climate Change (2020), https://www1.nyc.gov/assets/oec/technical-manual/18_Greenhouse_Gas_Emissions_2020.pdf. It does not direct city agencies to develop or employ a monetary valuation of those emissions. *Id.*

[110] Zero-Zone, Inc. v. Dep't of Energy, 832 F.3d 654 (7th Cir. 2016).

[111] 42 U.S.C. § 6295(o)(2)(A).

[112] Energy Conservation Standards for Commercial Refrigeration Equipment, 79 Fed. Reg. 17,726 (Mar. 28, 2014). For another example of a federal agency that employs cost-benefit analysis to carry out a statutory directive rather than executive order, see Bur. of Ocean Energy Mgmt., Economic Analysis Methodology for the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program 1-1 to 1-29 (2016); 43 U.S.C. § 1344(a)(1) (requiring Secretary to manage outer continental shelf "in a manner which considers economic, social, and environmental values of the renewable and non-renewable resources contained in the outer Continental Shelf….").

[113] *See* Palenik, *supra* note 61, at 405–10 (tracing line of recent cases).

[114] *See, e.g.*, Vecinos para el Bienestar de la Comunidad Costera v. FERC, 6 F.4th 1321 (D.C. Cir. 2021); High Country Conservation Advocates v. U.S. Forest Serv., 52 F. Supp. 3d 1174, 1181 (D. Colo. 2014).

instance, recently used the SCC to inform its comparison of program options in a draft environmental impact assessment.[115]

The third type of application involves including the SCC among other factors that inform decisions about what to procure or to whom funding should be granted.[116] Governments can apply the SCC to the procurement of a wide range of assets, including vehicle fleets, energy, and even the cement and steel used in infrastructure and buildings. Although the analyses of each of these differ in their particulars, in all cases they involve estimating the lifecycle emissions profiles of different procurement options and using the SCC to translate avoided emissions into a value comparable to other types of cost savings. Grant awards, similarly, can require applicants to include analyses of emissions impacts (or avoidance) of their proposals so that the awarding agency can weigh that aspect of the program or project against others in comparable terms.

State agencies have, to date, mainly used the SCC to inform decisions about planning and compensation in the power sector.[117] One such application involves the development and review of integrated resource plans, which spell out how an electric utility will develop and operate its assets.[118] In states that require utilities to consider greenhouse gas emissions impacts when choosing among alternative resource plans, utilities are often directed to apply the SCC to help weigh the costs and benefits of their proposals.[119] Notably, this application is less uniform than cost-benefit analysis by federal agencies and the variations across states are meaningful.[120] Other notable power sector applications of the SCC relate to compensation paid to non-emitting generation resources. Programs in Illinois, New Jersey, and New York require retail utilities to pay nuclear facilities for Zero

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[115] United States Postal Service, Draft Environmental Impact Statement: Next Generation Delivery Vehicle Acquisitions 4-19 to 4-28 (2021); *see also* BOEM, Cook Inlet Planning Area Oil and Gas Lease Sale 244 In the Cook Inlet, Alaska Final Environmental Impact Statement 4-190 to 4-191 (2016) (estimating the social cost of emissions resulting from proposed offshore oil and gas lease sales).
[116] *E.g.*, GSA, GSA Includes New Environmental Features in Next-Generation Parcel Delivery (undated), https://www.gsa.gov/cdnstatic/DDS3_green_features_fact_sheet.doc (describing application of SCC to procurements); U.S. DEPARTMENT OF TRANSPORTATION, BENEFIT-COST ANALYSIS GUIDANCE FOR DISCRETIONARY GRANT PROGRAMS 34–35 tbl.A-6; 40–41 (2021).
[117] For a compilation of states' uses of the social cost of carbon, see https://costofcarbon.org/states.
[118] DENISE A. GRAB, ILIANA PAUL & KATE FRITZ, INST. FOR POL'Y INTEGRITY, OPPORTUNITIES FOR VALUING CLIMATE IMPACTS IN U.S. STATE ELECTRICITY POLICY 13 (2019); *see also, e.g.*, Christina Van Winkle, Regulatory Framework for Greenhouse Gas Emissions Reductions, Legis. Council Staff (Oct. 16, 2019), https://leg.colorado.gov/sites/default/files/r19-775_regulatory_framework_for_greenhouse_gas_emissions.pdf.
[119] *See, e.g.*, Grab, Paul & Fritz, *supra* note 118, at 17–18 (Colorado) & 20 (Minnesota).
[120] *Compare* Elizabeth Hossner & Keith Faretra, Puget Sound Energy, 2021 IRP Webinar #5: Social Cost of Carbon, Planning Assumptions & Resource Alternatives Electric Portfolio Model (July 21, 2020) (describing use of SCC of $75 for 2022 rising to $99 by 2040 in resource planning in compliance with prescriptions of Washington State's Clean Energy Transformation Act), *with* Georgia Power, 2019 Integrated Resource Plan, Ga. PSC Docket No. 42310, at 4-23 to 4-24, 10-69 to 10-70 (July 21, 2019) (describing inclusion of $10 and $20 carbon pricing scenarios in resource planning "to estimate the impact of different carbon prices" in anticipation of potential "carbon legislation or regulation" and not pursuant to state law, regulation, or guidance).

Emissions Credits, the value of which derives in part from the SCC.[121] And in New York, the Public Service Commission uses the SCC to inform compensation paid to distributed energy resources.[122]

C. Potential applications of carbon valuation metrics

This final section draws on several scenarios to illustrate the role of SCC and/or a MAC-based emissions values in climate policy making. Those scenarios involve several dimensions, including the presence (or absence) of a binding emissions target, implementation by a federal or state agency, and application to various sectors. These illustrative scenarios serve to confirm two features of climate policy: first, the interaction of binding emissions targets with the analytic enterprise; and second, the potentially complementary role of a MAC-based threshold and the SCC, depending on the legal context.

With respect to the adoption of emissions reduction targets, there are at least four types of jurisdictions:

a) No binding, economy-wide emissions reduction target;
b) A clear and binding target;
c) A clear and binding target plus authorization to agencies to pursue more aggressive emissions reduction policies where warranted; and
d) A hazy or potentially binding target.

In the first two types of jurisdiction, the SCC and a MAC-based threshold are, respectively, the appropriate choices for agencies to employ for the purposes of valuing greenhouse emissions in most if not all applications. In jurisdiction (a) the lack of a binding target means that no tool can provide a better answer than the SCC to the question, How worthwhile is it to abate a marginal unit of emissions? In jurisdiction (b) the answer to that question should derive from MAC-based threshold, which is, in turn, grounded in the jurisdiction's emissions reduction target. In jurisdiction (c), the question is best answered in two steps: the first involves application of a MAC-based threshold, and the second, application of the SCC to determine whether greater ambition is warranted. Finally, in jurisdiction (d), where the target is either unclear, not firmly binding, or both, then there could potentially be a role for both a MAC-based threshold and the SCC. Practically speaking, some jurisdictions may straddle at least two of these categories rather than sitting well within the confines of just one.

The examples of climate policy measures below further illuminate the role of the SCC or a MAC-based threshold in a given jurisdiction's approach to policy formulation and implementation.

Royalty surcharges for leases to extract fossil fuels from federal lands. Pursuant to statutory directive, the Department of the Interior collects royalties for all fossil fuels extracted from federal lands.[123] Interior's decisions about royalties rest on the Mineral Leasing Act of 1920 and the Federal Land Policy and Management Act., and it operates under the broad directives of Executive Order 12,866

[121] Elec. Power Supply Ass'n v. Star, 904 F.3d 518, 521 - 22 (7th Cir. 2018) (describing Illinois ZEC program), *cert. denied* 139 S.Ct. 1547 (2019); Coal. for Competitive Elec., Dynergy Inc. v. Zibelman, 906 F.3d 41, 45 (2d Cir. 2018) (describing New York ZEC program), *cert. denied sub nom*. Elec. Power Supply Ass'n v. Rhodes, 139 S. Ct. 1547 (2019); Matter of Implementation of L. 2018, C. 16 Regarding Establishment of Zero Emission Certificate Program for Eligible Nuclear Power Plants, 467 N.J. Super. 154, 160, 250 A.3d 1136, 1139 (App. Div. 2021) (describing New Jersey ZEC program), *cert. denied sub nom*. Matter of L. 2018, C. 16, No. 085640, 2021 WL 2931320 (N.J. July 9, 2021).
[122] N.Y. Pub. Serv. Comm'n, Order on Net Energy Metering Transition, Phase One of Value of Distributed Energy Resources, and Related Matters, Case 15-E-0571, at 15–16 (issued and effective Mar. 9, 2017).
[123] Federal law prescribes a minimum rate of 12.5% of revenues for multiple resources. 30 U.S.C. § 226(b)(1)(A) (onshore oil and gas); *id.* § 207(a) (surface coal); 43 U.S.C. § 1337 (a)(1) (offshore oil and gas).

and similar guidelines. Accordingly, Interior should account for the full range of externalities associated with the activities that it licenses.[124] In the context of climate change, Interior should ensure that royalties reflect the cost of climate damage imposed by the consumption of fossil fuels.[125] Because the federal government lacks a binding emissions target, the SCC (rather than some MAC-based threshold) should be used to internalized climate-related harms into the royalty structure.

Valuing emissions avoided by energy efficiency investments. Dozens of states require retail energy utilities to sponsor energy efficiency programs.[126] As of this writing, Congress is considering the Build Back Better Act, which includes provisions that would stich greenhouse gas emissions reduction into the priorities of state programs that receive federal funds for residential energy efficiency retrofits. To be eligible, state programs must include a plan that, among other things, "value[s] savings based on time, location, or greenhouse gas emissions."[127] Let us assume that this bill passes and prompts a reorientation of state residential energy efficiency programs toward emissions abatement, so that participating states value the emissions avoided through federally sponsored energy efficiency investments. In states that embody the jurisdiction types discussed above, different emissions values would be appropriate. (a) Arkansas law does not presently impose any greenhouse gas emissions reduction requirements, so the SCC would be an appropriate value to apply there.[128] (b) Washington State is bound, by 2050, to reduce greenhouse gas emissions 95% below 1990 levels and to achieve net-zero emissions economy-wide.[129] This means that a MAC-based threshold is appropriate for valuing the emissions impacts energy efficiency investments. (c) Colorado law, as noted above, prescribes a 90% emissions reduction from 2005 levels by 2050 and directs agencies to pursue more ambitious emissions reductions if doing so would serve the public interest. It follows that a MAC-based threshold would be appropriate, unless exceeding that threshold were shown to be in the public interest, for instance, because doing so would yield greater net benefits. Finally, (d) Maryland's Greenhouse Gas Emissions Reduction Act imposes an economy-wide emissions reduction target of 40% below 2006 levels by 2030,[130] leaving 60% of 2006 emissions levels not subject to a reduction requirement and so leaving the obligations of particular sectors unclear. Maryland should, therefore, value residential energy efficiency using the SCC.[131]

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124 *See* JAYNI FOLEY HEIN & CAROLINE CECOT, INST. FOR POL'Y INTEGRITY, COAL ROYALTIES 6–7 (2016) (explaining economic logic for incorporating externalities into royalty payments consistent with the policy logic underlying royalties generally); , JAYNI HEIN & PETER HOWARD, INST. FOR POL'Y INTEGRITY, ILLUMINATING THE HIDDEN COST OF COAL 1 (2015) ("Accounting for both methane and transportation externality costs would justify adding 70.1 percent to the current 12.5 percent surface-mine royalty rate . . . . This would justify a new royalty rate of 82.6 percent for federal surface-mined coal.").

125 MAX SARINSKY ET AL, INST. FOR POL'Y INTEGRITY, BROADENING THE USE OF THE SOCIAL COST OF GREENHOUSE GASES IN FEDERAL POLICY 23 (2021).

126 *See* Am. Council for an Energy-Efficient Economy, *State and Local Policy Database: Energy Efficiency Resource Standards*, https://database.aceee.org/state/energy-efficiency-resource-standards#:~:text=An%20energy%20efficiency%20resource%20standard,energy%20savings%20target%20for%20utilities.&text=The%20legislation%20established%20Alaska's%20state,state%20by%2015%25%20by%202020 (accessed Nov. 15, 2021).

127 Build Back Better Act, H.R. 5376 § 30421(a)(2)(C)(ii)(III).

128 This would involve inclusion of the SCC in applications of the Total Factor Cost Test that the Arkansas Public Service Commission directs utilities to use estimate the value of a program to society.

129 Rev. Code Wash. 70A.45.020 (2020).

130 Md. Env't Code § 2-1204.1.

131 *See, e.g.*, Order Adopting the First New Jersey Cost Test, N.J. Bd. Pub. Utils., Docket Nos. QO19010040 & QO20060389, at 6, 17 (Aug. 24, 2020).

Congestion charge. Several cities—London, Milan, Singapore, and Stockholm—have imposed congestion charges on motor vehicles.[132] Congestion charges serve as a sort of entrance fee for motor vehicles seeking to drive in a designated portion of the city. Congestion charges can be designed to apply differentially so that they reflect vehicle weight, emissions intensity, timing, or other factors.[133] New York law establishes 2050 as the binding deadline for economy-wide emissions to fall 85% below a 1990 baseline and to reach net-zero. The same law—the Climate Leadership and Community Protection Act[134]—requires individual agency decisions conform to an overarching statewide emissions reduction target,[135] but authorizes state agencies to employ the SCC or a MAC-based threshold for the purpose of valuing greenhouse gas emissions.[136] Depending on whether one interprets its emissions reduction target to be fully clear and binding, New York can be said to represent a version of jurisdiction (b) or (d) from the list above. If classified as (b), use of a MAC-based threshold would be more appropriate to calibrate the price level and evaluate the emissions impacts of the congestion charge; if (d), the version of the SCC adopted by New York State's Department of Environmental Conservation should serve this purpose.[137]

Government procurements. An agency procuring a vehicle fleet can compare vehicles' greenhouse gas emissions profiles as well as other factors like capital costs and expected maintenance costs. Completing this comparison would require monetizing the value of the emissions quantities associated with different bidders' proposals. Federal agencies, which operate in a version of jurisdiction (a), should apply the SCC when comparing bids and for other purposes as well, such as assessing the environmental impacts of the procurement.[138] In Washington State, which, with a 95% emissions reduction commitment, resembles jurisdiction (b), the procuring agency should assign a value consistent with a MAC-based threshold derived from the state's emissions reduction target. In Colorado, an example of jurisdiction (c), the agency should apply both, using the SCC as a sort of sensitivity analysis to indicate whether relying on the MAC-based value would forgo societal cost savings. In Maryland—an example of jurisdiction (d) with its commitment to reduce emissions 40% from 2005 levels by 2030—the procuring agency should apply the higher of the SCC or a MAC-based value.

Conclusion

This article has argued that the debate over whether to improve the SCC or cast it aside in favor of a MAC-based approach is part of a long-lived set of arguments over the formulation and application of environmental policy instruments. Framing recent criticisms of the SCC and rejoinders from its proponents in this way can help guide policymakers as they choose whether and how to use particular instruments to formulate and implement climate policy.

For instance, as with cost-benefit and cost-effectiveness analysis, as well as price- and quantity-oriented regulatory mechanisms, different policy contexts often favor use of one instrument or the other. Thus, adoption of a firm and fully specified emissions reduction target can make a MAC-based value more suitable than the SCC for formulating climate regulations. But where generic

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[132] *E.g.*, Transport for London, *Congestion Charge*, https://tfl.gov.uk/modes/driving/congestion-charge (accessed Nov. 15, 2021).

[133] For a discussion of the externalities potentially addressed by a congestion charge, see MATHEW BUTNER & BETHANY DAVIS NOLL, A PILEUP: SURFACE TRANSPORTATION MARKET FAILURES AND POLICY SOLUTIONS (2020).

[134] Climate Leadership and Community Protection Act, ch. 106, N.Y. Laws of 2019.

[135] *Id.* § 7(2).

[136] Climate Leadership and Community Protection Act § 2; N.Y. Env't Conserv. L. § 75-0113(2).

[137] NYSDEC Value of Carbon Guidance (2020).

[138] *See, e.g.*, USPS Draft EIS, *supra* note 115.

administrative legal requirements direct agencies to estimate the benefits of regulations in terms of harm caused or averted, agencies cannot rely on a MAC's target-based analysis to justify regulations—only the SCC will do. These are just two examples of how context, including both rules and policy objectives, can inform instrument choice.

Another insight suggested by approaching the SCC-versus-MAC question as part of a larger and longer-lived debate is that resolution of disagreements over instrument choice often does not involve a winner that takes all, but a synthesis—some form complementary pairing that makes use of both. With the SCC and MACs, as with the other instrument pairs, neither should be cast wholly aside as inherently and irretrievably flawed. This conclusion is not undermined by the potential for meaningful misalignment of the SCC and a MAC-based value. Indeed, that potential weighs in favor of using each to "stress test" the other in order to glean information about both the instruments themselves and the policies informed by their outputs.