Editorial

Quality Science for Quality Decisions: Protecting the Scientific Integrity of Benefit–Cost Analysis

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Introduction

Every US administration since President Ronald Reagan's has required benefit–cost analysis (BCA) of major federal regulations to inform the policy-making process and encourage an evidence-based approach to regulation. The ability of the US Environmental Protection Agency (EPA) to successfully apply economics to inform the agency's policy decisions is highly dependent on scholarship from the environmental economics research community. Researchers are the wholesale operation that "supplies" our EPA retail outlet. That is, environmental economics researchers provide EPA with the theory, methods, and empirical models we need to assess benefits, costs, and economic impacts. This partnership with the environmental economics research community has been extremely productive. Indeed, both the quality and quantity of BCA have increased dramatically over the past 30-plus years, and there is no doubt that research in our field has contributed greatly to US policy-making.

The influence of BCA has also grown dramatically over this time.[1] Decision makers need to know the consequences of their policy decisions, and BCA provides that information to them. The more prominent the role of BCA in the policy process, the greater the need for

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[1] There are several reasons why BCA's influence has increased (McGartland 2013). Most importantly, every president since Ronald Reagan has required BCA to support major rule making. Those BCAs and the corresponding policy are then reviewed by the Office of Information and Regulatory Affairs at the Office of Management and Budget before becoming policy. For example, during the Obama administration, the White

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EPA to conduct unbiased scientific analysis. However, BCA's prominent role in the policy-making process also creates an incentive to produce results that support one's preferred policy. Indeed, rather than informing decision-making, BCA can become a tool for justifying a decision that is made by manipulating results in ways that are contrary to good science. Ideally, it should be science, including economic science, that dictates how BCAs are done.

This article discusses the evolution of the role of BCA in the EPA policy process and examines two serious and worrisome challenges that threaten the scientific integrity of BCA—the embedding of "science policy" in risk assessments and BCA and the erosion of the theoretical underpinnings of BCA.[2] Unfortunately, these two challenges have allowed policy officials, risk assessors, and others to influence how BCA is conducted in ways that are inconsistent with economic science. As I will discuss, these challenges have generally been held in check by both the environmental economics community and the public. I conclude by identifying some specific actions to help protect the scientific integrity of BCA.

Before discussing these issues in detail, I want to note that I am writing about a problem that is nice to have. Indeed, if the BCA did not play such an important role in environmental decision-making—if it were largely ignored—then no one would bother trying to influence the results. It is precisely because of the crucial role that BCA plays in the regulatory process that it is so important to raise awareness of the threats to its scientific integrity.

A History of the Role of Economics and BCA at EPA

In the early days of EPA, there was broad national support for making dramatic progress on the environment. Congress passed the 1970 Clean Air Act and the 1972 Clean Water Act, which explicitly called for the setting of environmental quality standards without weighing benefits and costs (Cropper and Oates 1992). The few economists who worked at EPA were generally sidelined; they weren't really needed. With the ambitious Clean Air Act and Clean Water Act to implement, decision makers were focused on making progress rather than on slowing the process down to accommodate BCA (McGartland 2013). As Nobel laureate Thomas Schelling once observed:

> Policy judgments are easier to come by, the farther we are from our goals. If there are only two directions and we know which is forward, and there are limits to how fast we can go, no fine discrimination is needed. . . . We know what we need to know to get moving. We can worry about how much is enough when we get close, if we ever do. Meanwhile we can push on. (Schelling 1984, 1)

Thus, throughout the 1970s and much of the 1980s, EPA promulgated many regulations (e.g., new National Ambient Air Quality Standards and water quality criteria) that were informed by environmental sciences, but economics and BCA were notably absent from the policy process. The United States achieved tremendous environmental gains during this period (Olden 2018). Indeed, one could argue that the country made bigger gains in improving

House rejected a regulation to control ozone and supported a regulation to control mercury on the basis of the results of the BCAs (Harford 2018).

[2] I define and discuss science policy below.

environmental quality than in addressing any other social problem; crime, poverty, education, drugs—none of these have experienced the same dramatic improvement as the environment.

Establishing a Foothold for Environmental Economics

President Reagan's Executive Order 12291, requiring BCA for all major regulations, jump-started BCA at EPA. However, in the early 1980s, including economists in policy briefings was still the exception, not the rule. During the mid-1980s, however, there were several huge successes for BCA, including the BCA of phasing out lead in gasoline (US EPA 1985) and several analyses of pesticides, including Alar (McGartland 2013). Economists soon contributed to EPA's success in promulgating rules offering large net benefits by identifying strategies that promised large benefits for relatively small costs. BCA also identified policies whose costs greatly exceeded any environmental returns, which helped EPA recognize the importance of maximizing social returns for society's investments in a better environment. EPA responded to this new information by refining its regulatory priorities. For example, under the Clean Air Act, EPA regulated particulate matter and its precursors, resulting in extremely large reductions in mortality risk. Economists also contributed to policy-making by producing cutting-edge epidemiology, promoting better policy instruments (e.g., market incentives), and incorporating irreversibilities, uncertainty, existence value, climate change economics, and human health risk valuation into policy analyses.

The Unpublicized Successes of BCA

Ideally, the BCA should help shape the policy decision. However, when this happens, the role of BCA in the decision-making process occurs behind closed doors. During my many years at EPA, I have been involved in policy briefings where the results of the BCA did not support the regulatory action initially favored by EPA leadership. Indeed, sometimes the BCA has led to eliminating policy options that were terribly inefficient, but the public never hears about EPA leaving such inefficient options on the cutting room floor. Sometimes the BCA would illuminate how fine-tuning a regulation (e.g., changing the scope or the effective date) could increase net benefits dramatically, and the EPA decision maker would modify the preferred option accordingly. Other times, decision makers would select their original preferred option after discussion about other features of the option not addressed in the BCA. For example, the preferred option might be more enforceable, achieve greater distributional justice, or even fulfill a campaign promise. In any case, BCA clearly has a place at the policy table. Indeed, the briefings for decision makers during the option selection process almost always showcase the results of the BCA.[3]

Transparency and Accountability

As our experience with BCA grew, we realized that the BCA plays another important role—ensuring transparency and public accountability. A BCA conducted to support rule making

[3]Of course, when the law forbids consideration of costs or other elements of the BCA, EPA may not include the BCA results in its briefings for decision makers.

is always made publicly available and is accessible at http://www.regulations.gov. The public can submit comments on proposed regulations, including comments on the BCA, through the website. This means that regulated entities, environmental organizations, Congress, journalists, the academic research community, and the broader public all have access to EPA's regulatory analyses. This does not mean that decision makers need to pick the option that maximizes net benefits according to the BCA. Rather, along with statutory direction and other legal concerns, as well as distributional and environmental justice concerns, enforceability, and other factors, the BCA becomes part of the public record. Agencies generally provide a rationale for their selected option based on these factors.

This availability of the BCA enables a public accountability that was not possible in the early days of EPA. Indeed, without a publicly available BCA, an administration could justify its regulatory decisions on the basis of conjecture or simply choose to highlight one aspect of the rule's impacts and ignore other pertinent impacts. Ideally, the BCA presents all the costs and all the benefits of each policy option. Fortunately, the same transparency that allows the public to see the benefits and costs of each option also allows the research community to review BCAs that are used in the regulatory process.[4] With this background on the history of economics and BCA at EPA, I next discuss the emergence of two worrisome challenges that threaten the transparency and quality of BCA and the sound science that underlies it.

Challenge One: Embedding Opaque Science Policy in BCAs

Contrary to public perception, there is a great deal of science policy embedded in the assessments of human health risks from exposure to environmental contaminants that are typically used in BCA. By science policy, I mean a predetermined set of policies, particularly the use of a set of default assumptions and models to deal with uncertainty, that govern how EPA conducts risk assessment. For example, when evaluating laboratory animal test results, agencies make science policy calls about quantitative methods for treating the uncertainty inherent in extrapolating animal test results to humans. Or an agency may have a science policy that requires a certain amount of evidence before any risk or hazard is quantified. There is even science policy governing the functional form of the "dose-response curve," which indicates the likelihood of a hazard as a function of pollutant exposure. Changes in such science policies can have a big impact on how we quantify benefits. To estimate the health benefits associated with regulatory options that reduce environmental contaminants, economists generally rely on these dose-response relationships, which are developed by toxicologists and other risk assessors.

Science policy crept into these risk assessments in the early days of EPA (1970s), well before BCAs were routinely conducted. In particular, to overcome the statistical and model

[4] For example, the Sloan Foundation supported the formation of the External Environmental Economics Advisory Committee, "an independent organization dedicated to providing up-to-date, non-partisan advice on the state of economic science as it relates to the U.S. Environmental Protection Agency's programs" (http://www.e-eeac.org/). One of its main activities is to review prominent BCAs done in recent years. See http://www.e-eeac.org/ for more details. In addition, the Institute for Policy Integrity at New York University has reviewed BCAs for many years and has promoted greater use of transparent, sound science. See http://policyintegrity.org/.

uncertainty associated with estimating human health risks using data from laboratory animal testing, policy officials worked with risk assessment experts to develop a body of science policy that governed how EPA would conduct risk assessments. Under this science policy, risk assessors used default assumptions concerning the use of upper-bound estimates, animal-to-human extrapolations, and the presumption of a population threshold for noncancer health end points. At the time, many of these default assumptions were generally viewed as "conservative" (i.e., defaults that led to a higher level of risk).[5] Proponents of embedding such science policy in risk assessments argued that the approach represents a practical method for addressing uncertainties. However, even in these early years of EPA risk assessments, dissatisfaction with government regulatory actions and the risk assessment practices on which they were based led to calls to reexamine these embedded science policy practices. Decisions on saccharin, nitrites in food, formaldehyde use in home insulation, asbestos, and air pollutants were all called into question, in part because of these risk assessment methods (NRC 1983).

The Red Book and Risk Assessments

In response to stakeholder concerns about risk decisions and risk assessments that are embedded with science policy, Congress mandated a study to examine the relationship between science and public policy in the assessment of the risk of cancer and other adverse health effects. In 1981, the National Research Council (NRC) formed the Committee on the Institutional Means for Assessment of Risks to Public Health, and in 1983, the committee released *Risk Assessment in the Federal Government: Managing the Process*, commonly known as the Red Book (NRC 1983). One of the major recommendations of the Red Book was an explicit call to separate risk assessment and risk management. According to the Red Book, risk assessment is the use of the factual, scientific base to estimate the health effects of exposed populations, while risk management is the process of weighing policy alternatives by integrating the results of the risk assessment and engineering data with social, economic, and political concerns to reach a decision. The Red Book stressed that risk assessment should be free from policy-induced biases. If risk managers want to be precautionary (i.e., conservative) in their policy decision, they should do so during the risk management process, not the risk assessment process. Had it been put into practice, this conceptual distinction between risk assessment and risk management might have moved risk assessment science in a different direction—toward the development of science-based defaults to govern risk assessment—and those defaults would have remained within the purview of scientists (not policy officials).

However, science policies have remained an integral part of risk assessment, which has left science vulnerable to political interference. That is, if not driven by science, policy officials can make policy calls, including on science policy. Many of these science policies are codified in guidances, which makes them more difficult to manipulate. However, this is less true for risk assessment methods used in BCA. For example, a policy official could replace the default linear no-threshold cancer model with a default presumption of a threshold for cancer, which would mean that low levels of exposure pose no risk of cancer; only when exposures go above a

[5] However, research that compares human studies and animal studies has challenged this conclusion (Dourson et al. 2001; Shanks, Greek, and Greek 2009).

threshold would cancer risk be assigned to this chemical. The same could be done when applying a dose-response relationship found in the epidemiology literature. Under a threshold assumption, regulatory options that drive exposures below the threshold would not look as attractive because the threshold model assumes no benefits from exposure reductions that are below the threshold. Such an approach would be appropriate if it was the science that led us to a threshold model. However, it would be wrong to use the single default of a threshold model when the biological theory suggests that a no-threshold model is more appropriate.

These science policies were largely developed before BCA became a mainstay of EPA regulatory analyses. In fact, many of these policies were designed to answer a different question than the ones answered by BCA. For example, some hazard assessments derive a reference dose, or reference concentration, defined as "an estimate, with uncertainty spanning perhaps an order of magnitude, of a daily exposure to the human population, including sensitive subgroups, that is likely to be without appreciable deleterious effects during a lifetime" (Baynes 2012, 270). This concept suggests that there is a population threshold, below which there are no appreciable risks. Reference doses have been applied even when there is evidence that a no-threshold model would be more appropriate (e.g., methyl mercury), but they are of no use to economists seeking to quantify the marginal benefits of exposure reductions.[6]

The Silver Book and Risk Assessment Reforms

Some of our colleagues in the risk assessment community have recognized that their current methods do not meet the needs of BCA, and EPA asked the NRC for recommendations on how to advance risk assessment to meet these needs. In response, the NRC (2009) published *Science and Decisions: Advancing Risk Assessment*, currently known as the Silver Book, which called for new risk assessment reforms and methods that would better support BCA. Unfortunately, progress in implementing the recommendations of the Silver Book was initially very slow, but work is continuing.[7] The Silver Book calls for reexamining much of the science policy in risk assessment; it also recognizes that some default assumptions and methods will be needed but argues that these should be based on science and fully transparent.

Challenge Two: Disregarding the Theoretical Underpinnings of BCA

Who gets to decide how to measure benefits and costs? The original theoretical underpinnings of BCA rest on the Kaldor–Hicks criterion—that is, for any given policy option, could those who gain from an economic change compensate the losers and still be better off than before?[8] The use of this criterion to assess such a potential Pareto improvement is a positive

[6] For a more detailed review of the reference dose concept and why a continuous dose-response relationship is a model more consistent with the science, see chap. 5 of NRC (2009).

[7] The title Silver Book not only reflects the color of the report's cover but also signals that this new report modifies and extends the original Red Book.

[8] The Pareto criterion maintains that if an economic change harms no one and makes at least one person better off, there is an increase in social welfare (Revesz and Stavins 2004). The Kaldor–Hicks criterion captures the intuition of the Pareto criterion but allows for some to be made worse off by the economic change

scientific exercise that requires relying on a consumer sovereignty principle in assessing benefits and costs. That is, economists must measure what economic actors are willing to pay for the change. To make this point, I often describe BCA as a simulation of a market test, much like Adam Smith's invisible hand. If we could sell clean air or clean water (without the free rider problems), could we produce it and sell it at a profit? The private market's ability to allocate resources efficiently does not work for pollution (and other market failures), and thus the BCA helps provide this information. But just as in the free market, economists should not base the value of any benefit or cost on the views of any government official. Rather, we need to know consumers' willingness to pay for the benefit (or their cost avoidance). Moreover, to assess whether there is a potential Pareto improvement, all the benefits and all the costs should be included. However, BCAs are often performed in a manner that is inconsistent with these theoretical underpinnings (i.e., the Kaldor–Hicks criterion), and this changes the BCA into a normative, subjective appraisal of regulatory options that can be influenced by the views of the analysts, other scientists, and decision makers.[9]

The Slippery Slope of Normative BCAs

If we could go back in time and ask policy officials whether BCA is a positive scientific assessment appropriately left to economists and scientists to conduct or an assessment at least partially determined by policy priorities and views (and therefore a normative exercise), I believe that a majority would indicate the latter. I suspect that we would get the same answer if we were to ask this question at the Society for Benefit-Cost Analysis annual meetings (gatherings of both practitioners and academics who focus on BCA). In short, the policy community often does not appreciate that BCA has a theoretical underpinning that governs how assessments should be conducted so that they are consistent with economic science. Rather, some see the BCA as an analysis of how well the policy maximizes what the policy officials view as relevant benefits and costs. The problem is that if decision makers view BCA this way, they will likely feel free to design individual BCAs that reflect their policy choices. If this happens, the BCA becomes an analysis that no longer objectively answers the Kaldor–Hicks question; rather, it becomes an analysis that emphasizes what policy officials want the public to see.[10]

Clearly, decision makers can and do weigh benefits in ways that differ from the approach used in BCA. Very few, if any, of us would argue that the BCA alone should determine the decision for the policy maker. Nevertheless, as emphasized above, the BCA should not be a

(Revesz and Stavins 2004). For there to be an increase in social welfare, Kaldor–Hicks requires a "potential" Pareto improvement, which occurs when those who gain from the economic change would be willing to compensate the losers and still be better off. The rules of BCA, including the use of the consumer sovereignty principle, follow from this criterion. This means that BCA must value benefits and costs based on consumers' values, not what a policy maker in Washington thinks the benefits and costs are worth.

[9] For example, the BCA may be changed if a policy official deems some benefits or costs to be more important than others or decides not to quantify some benefits or costs altogether.

[10] Imagine that there are two regulatory options, A and B. The policy official wants the least expensive option, A, and this option has quantified benefits that are roughly equal to costs. Option B requires the adoption of an additional pollution control technology that would also deliver extremely large "cobenefits." If cobenefits are omitted from the analysis, the BCA would conclude that option A has the largest net benefits. However, if cobenefits are included (as they should be), the conclusion would change to option B.

quantitative analysis of how the decision maker weighs benefits and costs; it should be an analysis of how society values these benefits and costs in the context of the Kaldor–Hicks criterion.

Distributional Analysis and Environmental Justice Issues

Additional analysis can and should be conducted to assess distributional impacts, environmental justice, and other potential consequences of a proposed regulation.[11] Decision makers are free, even encouraged, to weigh these in making their decisions. Ideally, they would also be transparent about such considerations. Although many economists, lawyers, and policy analysts have advocated for changes to BCA to give greater weight to benefits or costs that accrue to low-income or other disadvantaged subpopulations (Adler 2016), I believe that these important concerns would be buried in the analysis and, ultimately, less transparent. There is also no obvious way to account for baseline conditions, which can be crucial when evaluating environmental justice concerns. Hence, in my view, the BCA is not the place to insert policy or welfare weights; rather, these considerations merit their own separate analysis. Trying to address both efficiency and distributional justice issues within one framework shortchanges both issues.

Clearly, both environmental justice and distributional impacts need to be explored in regulatory analysis to better inform decision-making. But combining these normative notions into the BCA necessarily opens the door for policy makers to dictate how the BCA is done, creating the potential for an agency to emphasize selected benefits or costs.

Consequences of Ignoring Both Challenges

Together, the inclusion of science policy practices in risk assessment and the movement away from strict adherence to the Kaldor–Hicks efficiency criterion (i.e., allowing inclusion of normative policy preferences) open the door to undermining the scientific integrity and credibility of BCA. And the more that normative policy choices hide behind scientific methods, the less meaningful the BCA exercise becomes. Here are some examples of the potential consequences of allowing these two challenges to affect the way we do BCA:

1. Decisions on whether a specific benefit or cost is quantified and valued in a BCA are made by political appointees, sometimes after the BCA is completed. Policy officials could decide that we should not quantify the benefit in question, even when experts suggest that the contaminant is "likely causal" and there is published epidemiology to support quantification. Although there are no clear guidelines on how to decide whether a specific benefit category should be quantified and valued, McGartland et al. (2017) argue that the public will have significant willingness to pay to avoid uncertain but serious health effects from exposure to environmental contaminants. For example, if there were strong but inconclusive evidence that ground-level ozone caused mortality, under an expected utility model or a model with risk aversion, the associated benefits could be very large.

[11] The distributional impacts of an environmental regulation, including how the benefits from reduced pollution are distributed, are not the same as a more comprehensive environmental justice assessment. See Lee (2021).

2. In some cases, the BCA ignores the uncertainty about whether a contaminant causes a health effect.[12] Ignoring such model uncertainty can lead to overstatement of benefits (or costs).

3. The BCA could adopt a threshold if that best supports a policy preference, even if the biological theory and evidence suggest otherwise. The Silver Book (NRC 2009) argued that the dose response is best depicted as linear and no-threshold when any marginal exposure adds to a background dose or when there is heterogeneity in susceptibility in the exposed human population.

4. In some cases, a national regulation can have a small effect on a large population. When the effects per person are very small, they may be considered "de minimus" and not quantified, even when these small effects add up to significant benefits across large populations.[13]

5. Regulations often generate both the benefits envisioned by the statutory authority (e.g., the Clean Air Act) and other benefits (or disbenefits) labeled "cobenefits" or "ancillary benefits" (Aldy et al. 2020). Cobenefits may be left out of the analysis, displayed separately from "targeted" benefits and given less weight (implicitly), or included in the main benefits presentation. Often, there are significant benefits and costs beyond those targeted by an environmental statute, and the treatment of such cobenefits can swing the number of quantified net benefits dramatically.[14]

6. Science policy can also be embedded in the economic content of BCAs. To illustrate, most federal agencies, including EPA, use a uniform value of mortality risk reduction (sometimes called the value of a statistical life).[15] This approach means that the BCA reflects neither the specific attributes of the risk (e.g., cancer mortality relative to accidental death) nor the attributes (e.g., age) of the population that experiences the risk reduction. The concept of valuing mortality risks remains controversial; this approach allows agencies to avoid difficult communications concerning this controversial issue.

[12] It is relatively straightforward to account for the statistical uncertainty associated with a dose-response curve that relates reductions in exposure to an environmental contaminant to reductions in various health risks. However, the model uncertainty (including the uncertainty over whether there is a causal relationship) is often ignored because expensive and time-consuming methods like expert elicitation are often used to quantitatively deal with model uncertainty. See "Appendix A: Approaches to Accounting for Uncertainty" in Institute of Medicine (2013).

[13] This issue reveals a fallacy concerning how to aggregate benefits across regulations. To illustrate, assume that one rule would reduce lead exposure and result in a half-point increase in IQ per child. Some might argue that this is too small to be "felt" and hence should not be counted. Others might argue that IQ tests have measurement errors larger than half an IQ point and hence that these benefits are too uncertain. If we accept either or both arguments, then if there were five different lead reduction rules, with each increasing IQ by half a point, these individual IQ benefits would not be counted. However, if the five rules were bundled into one rule, then we would count the 2.5 IQ-point increase per child as a benefit.

[14] For example, wet storage of coal ash means that the ash is mixed with water and stored in large ponds. These wet disposal areas are called "surface impoundments." In the past, the walls of a few of these impoundments broke open, causing environmental disasters. EPA estimated that the regulations limiting effluent discharges from coal ash surface impoundments would also lead to the closure of some impoundments, thereby reducing the risk of ruptures of the coal slurry into the environment. The reductions in effluent would be the direct benefit. The reduced risk of impoundment rupture is a cobenefit. Another example is a regulation to reduce toxic emissions from the power sector, which would also result in reductions in particulate matter pollution. The relevance of these cobenefits continues to be debated in policy circles but seems to be settled science for conducting the BCA. See Aldy et al. (2020) and Evans et al. (2021).

[15] See http://www.epa.gov/environmental-economics/mortality-risk-valuation for details on EPA's approach to valuing mortality risk reductions in BCAs.

Conclusions: Protecting the Scientific Integrity of BCA

Tom Schelling's (1984, 1) words "We can worry about how much is enough when we get close, if we ever do" appear to be upon us. Indeed, some believe that we are close to or have even surpassed many of our environmental policy goals. Others feel equally strongly that we have much further to go. Unfortunately, the consensus for improving the environment has eroded, and, as with so many other policy and political issues in the United States, the country is divided over national environmental policy.

As a result, the environment is on a "yo-yo" diet. That is, we implement regulations under one administration, only to remove them a few years later under the next administration and then perhaps reimpose those same regulations under a subsequent administration.

Of course, this diet comes with some significant costs. Many environmental regulations require significant up-front capital investment (e.g., installation of scrubbers to control sulfur dioxide). And, once installed, these costs are sunk. This means that the cost savings from removing a regulation may be much smaller than the original cost estimates for implementing the regulation (e.g., the cost savings for repealing the Clean Power Plan turned out to be trivial because the industry had already complied ahead of the rule's schedule). The yo-yo diet also causes uncertainty for regulated entities. How can an industry make plans for new investment when the regulatory landscape changes so frequently? Make no mistake—removing ineffective regulations that fail to deliver their promised benefits at estimated cost levels can be a very good policy move. But on again, off again regulations clearly do not offer a long-run social optimum.

BCA is ideally suited to help address the problems caused by a changing regulatory landscape. A scientific and rigorous assessment of the costs and benefits of each regulation should provide decision makers with the information they need to promulgate regulations that promise to make the country better off. Moreover, when those regulations are revisited, we would expect the analysis to support the same scientific record as the first BCA unless there have been scientific advancements.[16] Presumably, these benefits and costs would be harder to remove as well since the same strong scientific basis used to justify the original regulation would argue for keeping it under future administrations. Indeed, summarily dismissing or ignoring the previous scientific record that supported the original rule could be deemed arbitrary and capricious by the courts. Judicial deference to agency expertise does not permit the agency to operate on the principle of ipse dixit (i.e., because I said so). The courts may reject an agency's statement that it made an expert scientific and technical judgment when the administrative record is devoid of any discussion by the agency regarding how it applied its expert judgment to facts that were already in the record (including the previous BCA).[17] Further, the transparency provided by the BCA would provide the public with information about how our environment and our welfare are affected by changes to regulations. However, as I have argued here, if normative or policy judgments enter our BCAs, then

[16] The costs and benefits of a rule may change as a result of a change in economic conditions. The point here is that unless the science changes or some underlying economic features change, the underlying analysis will not change if a BCA is under the purview of economic science.

[17] For a review of recent court decisions, including many in which the courts found that the administration did not adequately address the existing record, see Institute for Policy Integrity (2021).

objective assessments will not be possible, and the BCA cannot support the integrity of the regulatory process.

I conclude by proposing five actions that the environmental economics profession could take to help protect the integrity of BCAs, presented in order of increasing difficulty of implementation.[18]

1. Reach an economic science consensus regarding the theoretical underpinnings of BCA. Specifically, the BCA should be designed to address the Kaldor–Hicks economic efficiency criterion. To support this reemphasis, environmental economists need to publish translational research that provides clear best practices and standards for BCA. Ideally, these best practices would also address very specific applied challenges confronted by BCA analysts and economists at government agencies (e.g., criteria for when benefits should be quantified).

2. Build an awareness among decision makers, journalists, stakeholders, and the public that BCAs have strong theoretical underpinnings, that they are scientific exercises, and that they should be free from inappropriate interference from policy officials.

3. Develop new risk assessment and BCA methods that properly account for risk and uncertainty, including uncertainty surrounding causal inference. As I discussed above, uncertainty is often offered as a rationale for not quantifying a particular benefit. But uncertain benefits do not imply that the benefits are zero.

4. Reexamine the body of science policy that is embedded in risk assessment and BCA and make it more transparent and more supportive of unbiased estimation of benefits and costs. For example, are the policies governing the use of default models designed to address different questions than the Kaldor–Hicks criterion? If so, we need to develop new science policy that provides us with methods that produce unbiased, robust estimates of benefits and costs. The NRC's (2009) Silver Book provides an excellent starting point.

5. Last, empower the National Academy of Sciences or a similar institution to address the broad issue of making BCA a scientific enterprise. This institution should publish detailed best practices that address issues such as benefits quantification, risk assessment, cost estimation, and discounting. This new effort should also promote better communication between risk assessors and economists.

Finally, I would like to express my great appreciation to the Association of Environmental and Resource Economists and the entire environmental economics profession. Your contributions and support mean everything to the economists at the EPA. EPA economists aim to conduct the best economic science possible, and we rely heavily on your research, your participation in the EPA Science Advisory Board, and your other peer review activities and advice opining on EPA work products. Your contributions and leadership have enabled economics to transparently and effectively inform environmental policy-making. While rigorous scientific economic assessment of the benefits and costs of regulations will not end the debate about how much environmental quality is enough, it will certainly inform the debate and perhaps tilt the odds in favor of an environmental policy that balances benefit and cost considerations properly.

[18] There is some overlap in these proposals.

References

Adler, M. D. 2016. Benefit-cost analysis and distributional weights: An overview. *Review of Environmental Economics and Policy* 10 (2): 264–85.

Aldy, J., M. Kotchen, M. Evans, M. Fowlie, A. Levinson, and K. Palmer. 2020. Co-benefits and regulatory impact analysis: Theory and evidence from federal air quality regulations. *Environmental and Energy Policy and the Economy* 2: 117–56.

Baynes, R. E. 2012. Quantitative risk assessment methods for cancer and noncancer effects. In *Progress in molecular biology and translational science*, vol. 112, ed. Hodgson, E., 259–83. Amsterdam: Academic Press.

Cropper, M., and W. Oates. 1992. Environmental economics: A survey. *Journal of Economic Literature* 30: 675–740.

Dourson, M., M. E. Anderson, L. S. Erdreich, and J. A. MacGregor. 2001. Using human data to protect the public's health. *Regulatory Toxicology and Pharmacology* 33 (2): 234–56.

Evans, M., K. Palmer, J. Aldy, M. Fowlie, M. Kotchen, and A. Levinson. 2021. The role of retrospective analysis in an era of deregulation: Lessons from the US mercury and air toxics standards. *Review of Environmental Economics and Policy* 15 (1): 163–68.

Harford, T. 2018. Review of *The Cost-Benefit Revolution* by Cass Sunstein. http://timharford.com/2018/09/review-of-the-cost-benefit-revolution-by-cass-sunstein/.

Institute for Policy Integrity. 2021. Roundup: Trump-era agency policy in the courts. http://policyintegrity.org/trump-court-roundup.

Institute of Medicine. 2013. Environmental decisions in the face of uncertainty. Washington, DC: National Academies Press. https://doi.org/10.17226/12568.

Lee, C. 2021. Confronting disproportionate impacts and systemic racism in environmental policy. *Environmental Law Reporter* 51: 10207–25. http://elr.info/news-analysis/51/10207/confronting-disproportionate-impacts-and-systemic-racism-environmental-policy.

McGartland, A. 2013. Thirty years of economics at the Environmental Protection Agency. *Agricultural and Resource Economics Review* 42 (3): 436–52. https://doi.org/10.1017/S1068280500004925.

McGartland, A., R. Revesz, D. A. Axelrad, C. Dockins, P. Sutton, and T. J. Woodruff. 2017. Estimating the health benefits of environmental regulations. *Science* 357 (6350): 457–58.

NRC (National Research Council). 1983. *Risk assessment in the federal government: Managing the process*. Washington, DC: National Academies Press. https://doi.org/10.17226/366.

———. 2009. *Science and decisions: Advancing risk assessment*. Washington, DC: National Academies Press. https://doi.org/10.17226/12209.

Olden, K. 2018. The EPA: Time to re-invent environmental protection. *American Journal of Public Health* 108 (4): 454–56. https://doi.org/10.2105/AJPH.2017.304303.

Revesz, R., and R. Stavins. 2004. Environmental law and policy. In *The handbook of law and economics*, eds. Arrow, K., and M. Intriligator, 499–589. Amsterdam: Elsevier Science.

Schelling, T. 1984. *Choice and consequence: Perspectives of an errant economist*. Cambridge, MA: Harvard University Press.

Shanks, N., R. Greek, and J. Greek. 2009. Are animal models predictive for humans? *Philosophy, Ethics, and Humanities in Medicine* 4: 2. https://doi.org/10.1186/1747-5341-4-2.

US EPA (US Environmental Protection Agency). 1985. Costs and benefits of reducing lead in gasoline: Final regulatory impact analysis. EPA-230-05-006. http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=9100YK16.PDF.