ADVANCING THE FRONTIERS OF BENEFIT–COST ANALYSIS:

PROGRESS ON FEDERAL PRIORITIES, INSIGHTS FOR THE RESEARCH COMMUNITY, AND EMERGING TOPICS

A Report by the

SUBCOMMITTEE ON FRONTIERS OF BENEFIT–COST ANALYSIS

COMMITTEE ON ENVIRONMENT

of the

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

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About the NSTC Subcommittee on Frontiers of Benefit-Cost Analysis

The Subcommittee on the Frontiers of Benefit-Cost Analysis (SFBCA) was established by OSTP under the Committee on Environment of the NSTC in March of 2023. Co-chaired by the Council of Economic Advisors, Office of Information and Regulatory Affairs, and OSTP, the purpose is to coordinate and advance efforts that harness the best-available science and economics to address challenges in quantifying and monetizing a broad range of relevant impacts in benefit-cost analyses.

About this Document

The SFBCA charter calls on the Subcommittee to create an annual public report that identifies opportunities to advance the frontiers of benefit-cost analysis in federal practice. This report summarizes progress on a set of common effects that are currently difficult to monetize or quantify in analyses of agency regulations, projects, programs, or other actions; highlights ways for the research community to engage with the policy process and provide policy-relevant science and economics for benefit-cost analyses; and identifies additional frontiers topics.

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Abbreviations, Acronyms, and Definitions of Key Terms

BCA	Benefit-Cost Analysis—a systematic method of assessing the impacts of government projects or policies, in which benefits and costs are reported and compared to the extent feasible using a common measure (usually monetary).
BCR	Benefit-Cost Ratio—is the ratio of the benefits of a project or policy relative to its costs, using a monetary measure.
BLM	Bureau of Land Management, Department of the Interior
BOEM	Bureau of Ocean Energy Management, Department of the Interior
CEA	Council of Economic Advisors, Executive Office of the President
CEQ	Council on Environmental Quality, Executive Office of the President
CFPB	Consumer Financial Protection Bureau
CGE model	Computable General Equilibrium model—a model to simulate the workings of the price system jointly across multiple markets to represent the behavior of the economy.
Circular A-4	the Office of Management and Budget's guidance on regulatory analysis.
CMS	Centers for Medicare and Medicaid Services
COI	Cost of Illness—a metric that summarizes the expenses that an individual must bear for illness, such as hospital admissions, visits to the emergency department and other outcomes; this metric includes the value of medical expenses and lost work, but not the value that individuals place on pain and suffering associated with the event.
CPSC	Consumer Product Safety Commission
DHS	Department of Homeland Security
Distributional analysis	a quantitative or qualitative estimate of likely effects on those in a particular group across the population and economy.
DOC	Department of Commerce
DOD	Department of Defense
DOI	Department of the Interior
DOL	Department of Labor
DOT	Department of Transportation
ED	Department of Education
EJ	Environmental Justice—the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or

	income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.
Elasticity	a price elasticity of supply or demand measures the relationship between a change in a good's price and the quantity supplied or demanded. It is calculated as the percentage change in quantity supplied (or demanded) that occurs in response to a percentage change in price.
EPA	Environmental Protection Agency
EOP	Executive Office of the President
ES	Ecosystem Services—contributions to human welfare from the environment or ecosystems. Examples include water purification or flood mitigation.
Ex ante	an estimate made prospectively, before the policy, program, or action of interest is in effect.
Ex post	an estimate made retrospectively, after the policy, program, or action of interest is in effect.
Expert elicitation	a formal, highly structured, and well-documented process for obtaining the judgments of multiple experts
Externality	externalities arise any time one person's actions have costs or benefits (that do not operate through market prices) for anyone not directly part of the decision-making process.
FEMA	Federal Emergency Management Agency, Department of Homeland Security
FDA	Food and Drug Administration
Focal Category	one of the categories of effects that this Report highlights for research into enhanced quantification and monetization
FTC	Federal Trade Commission
Hedonic model	an approach that uses market transaction observations to estimate the value of key characteristics of goods and services, including those that are not explicitly exchanged in markets; for example, using housing market data, an analysis can reveal the implicit price associated with changing a particular attribute or amenity of a house, such as number of bathrooms, local school district quality, or access to environmental amenities like public parks.
HHS	Department of Health and Human Services
HUD	Department of Housing and Urban Development
ICER	Incremental Cost Effectiveness Ratio—the ratio of the difference in costs between two strategies to the difference in effectiveness; a

	summary measure that can be interpreted as the cost of obtaining an extra unit of effectiveness.
Incidence	a measure of costs or benefits that describes who ultimately bears these effects, which may be different than who is initially affected. In some other literatures, "incidence" may refer to "frequency" (e.g., the incidence of flu in a particular region).
IPA	the Intergovernmental Personnel Act, which allows the temporary assignment of personnel to federal government from state, local, or Tribal Nations and Indigenous Peoples governments, academic institutions, federally funded research centers, and other eligible organizations.
IWG	Interagency Working Group
MCC	Millennium Challenge Corporation
Meta-analysis	a statistical method of pooling data and/or results from a set of comparable studies
Monetization	the process for partially or fully valuing effects in monetary terms, typically by measuring willingness to pay or willingness to accept. Translating effects into a common metric (such as dollars) facilitates comparison across effects and provides context for decision-makers and the public.
MVPF	Marginal Value of Public Funds
NCEE	National Center for Environmental Economics, Environmental Protection Agency
Net Benefits	net benefits are calculated by subtracting costs from benefits.
NIH	National Institutes of Health
NOAA	National Oceanic and Atmospheric Administration, Department of Commerce
NSF	National Science Foundation
NSTC	National Science Technology Council, Executive Office of the President
OECD	Organization for Economic Co-operation and Development
OIRA	Office of Information and Regulatory Affairs, Office of Management and Budget
OMB	Office of Management and Budget, Executive Office of the President
OSMRE	Office of Surface Mining Reclamation and Enforcement, Department of the Interior
OSTP	Office of Science and Technology Policy, Executive Office of the President
PRA	Paperwork Reduction Act of 1995

Public Benefit Programs	programs that provide either cash assistance or in-kind benefits to individuals and families from any governmental entity
QALYs	Quality Adjusted Life Years—A QALY uses a scale of 0.00 to 1.00 for each health status; it is the product of duration of life and a measurement of quality of life. For example, 2 years of perfect health = 2 QALYs.
Reclamation	Bureau of Reclamation, Department of the Interior
Reference dose	an estimate of oral daily exposure to a substance that is likely to be without an appreciable risk of deleterious effects during a lifetime
Retrospective review	the process by which agencies assess existing regulations, programs, or other decisions to evaluate whether the costs and benefits of those actions, as they take effect, are different than originally estimated or have changed over time
Revealed preference method	a method for estimating the value of goods or services—or attributes of those goods or services—based on observable tradeoffs people make
RIA	Regulatory Impact Analysis
SFBCA	NSTC Subcommittee on the Frontiers of Benefit-Cost Analysis
SSRN	Social Science Research Network
Stated preference method	a method for estimating the value of goods or services—or attributes of those goods or services—that relies on choice data that are reported as a response to hypothetical situations, rather than on choice behavior observed in actual markets. Stated preference methods include contingent valuation, attribute-based methods (sometimes called choice experiments), and risk-tradeoff analysis.
Stated preference survey	a survey used to reveal willingness-to-pay through stated preference methods
Treasury	United States Department of the Treasury
USACE	United States Army Corps of Engineers, Department of Defense
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USGS	United States Geological Survey, Department of the Interior
VSL	Value of Statistical Life, sometimes called the value of mortality risk reduction—a summary measure of the dollar value of small changes in mortality risk experienced by a large number of people
WTP and WTA	willingness-to-pay (WTP) is the maximum amount of money an individual would be willing to give up in order to acquire a good or service or to avoid an effect; willingness-to-accept (WTA) is the minimum amount of money an individual would be willing to accept in order to relinquish a good or service.

Executive Summary

During his first week in office, President Biden issued a memorandum to federal agencies, directing them to modernize their analytical approaches (Modernizing Regulatory Review, Jan. 26, 2021). Among the directives were two complementary goals: agencies should fully account for the effects of their actions, even those that may currently be difficult or impossible to quantify or monetize; and agency analyses should reflect the newest developments in scientific and economic understanding. The public benefits of government decisions should outweigh the costs. Agencies conduct analyses in a range of contexts to test this premise for important federal policies, programs, and other decisions. These tests include regulatory impact analyses, programmatic cost effectiveness assessments, and environmental impact reviews, among others. Robust analysis of costs and benefits makes federal actions more transparent to the public, and it helps decision-makers to weigh, explain, and support policy choices that promote public well-being.

The Subcommittee on the Frontiers of Benefit-Cost Analysis (SFBCA) was established to harness the best-available science and economics to address challenges in quantifying and monetizing a broad range of relevant impacts in benefit-cost analysis (BCA) across federal agencies. Specifically, SFBCA is charged with identifying topics with significant effects on public well-being that are relevant to upcoming agency actions and have potential for expanded quantification or monetization in BCA; highlighting those areas for government and nongovernment researchers; and providing an ongoing mechanism for the resulting advances to inform agencies' actions.

Current federal guidance (Office of Management and Budget (OMB) Circular No. A-4 and Circular No. A-94, Nov. 9, 2023) supports a range of options for appropriate analysis, recognizing the varying authorities, types of effects, and evidence bases relevant to the wide scope of analyses supporting agency decisions. Federal guidance recommends that agencies monetize (i.e., in dollar terms), quantify (i.e., in other terms such as number of visitors to national parks), or describe expected changes, in that order of preference. This approach provides as much information as possible to both decision-makers and the public about the size of expected changes that result from a policy and who will experience them (distributional analysis will help to understand the specific impacts of costs and benefits on different populations).

The SFBCA recognizes this spectrum of approaches and explores opportunities to advance the frontiers of analysis to strengthen agency decision-making. Improved quantification or monetization of effects could reveal benefits or costs that are lower or higher than previously anticipated. Improved quantification efforts could also increase understanding of who will be affected (the incidence of effects across population groups). For example, even if an estimate of total regulatory costs is already accurate, it would be useful to better understand who will bear those costs across the population and economy, such as among regulated entities, their employees, their customers or suppliers, or other stakeholders.

This report discusses progress on frontiers focal topics, provides insights for researchers on producing policy-relevant research, and identifies a new frontier topic. This builds on the inaugural report (December 2023) in which SFBCA identified a set of common impacts that agencies have difficulty quantifying or monetizing. Those five focal topics are:

- Non-Fatal Health Effects
- Ecosystem Services Effects
- Wildfires and Extreme Weather Effects
- Information and Transparency Effects
- Effects of Public Benefit Programs

Two cross-cutting themes are also called out for advancement:

- Distributional Analysis
- Risk Analysis

Progress on Frontiers Focal Areas

The frontiers of quantification and monetization either push the cutting edges of scientific and economic understanding or probe the limits of available evidence, knowledge, and data. There is increasing evidence to support richer analysis on several of these topics, and many agencies are actively expanding the frontiers to increase the accuracy, robustness, and transparency of their analyses. All of the five focal topics and the two cross-cutting themes remain important areas where continued research could materially improve the quantification and monetization of the effects of agency actions.

In 2024, the SFBCA made progress on the focal topics by increasing the research community's awareness of difficulties in quantification and monetization in these areas, identifying barriers to research that would fill gaps, and pursuing approaches to overcome those barriers. Specifically, the SFBCA created interagency working groups (IWGs) corresponding to three of the five focal areas, with the intent of furthering progress and deepening engagement with the research community: (1) non-fatal health effects, (2) ecosystem services effects, and (3) effects of public benefits programs.

Through workshops that brought together key agency personnel and academic research community experts, the IWGs identified key missing data, models, and tools that would advance these frontiers in BCA. While the actual data underlying the focal topics varies, common themes emerged. For agencies to better understand and estimate the effects of their actions, all of the groups found that there are data needs for quantification and monetization. In some cases, data are available in one specific location but cannot be applied or extrapolated to a national scale hindering analysis. Other times, the understanding of how the agency actions will translate to effects is not well-characterized. Detailed data gaps and needs are highlighted in this report.

Progress to open the dialogue between agencies and the research community was initiated in these workshops and new collaborations continue. This report provides feedback from these engagements on ways in which the academic community can increase the policy-relevance of their research and how both researchers and agencies can take steps to increase the availability and use of policy-relevant science and economics for BCAs.

Insights for Producing Policy-Relevant Research

Objective, high-quality research plays an important role in informing agency decision-making. There are several actions that academic researchers can employ to increase the policy-relevance of their scholarship, including improving their understanding of the regulatory notice and comment process for Regulatory Impact Analysis (RIA), providing relevant information in requests for comments, engaging with government analysts as part of a broader research community, engaging with science advisory committees, and others. To maximize researchers' impact on policy, they can:

- Consider federal agencies as the audience
- Show the underlying work
- Evaluate external validity
- Discuss retrospective vs. prospective analysis
- Engage with agencies at multiple stages

Agencies can also take actions that would help incentivize more research on frontiers focal areas including:

- Providing access to data
- Citing relevant research in ways that will be recognized in academia
- Engaging with researchers
- Funding research on high priority questions
- Alerting researchers of the use of their work

At a minimum, agencies can identify research needs in reports, white papers, memoranda, and presentations, among other vehicles, to help facilitate engagement. A checklist for policy-relevant research appears at the end of the section *Insights for Researchers and Agencies for Producing Policy-Relevant Research.* Finally, an important role of the SFBCA is to regularly consider new frontiers in benefit-cost analysis.

Emerging Frontiers Focal Areas

While progress was made since the original five focal topics and two cross-cutting areas were identified in 2023, continued research could materially improve the quantification and monetization of the effects of agency actions. In addition, this report describes an emerging cross-cutting theme: Multi-Market Analysis. Agencies have long recognized that regulations may create externalities, or benefits and costs beyond the market in which the regulations intervene most directly. Ignoring such changes may lead to substantial errors in BCA, both in estimating net benefits and in characterizing the distribution of net benefits across people and entities in the economy. The last section of this report describes existing agency and other guidance, challenges to this cross-cutting theme, and ways to advance this frontier.

Progress on Frontiers Focal Areas

The 2023 SFBCA report identified five focal categories with significant opportunities for advancing BCA through expanded quantification or monetization:

- **Non-Fatal Health Effects**, such as liver disease, low birth weight, and mental health. Key data gaps include a lack of dose-response functions (i.e., the magnitude of response by level of exposure to a substance) for non-cancer diseases and distribution of baseline health risks and exposure data across different population groups, among others. Major methodological challenges include accounting for latency (or the time lag between exposure and effects) and identifying social determinants of health—like health care access—that may lead to different dose-response relationships across population groups.
- **Ecosystem Services Effects,** such as recreational and subsistence uses, and climate mitigation. Major data challenges relate to a lack of environmental data on current conditions (e.g., the extent of certain habitats, the effect of ecosystem functions) and data linking ecosystem conditions to social outcomes (e.g., mental health outcomes, cultural uses). Key methodological challenges relate to inconsistent use of definitions for some effects and the need to employ challenging survey methods to fill some data gaps.
- **Wildfires and Extreme Weather Effects**, including the benefits and costs of disaster relief, risk reduction, and resilience-building efforts. Challenges for these effects are dominated by data gaps, including data needed to help differentiate effects of specific wildfire management actions, separate costs borne by different groups, and evaluate health impacts from extreme events, among others. BCA would inform best management practice and investment levels within a type of action (e.g., mitigation – fuel treatments versus fire prevention versus hardening infrastructure) and between types of action (e.g., mitigation versus fire suppression response).
- **Information and Transparency Effects**, such as consumer information, contract transparency, and information on public risks. Examples of data gaps include baseline information on consumer choices and preferences, such as how consumers respond to information about whether produce is organic or non-organic. Methodological needs include more experiments and models of how informational improvements may affect consumer or producer behavior.
- **Effects of Public Benefit Programs**, such as the long-term benefits to program recipients, paperwork costs and barriers to access, and cost-savings to related government programs. Data gaps include information on links between recipients of public benefit programs and their families' outcomes and more complete information on the burdens of accessing programs. Methodological challenges include understanding whether, in the absence of federal programs, recipients would otherwise obtain similar direct or long-term benefits from other sources (such as local governments or private institutions).

Two cross-cutting themes—**Distributional Analysis** and **Risk Analysis**—are also called out for advancement. Distributional analysis challenges surfaced across all focal themes. For example, data for differentiating effects on various income or social groups (e.g., race and ethnicity, sex, gender, geography, wealth, disability, sexual orientation, religion, national origin, age or birth cohort, family composition, occupation, or veteran status) are lacking for many effects, such as baseline estimates of disease incidence. Risk analysis challenges were also common across all focal themes, such as how to estimate low-probability catastrophic events like pandemics or large-scale climate disruptions.

In 2024, the SFBCA sought to make progress on the focal topics to increase awareness and engagement with the research community, to identify barriers to research that would fill gaps and approaches to overcome those barriers, and to identify emerging focal topics. In 2024, SFBCA created IWGs corresponding to three of the five focal areas with the intent of furthering progress and deepening engagement with the research community[1]. These working groups corresponded to the focal areas of (1) non-fatal health effects, (2) ecosystem services effects, and (3) public benefits programs. Each IWG included participants from multiple agencies and was charged with increasing awareness of the specific elements of their focal topic that needed additional research to inform agency BCAs. The three IWGs each convened a workshop on their topic and included both agency and research community participants. This section describes each of the IWGs in more detail and documents the workshops and findings.

Importantly, the SFBCA recognizes that agencies differ in terms of their own authorities, resources, and other factors, and these components should be considered when deciding how to incorporate a new frontier into agency analysis. Agencies should continue to exercise their judgment and rely on qualitative descriptions of effects when further quantification or monetization is not feasible or appropriate. When possible, the SFBCA, aligned with federal guidance, encourages agencies to coordinate their research efforts, draw from the latest scholarship, and work together to advance the government's analysis of costs and benefits across these high-impact categories of effects.

Non-Fatal Health Effects Interagency Working Group

Topic Significance

Non-fatal health effects are an important frontier for BCA. Historically, agency analyses of federal actions have often focused attention on changes in mortality risks and a relatively small subset of non-fatal health effects where data are the most robust. Changes in many other non-fatal health effects are often not quantified or monetized and therefore are undercounted in BCAs. Non-fatal health effects include those involving the endocrine system (e.g., diabetes, hormonal disorders), reproductive health (e.g., infertility, low birth weight), the hepatic system (liver), neurodevelopment (e.g., general intelligence, Attention-Deficit/Hyperactivity Disorder), and other body systems and processes, including those influencing mental health. More complete analysis of non-fatal health effects is a multi-disciplinary challenge; analysts often lack information on the quantitative relationships between exposure to stressors and health effects and on the values that individuals place on changes in those health effects.

Facilitating Progress

A Non-Fatal Health Effects IWG was formed as a community of practice for federal agency representatives to consider approaches and facilitate progress for information gaps for quantification and monetization of non-fatal health effects. The IWG was co-chaired by representatives from the Environmental Protection Agency (EPA) and Council of Economic Advisors (CEA), and included participants from Office of Information and Regulatory Affairs (OIRA), Consumer Product Safety Commission (CPSC), Food and Drug Administration (FDA), Department of Housing and Urban Development (HUD), National Oceanic and Atmospheric Administration (NOAA), National Science

[1] Focal topic IWGs were established based on capacity and expertise of agency representatives serving on the SFBCA; they do not reflect prioritization of the focal topics.

Foundation (NSF), Department of the Treasury (Treasury), and other agencies and components. The IWG planned and convened a workshop to bring together federal agency representatives and academic researchers with the objective of highlighting the specific areas that need progress to inform agency analyses, engage academic researchers in the field, increase awareness of the state of the science and economics, and identify actionable approaches to further progress on this topic.

Workshop Details

On June 6, 2024, the Non-Fatal Health Effects IWG held a workshop at EPA Headquarters that brought together over 80 attendees from federal agencies, nonprofits, and academia. Several key themes emerged at the workshop. The general framework for assessing non-fatal health effects typically begins with evaluating existing evidence to establish a link between a particular regulation and non-fatal health outcomes. It then quantifies and monetizes those impacts relative to a projected baseline characterizing outcomes in the absence of the regulation. One of the most commonly cited challenges to quantification and monetization of health effects stems from the wide array of different non-fatal health effects or endpoints that might be affected by a regulation, which we will refer to here as high dimensionality. Presenters discussed that a regulation might affect such disparate endpoints as cancer, liver disease, or low infant birth weight. Even within a single non-fatal health effect, there can be important differences in aspects such as duration and severity that affect valuation. For example, the value of avoiding chronic kidney disease will vary depending on if it is mild, moderate, or has reached the stage of kidney failure requiring dialysis or transplant.

An important step when conducting a BCA is to quantify the changes in health risks attributable to policy options. The high dimensionality of non-fatal health effects makes it challenging to comprehensively quantify expected changes from a regulation, including marginal changes relative to a baseline. This problem is compounded by limited data on the large number of environmental and foodborne contaminants and other stressors that could be subject to agency regulations. The large number of different contaminants combined with the difficulty in isolating causal effects of each contaminant on each human health endpoint means that many health effects are not quantitatively characterized. Another consideration is the time lags between exposure to a contaminant and the resulting health outcomes, which can make it challenging to quantitatively characterize when health effects of contaminant regulations will occur. Workshop participants discussed a variety of approaches to tackle these challenges.

Many presenters discussed components of risk assessment (i.e., hazard identification, dose-response assessment, exposure assessment, and risk characterization) as they generate important information for the quantification of changes in health risks.[2] These components help characterize specific risk outcomes to be valued. Dose-response assessment quantifies the relationship between varying levels of exposure and different health outcomes. Exposure assessment measures how much, how often, and for how long a population is exposed to a hazard. Exposure relates to specific economic behaviors where the intensity and duration of exposure are influenced by market forces. Finally, risk

[2] The 1989 National Academy of Sciences seminal report titled “Risk Assessment in the Federal Government” also known as the “Red book” established the concept of Risk Analysis consisting of three components: Risk Assessment, Risk Management, and Risk Communication. It also established a now widely accepted framework for risk assessment as composed of hazard identification, dose-response assessment, exposure assessment, and risk characterization. Available at: https://www.ncbi.nlm.nih.gov/books/NBK216619/

characterization combines the exposure and dose-response assessments to estimate the incidence of health outcomes under various conditions of exposure.

Integrating risk assessments with BCA to quantify changes in health risks is complex and requires careful selection of models and data. One of the challenges discussed is that risk assessments can be protective rather than predictive, or in other words, are safety assessments presented as risk assessments. Unlike predictive assessments that use probability distributions to characterize incremental changes in risk, protective assessments may not allow the characterizing of incremental changes in health risk that is needed for quantifying marginal benefits in BCA.[3]

Filling knowledge gaps in human health by using studies of non-human animals is one approach to enable more comprehensive quantification of non-fatal health effects. Results from experimental studies of toxin exposure in animals can be used to estimate probabilistic dose-response functions linking exposures to human health outcomes (although this approach may not always be representative of human response). To estimate the benefits of reducing exposure to a toxin, agencies can combine the dose-response relationships with estimates of the value of avoiding the health condition in human populations. For example, exposure to many toxins can reduce infant birth weight in both animals and humans. Reduced birth weight in humans causes near-term increases in medical expenditures and later-in-life adverse labor market outcomes. These economic effects can be estimated and aggregated to generate a value of avoided reduced birth weight. Other methods that provide data on likely health effects with less reliance on animal testing could also be considered.[4]

Research that links human exposures to health effects, labor market outcomes, and other economic outcomes remains important as well but critically depends on researchers having access to high resolution data and detailed knowledge about policy implementation. More efforts like the Census Environmental Impacts Frame, which combines detailed demographic and economic data with environmental data, would be useful for closing research and data gaps in this space.[5]

Another potentially promising approach to reducing the high dimensionality of non-fatal health effects is to group them by attributes. This is distinct from monetizing quality-adjusted life years (QALYs) or similar measures using the value of a statistical life that would require original research. For example, one could group endpoints by severity of characteristics such as pain, mobility, and ability to engage in regular activities.[6] If willingness-to-pay (WTP) is elicited for reduced disease severity characterized in a

[3] The 2009 National Academy of Sciences report titled "Science and Decisions Advancing-Risk Assessment" also known as the "Silver book" embedded the concepts from the "Red book" within a broader framework for risk-based decision-making. Available at: https://nap.nationalacademies.org/catalog/12209/science-and-decisions-advancing-risk-assessment

[4] Animal studies offer reliable, controlled, and biologically relevant data but face ethical, cost, and species extrapolation challenges. Other methods, sometimes known collectively as "New Approach Methods" or NAMs, can provide human-relevant, ethical, and efficient alternatives but may pose other challenges, for example, not fully capturing complex biological responses. See EPA New Approach Methods: Efforts to Reduce Use of Vertebrate Animals in Chemical Testing | US EPA.

[5] Voorheis, John L., Jonathan M. Colmer, Kendall A. Houghton, Eva Lyubich, Mary Munro, Cameron Scalera, and Jennifer R. Withrow. *Building the Prototype Census Environmental Impacts Frame*. No. w31189. National Bureau of Economic Research, 2023. w31189.pdf (nber.org)

[6] Hammitt JK and Haninger K. (2017). Valuing nonfatal health risk as a function of illness severity and duration: benefit transfer using QALYs. *Journal of Environmental Economics and Management, 8*, 17-38.

broadly-applicable manner, those WTP estimates could then be used to value a variety of different non-fatal effects with similar levels of severity. To implement this approach, diseases would need to be mapped to attributes, and empirical valuation estimates of changes in these attributes would need to be ascertained.

Workshop participants discussed that economists typically rely on revealed or stated preference methods to estimate WTP for risk reductions. Each approach has its own advantages and limitations. Relatively few WTP estimates are available for many morbidity risks. While WTP is the most comprehensive approach for valuing non-fatal risk reductions, it is not available for all known non-fatal health effects. In such situations where WTP estimates are not available, alternative approaches using proxy measures such as cost of illness (COI) estimates, averted costs, monetized QALYs, or the combination of the two, are used in some analyses.

Stated preference surveys offer the opportunity to study specific health effects and randomly assign participants to different levels of risk or severity. Researchers have developed robust approaches to mitigate hypothetical bias, drawing on decades of scholarship. However, well-designed stated preference surveys are expensive and time consuming, making it all the more important to design surveys whose results are applicable to other contexts.

The defensive expenditures approach estimates WTP based on the amount of money individuals spend to avoid adverse outcomes or to mitigate risks. It focuses on the expenditures incurred to prevent or reduce harm. While this method offers a revealed preference approach to estimating WTP, defensive expenditure studies often substantially underestimate the welfare effects of non-fatal health conditions and are difficult to link to individual health effects. In addition, the approach doesn't inherently account for differences in income across population subgroups, potentially introducing aggregation bias.

COI studies are another commonly used approach in practice because they rely on reasonably accessible data. COI expenditures include medical costs that may be avoided if risk is reduced and may also include indirect costs such as productivity losses. The downside is that they often underestimate the value of risk reduction. Medical expenditures do not reflect a patient's actual WTP for risk reductions because they exclude the welfare losses caused by pain and suffering and any effects for which people do not seek treatment. In addition, health insurance drives a wedge between expenditures and patient WTP. There may be opportunities to improve COI estimates, including inpatient, outpatient, and other costs. One participant suggested that more work could be done using labor market data to understand the trade-offs workers face between earnings and risks from non-fatal health effects, similar to the hedonic wage studies used to estimate the value of reducing fatal risks.

The usefulness of these approaches depends on how readily human health data can be linked to medical cost, labor market, and other economic data. A challenge for this focal area is that relevant datasets are not always straightforward to access and combine. Participants noted an emerging challenge about health data availability. The Centers for Medicare and Medicaid Services (CMS) is a major source of healthcare utilization and health outcomes data, in the form of claims records from Medicaid and Medicare. Due to compliance and data security concerns and to offset costs incurred supporting researcher access to data, CMS recently proposed increasing fees and requiring all users to connect with data via remote servers. The impact of such changes, as originally proposed, could increase the costs of accessing data by 1000% or more. At the time of this report, CMS had delayed implementation of this policy change in response to researcher concerns, and the policy change had not been finalized.

Another challenge raised by presenters is how to account for benefits when the evidence about the causal link between a given toxin or stressor and health endpoint is uncertain. Systematic reviews can be used to gauge the strength of the current evidence base but are expensive and time-consuming. When the evidence base demonstrates only suggestive or inconclusive effects, as opposed to causal or likely causal effects, they are sometimes only mentioned qualitatively or entirely excluded from the benefits analysis. However, there is likely to be some WTP by the public to avoid some probability of experiencing an adverse health effect. For serious health effects, WTP may be quite large even with uncertainty about causality. This suggests that even those health effects where causality is less certain should receive some quantitative weight in benefits analysis. The theoretically correct approach for estimating benefits in such cases depends on people's preferences about risk and ambiguity. A tractable approach consistent with risk-neutral preferences would be to weight expected benefits using quantitative characterizations of the probability of causality, perhaps generated by expert elicitation. Alternatively, WTP can be elicited directly under conditions of uncertainty, which is an approach that is more robust to alternative assumptions about risk preferences. The specifics of either approach and the underlying theoretical basis would need to be carefully developed, especially to make it broadly applicable.

Figure 1. Non-Fatal Health Effects Workshop

This photo shows participants engaged in knowledge-sharing during the non-fatal health effects workshop held at the Environmental Protection Agency headquarters. Photo credit: Mike Geruso, CEA

The relatively low monetized values of non-fatal health effects affect the likelihood that relevant studies get published in peer-reviewed journals. This publication challenge is exacerbated by the high dimensionality problem. Journal editors might be less willing to publish a paper on a new non-fatal health effect if it is not sufficiently (in the view of the editor) different from existing work on other non-fatal health endpoints. Yet, an agency typically seeks research that is specific to the chemical or stressor being regulated and to each health endpoint. Researchers need to explore new ways to publish studies of non-fatal health outcomes—whether that's through using new data (including longitudinal data), looking at long-term or cumulative impacts, or taking other novel approaches—to increase the probability of publication.

Participants also discussed approaches to increase the visibility of research conducted by government and nongovernment researchers across institutions. Participants noted that government regulatory impact analyses, as well as technical support and related documents, typically do not generate discoverable citations for academics, even when academic work is cited. Placing government analyses in repositories that are incorporated into citation databases would provide a signal to cited researchers that their work is valuable, and it would make government analyses more readily available and citable by nongovernment researchers. Researchers can also increase the probability that their research is found by relevant agencies by posting manuscripts in PubMed Central, an archive of biomedical and

other science literature maintained by the National Institutes of Health's National Library of Medicine.[7] Particularly for economists working on health-related research, including research papers in PubMed Central can help agencies find the work during literature reviews that rely on biomedical rather than social science databases.

Participants noted that funding is critical for doing the data- and experiment-intensive work required to quantify and monetize non-fatal health effects. Requests for proposals from funding agencies on specific topics in this space would be useful. There are sometimes opportunities to address questions at the intersection of two agency missions through joint initiatives (e.g., NSF and National Institutes of Health funding research that advance understanding of the biomedical research enterprise by leveraging the expertise of the Science of Science research community[8]). Even though this program is successful, participants discussed that funders should be aware of potential administrative burdens that joint initiatives might create as they pursue new collaborative efforts. Participants also raised the possibility of publishing journal special issues to assist with some of the publication barriers identified above.

Progress in 2024

The Non-Fatal Health Effects IWG workshop was an enlightening and lively day that increased the connections between federal agency representatives and researchers, raised awareness of the needs of agencies and barriers to conducting needed research, and highlighted approaches to overcome these barriers to support increases in the capacity of agencies to quantify and monetize non-fatal health effects in BCAs. Participants discussed the nuance in challenges associated with quantification and monetization of non-fatal health effects and increased the shared understanding of the types of information that would best serve agency needs for BCA. An important challenge that rose to the surface was the high dimensionality of non-fatal health effects, or the many types of conditions that could be caused from a single substance or contaminant. Several approaches were suggested to increase the understanding of non-fatal health effects including integrating risk assessments with BCA to quantify changes in health risks and methods for using studies of non-human animals to enable more comprehensive quantification of non-fatal health effects. For monetization, an approach to value non-fatal health effects under uncertainty was suggested, which would be to weight expected benefits using quantitative characterizations of the probability of causality, perhaps generated by expert elicitation. A key outcome of this workshop was identifying approaches to increase academic researcher interest and engagement in policy-relevant studies. An important suggestion is to place government analyses in repositories that are incorporated into citation databases. This would signal to cited researchers the importance of their work and make government analyses more readily available and citable by nongovernment researchers.

[7] https://www.ncbi.nlm.nih.gov/pmc/

[8] See https://new.nsf.gov/funding/opportunities/science-science-approach-analyzing-innovating

Ecosystem Services Effects Interagency Working Group

Topic Significance

In practice, agencies that affect or manage natural resources in fulfilling their missions may consider ecosystem services[9] to various degrees within BCA frameworks or more broadly as benefits to agency actions. However, agencies do not always quantify and monetize these effects, in part due to data and methodological constraints, limiting their inclusion in agency decision-making. The OMB's re-issuance and update of Circulars A-4 and A-94[10,11] in 2023 and Ecosystem Services Valuation guidance[12] in 2024 reaffirms direction to agencies to consider a range of services from the environment or ecosystems in agency BCA. The updated guidance places these services under the collective heading "ecosystem services."[13] By providing general guidance on ecosystem services (ES), these documents should help agencies that have not historically considered ecosystem-service effects within the context of BCA begin to do so in an efficient manner. The state of ecosystem-service science has advanced considerably over the last several decades. However, current research gaps may hinder efforts to understand the effects of specific agency actions on the provision and valuation of ecosystem services.

Facilitating Progress

The Ecosystem Services (ES) IWG focuses on ecosystem service effects in BCA. Co-chaired by representatives from the Office of Science and Technology Policy (OSTP) and the Department of the Interior (DOI) Office of Policy Analysis, 15 agencies or offices participated including OMB, Council on Environmental Quality, NOAA, Bureau of Land Management, Bureau of Ocean Energy Management, Office of Surface Mining Reclamation and Enforcement, Bureau of Reclamation, United States Geological Survey (USGS), EPA, Millennium Challenge Corporation (MCC), United States Army Corps of Engineers, and the US Forest Service. The ES IWG was established in January 2024 to provide federal staff interested in or actively researching ES an interagency community to discuss the state of ES knowledge, identify gaps in the science that would inform regulatory analysis, and engage the research community to close those gaps.

The 2023 inaugural report of the SFBCA[14] identified specific agency needs and research gaps related to ES. Generally, data gaps were the most common challenge identified for valuing changes to ES as a result of actions (i.e., the marginal benefit or disbenefit), including gaps in environmental data needed to estimate how a federal action may affect ES, how environmental changes affect human welfare, how

[9] Ecosystem services are contributions to human welfare from the environment or ecosystems. Examples include water purification or flood mitigation.

[10] OMB. Circular A-4, Regulatory Analysis (November 9, 2023). https://www.whitehouse.gov/wp-content/uploads/2023/11/CircularA-4.pdf

[11] OMB. Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs (November 9, 2023). https://www.whitehouse.gov/wp-content/uploads/2023/11/CircularA-94.pdf

[12] OMB. Guidance for Assessing Changes in Environmental and Ecosystem Services in Benefit-Cost Analysis (February 28, 2024). https://www.whitehouse.gov/wp-content/uploads/2024/02/ESGuidance.pdf

[13] The last issuance of A-4 was 2003. The collective term "ecosystem services" only began to gain common usage after 2005.

[14] Advancing the Frontiers of Benefit-Cost Analysis: Federal Priorities and Directions for Future Research. Annual Report by the Subcommittee on Frontiers of Benefit-Cost Analysis of the National Science and Technology Council. 2023. Washington, DC. https://www.whitehouse.gov/wp-content/uploads/2023/12/FINAL-SFBCA-Annual-Report-2023.pdf

people's preferences or behaviors change as the provision of ES changes, and the resolution of data or lack of data for specific locations and populations. The 2023 report also identified methodological challenges.

To engage the research community in addressing these gaps, the ES IWG designed and convened a workshop of leading ES researchers to discuss agency needs, review the state of the science, and identify actionable approaches to make progress.

Workshop Details

On May 28, 2024, the workshop brought together federal staff and academic researchers at the Eisenhower Executive Office Building in Washington, DC. Twenty-five participants attended, representing academia and federal agency researchers, technical experts, and managers. By design, the workshop included knowledge-sharing sessions, as well as an interactive activity to increase collaboration between agencies and researchers on identifying ecosystem-service research gaps and paths for filling those gaps.

Figure 2. Ecosystem Services Effects Workshop

This photo shows participants engaged during opening remarks at the ecosystem services effects workshop held at the Eisenhower Executive Office Building in Washington, DC. Photo credit: Christian Crowley, DOI

Knowledge-sharing

Federal government representatives presented on current agency practices and challenges related to ES with a focus on priority areas to develop additional ecosystem service data, tools, and methods for supporting regulatory BCA. Agency presentations focused on three areas, summarizing:

1. Agencies' primary regulatory contexts and decisions that may affect ES,
2. The most prevalent or prominent ES that may be affected by agency work, and
3. Limitations on quantifying or monetizing ecosystem-service effects (i.e., data, models, methodology).

During these presentations, agencies reported on their role in managing land and water resources, including energy and minerals leasing, agriculture, forestry, hazard mitigation (including flooding), ocean fisheries, and environmental protection, among others. Common areas in which ES emerged as most prominent were water quality, hazard mitigation, and recreation (and other cultural services). Further, agencies identified similar limitations on quantifying and valuing ES, including a lack of understanding of how an action will affect the provision of ES and lack of data on the specific places and populations that would be affected by a decision. Participants also discussed cases when it is necessary or appropriate to qualitatively assess ES. The SFBCA is focused on improving the quantification and monetization of the effects of agency actions; important ES might be difficult or impossible to quantify or monetize, but these effects should not be ignored because of this challenge. OMB Circular A-4 provides general guidance on how to treat non-monetized benefits and costs.[15]

[15] OMB Circular A-4 (2023): 44-48

Academic researchers provided overviews of their areas of ES research, responding to three prompts:

1. The primary ES or methods involved in their research,
2. Opportunities to coordinate or contribute to meeting the needs of federal agencies, and
3. Disconnects or barriers between agency needs and research interests.

The diverse group included leading ecosystem-service researchers with areas of expertise such as ecological research on ES, valuation of coastal services, meta-analysis, recreation, benefits-transfer, cultural ES, and non-monetary valuation. Researchers included economists, other social scientists, ecologists, and other physical scientists. They reported on the state of the science, recent advances, and available resources in ES quantification, economic valuation techniques, and non-monetary valuation. Numerous participants mentioned a mismatch of incentives between policy needs and what motivates academics (e.g., the importance of being cited).

Collaboration exercise

Following the knowledge-sharing, the participants separated into three smaller groups comprised of federal agency staff and academic researchers to work through a hypothetical BCA scenario. The objective of the activity was to consider the applicability of currently existing datasets, tools, and methods for quantifying and valuing the affected ES using a scenario-based approach. The scenarios were designed to reflect the diversity of decision contexts and ecosystem settings that the participants may encounter in a BCA. One scenario focused on a coastal community, one was set in a rural forest, and the third had an urban river setting. Each group identified the relevant ES for their scenario; whether each service is quantifiable and monetizable; and relevant data, tools, methods, and limitations for assessing and valuing the ES identified. In the final session of the day, each of the three groups presented the results of their work on the exercise, followed by a general discussion with all participants.

Workshop participants enthusiastically shared knowledge, applied their expertise and experience to BCA scenarios, identified critical gaps in ecosystem-service benefits assessment, and proposed actionable steps to close those gaps.

One point of discussion was the opportunity for agencies to more prominently cite research used in rulemaking to increase accessibility, machine readability, and to provide a clear signal as to what types of research are useful. Participants agreed that more closely aligning with existing incentive structures for researchers (i.e., the need to be cited) would motivate researchers to fill the identified gaps. Several recommendations were provided for this area. One is to include changes to the Federal Register that would enable publications cited in the Federal Register to be searchable in research-focused databases. Another recommendation was to regularly upload regulatory impact analyses (RIAs) and other government publications to pre-print opensource databases, and including searchable citations in RIAs and other government publications. Other recommendations include journal publications synthesizing and highlighting policy-relevant research; an OIRA-managed citation database that includes Docket number, Document title, Issuing Agency, Citation information (author, source, date); and federal competitions to incentivize early-career scientists to investigate specific topics. Continued federal agency involvement in professional conferences is another opportunity for soliciting and highlighting policy-relevant work. For example, the Association of Environmental and Resource Economists included a session in their 2024 Fall Workshop titled “Actionable Economic Research for Policy Making.”[16] The Society for Benefit-Cost Analysis has hosted similar relevant workshops including a

[16] https://www.aere.org/fall

session on "Benefit-Cost Analysis for U.S. Regulations"[17] from its 2024 Professional Development Series. Public policy focused conferences such as those hosted by the Association for Public Policy Analysis and Management[18] are also an opportunity for federal agencies to increase awareness of needs in BCA.

Another opportunity the group identified was for federal agencies to solicit work on specific topics to be included in databases the agencies rely on and for the broader research community to compile that data and pair it with robust and publicly searchable citations of examples of agency use. Examples of frequently used databases and tools for ES identified are: Oregon State University's Recreation User Value Database,[19] EPA's BenSPLASH water quality valuation tool,[20] BlueValue.org,[21] and USGS's former Benefit Transfer Toolkit.[22]

Participants discussed the need for ongoing collaborations between government agencies and academic researchers, and they cited EPA's Science to Achieve Results[23] grant program as an example of a vehicle for policy-relevant collaborations spanning years rather than stopping with one-off efforts. The Cornell University-led Social Cost of Water Pollution Workshop[24] is one such example. Another example is OMB's Evidence Forums partnership with Pew Charitable Trust's Evidence Project,[25] convening leaders in government, academia, and civil society to bridge gaps between academic research and real-world issues like climate change, health disparities, and economic inequity.

Participants discussed the need for clarity on ecosystem-service concepts and terminology to facilitate cross-agency discussion and the options for a common ecosystem-service classification framework (e.g., EPA's National ES Classification System, NESCS Plus[26]). Future discussions of the ES IWG could focus on ES that might prove difficult to classify and quantify and the pros and cons of adopting a single framework for the U.S. government. A related topic is the lack of capacity and skilled personnel to go out into the field to measure, report, and analyze data from nature-based solutions and the ES they provide.

Participants agreed that it is helpful to be able to refer to current examples of BCAs and suggested producing an updated and broadened collection of outstanding examples along the lines of R.D. Morgenstern's "Economic Analyses at EPA: Assessing Regulatory Impact."[27] Examples could be drawn from MCC's published BCAs[28] for the projects they support. Another example is a review of a BCA of DOT safety regulations.[29]

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[17] https://www.benefitcostanalysis.org/sbca-online-workshops
[18] https://www.appam.org/
[19] https://recvaluation.forestry.oregonstate.edu/database
[20] https://sab.epa.gov/ords/sab/r/sab_apex/sab/advisoryactivitydetail?p18_id=2655
[21] https://www.bluevalue.org/
[22] The benefit transfer toolkit is no longer supported online; for a description see the USGS Open File Report 2016–1178 "Facilitating the Inclusion of Nonmarket Values in Bureau of Land Management Planning and Project Assessments" (https://pubs.usgs.gov/of/2016/1178/ofr20161178.pdf)
[23] https://www.epa.gov/research-grants/star
[24] https://www.atkinson.cornell.edu/research/social-cost-of-water-pollution/
[25] https://www.pewtrusts.org/en/projects/evidence-project
[26] https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-nescs-plus
[27] Morgenstern, RD. "Economic Analyses at EPA: Assessing Regulatory Impact". 1997, 2014.
[28] https://www.mcc.gov/our-impact/err/
[29] Aiken DV, Brumbaugh S. Assessing Risk, Effectiveness, and Benefits in Transportation Regulation. Journal of Benefit-Cost Analysis. 2023;14(2):318-335. doi:10.1017/bca.2023.19

Figure 3. Ecosystem Services Effects Workshop Participants

This is a group photo of participants at the ecosystem services effects workshop at the Eisenhower Executive Office Building, Washington, DC. Photo credit: Christian Crowley, DOI

Participants noted that going forward, researchers reviewing government BCAs and the assumptions that underlie them using retrospective analysis is one approach for assessing the accuracy

of assumptions and gauging how the field advances over time. An important step to understanding the effectiveness of mitigating natural hazards and ecosystem restoration is to monitor the effectiveness of projects and programs through field-level observations. With improved information on the effectiveness of projects and programs, economists may be better positioned to link biophysical relationships with economic outcomes in forward-looking policy questions.

Progress in 2024

The ES IWG's workshop to share knowledge, identify gaps in the science that would inform regulatory analysis, and engage the research community to close those gaps was a highly productive activity. Actionable recommendations to increase connections between agencies and academia and better align incentives for conducting policy-relevant research were identified. An important finding of the workshop, echoing the Non-Fatal Health Effects Workshop, is the criticality of more prominently citing research used in rulemaking to increase accessibility, machine readability, and to provide a clear signal as to what types of research are useful. Participants from both the research community and agencies shared information on opportunities and previous approaches to increase engagement on ES science and economics topics, providing a blueprint for how this can be done in the future.

Workshop participants gained a deeper understanding of the federal government's role in implementing and operationalizing ES principles in BCA, and academic researchers assisted in filling

knowledge gaps. In addition, the academic researchers who participated now have a clearer understanding of the needs of government agencies in this area. Federal staff and researchers have engaged in subsequent conversations, including conversations on the use of non-monetary valuation as a complement to non-market valuation in BCA. The ES IWG plans to continue making progress on closing gaps in research on ES.

Effects of Public Benefit Programs Interagency Working Group

Topic Significance

Millions of Americans participate in public benefit programs each year, and the programs provide a wide array of benefits and services to individuals and families. Current analyses sometimes focus on the government's costs in administering the programs or on changes in some types of administrative burden in accessing or interacting with the programs. To improve such analyses, better quantification and monetization of the effects—particularly the effect of administrative burden—can be especially helpful. In addition, while administrative and programmatic costs are important, they constitute a fraction of the total effects of these programs. Therefore, alternative economic approaches to valuing the goods, services, and transfers provided by public benefit programs may be more informative. Relatedly, there is a gap in understanding the link between changes in administrative burden and program take-up or participation.

Facilitating Progress

The Public Benefit Programs IWG was formed as a community of practice for federal agency representatives to consider approaches to, and facilitate progress on, information gaps for quantification and monetization of effects of public benefit programs. The IWG, which met throughout the spring and summer of 2024, was led by representatives from the OIRA and Department of Health and Human Services (HHS) and included participants from multiple components of HHS, HUD, and the Department of Agriculture (USDA). The IWG planned and convened a workshop to bring together federal agency representatives and academic researchers with the objective of highlighting the specific areas that need progress to inform agency analyses, engage academic researchers in the field, increase awareness of the state of the science and economics, and identify actionable approaches to further progress on this topic.

Workshop Details

On June 17, 2024, the IWG convened a workshop with federal agency representatives and non-profit and academic researchers in the Eisenhower Executive Office Building (Washington, DC) to consider the research questions it has chosen to focus on from the 2023 SFBCA report. Federal government presenters opened the workshop by describing the legal and policy motivations for accurately assessing the benefits and costs of agency actions and laid out some of the challenges unique to the assessment of public benefit programs. The workshop then had three sessions focused on making progress on specific research questions. These sessions included how to assess the value of public benefit programs to program recipients beyond estimates of the direct spending per recipient; how to make existing evaluations of the administrative burden of public benefit more accurate; how to incorporate potentially important additional sources of administrative burden into economic analyses of programs; and how to relate changes in administrative burden to subsequent effects of the program. These questions were discussed in the context of food and housing policies. The workshop presenters

and participants also devoted substantial attention to the question of how to improve researcher engagement in the regulatory analysis process, both for public benefit programs and for regulations more broadly.

The introductory presentations by representatives from HHS and OIRA described the regulatory process and the legal basis for agency assessments of the costs and benefits of their actions. The discussions highlighted the multiple opportunities for researcher engagement that are created by the regulatory process.

Discussions throughout the day included focus on the central challenges in analyzing the economic effects of public benefit programs. In terms of fiscal outlay, public benefit programs are a large portion of the total federal budget and the economy. Millions of Americans are recipients of public benefit program support each year.[30] Public benefit programs also generate a large number of regulatory analyses.

As described at the start of this section, the economic analysis of changes in public benefit programs often focuses on changes in administrative burdens and costs. Changes in the actual funding or in-kind goods provided by the program are often considered to be a transfer. As stated in Circular A-4, a transfer, "in its simplest form, is a shift in money (or other item of value) from one party to another," and "when a regulation generates a gain for one group and an equal-dollar-value loss for another group, the regulation is said to cause a transfer from the latter group to the former."[31] In regulatory BCAs under Circular A-4, transfers may be accounted for as a separate category of effects from other benefits and costs, or may be accounted for as offsetting benefits and costs.[32]

By classifying the outlays of public benefit programs as transfers, analyses of the programs acknowledge that there has not (or has not yet) been estimation of change in net social welfare from the program other than through the transaction costs of implementation. This approach to classification may obscure potentially important issues on both the benefit and cost sides.

One way to see the effect of the first method is to compare decisions about how to fund different programs. Consider, for example, food assistance programs like the Supplemental Nutrition Assistance Program; the Special Supplemental Nutrition Program for Women, Infants, and Children; or the National School Lunch Program. Together these programs provided $166.4 billion in assistance to individuals and families in 2023.[33] Is this the right level of funding? And is the distribution of funding across these programs maximizing the social impact that the programs might have? By treating all outlays from these programs as transfers, the effects of the programs are implicitly being treated as the same. Treating the payments or goods provided by these programs as transfers means that the analyses

[30] For example, 99 million people participated in at least one of ten social safety net programs in 2019. 65 million Americans participate Medicare, and 75 million Americans participate in Medicaid. Macartney and Ghertner (2023) "How Many People Participate in the Social Safety Net?" https://aspe.hhs.gov/sites/default/files/documents/18eff5e45b2be85fb4c350176bca5c28/how-many-people-social-safety-net.pdf; https://www.census.gov/library/stories/2022/05/who-is-receiving-social-safety-net-benefits.html.

[31] OMB Circular A-4 (2023), 57.

[32] *See* OMB Circular A-4 (2023), 57-60.

[33] USDA Economic Research Service, "Food Security and Nutrition Assistance." November 29, 2023. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-security-and-nutrition-assistance/

cannot speak to whether a dollar spent on one program provides more or less actual change in welfare to recipients.

One alternative approach to evaluating the effects of these programs is to assess the WTP that program participants have for the payment or in-kind good provided by the program. In recent studies from the field of public economics, one common economic endpoint used to assess this WTP is the change in earnings for program participants caused by the program.[34] Regulatory BCAs might not use earnings changes to assess WTP because of questions about how much the earning effects are additional. Another often-unanswered question is the extent to which increases in earnings represent improved productivity (and thus, from a society-wide perspective, are appropriately categorized as a benefit), as opposed to the portion instead representing a shift between workers (with some workers being placed in higher-paying jobs and others displaced to lesser-paying jobs). If the person is already optimizing their labor-leisure choices, for example, then the earnings gains from increased hours worked are more than fully offset by utility losses from reduced leisure.[35] In contrast, changes in mortality are one of the most commonly monetized effects in regulatory BCAs.[36] Mortality effects, according to workshop participants, are rarely included in academic analyses of public benefit programs. This difference in focal endpoints creates a gap between the research being produced on public benefit programs and the research needs for agencies.

If the main goods, services, or payments provided by the program are treated as transfers, the primary method for comparing two different program alternatives is through the net benefits created by changes in administrative costs and administrative burden. This makes both of these types of effects important to accurately estimate. Administrative burden is also important because it affects the rate at which eligible individuals actually participate in public benefit programs.[37] Recent initiatives by the OIRA and other government agencies have sought to reduce these burdens.[38]

One commonly assessed type of administrative burden is time cost to fill out paperwork or otherwise engage with the program.[39] Time cost burdens are just one of many potential types of administrative burden. A series of research projects could help improve the analysis of administrative burdens. First, researchers could help agencies by working to provide methods and estimates to better quantify and monetize time-based burdens. Given that time costs are currently widely used to measure administrative burden, improvements in these measures could be relatively readily incorporated into BCAs. Some improvements could be to generate methodologies to more consistently go beyond

[34] See, for instance, Chetty, Raj, Nathaniel Hendren, and Lawrence F. Katz. "The effects of exposure to better neighborhoods on children: New evidence from the moving to opportunity experiment." *American Economic Review* 106, no. 4 (2016): 855-902.

[35] See recent research on the peoples' preferences for nonemployment - https://academic.oup.com/qje/article/135/4/1905/5838866#206773390

[36] The majority of monetized benefits in federal regulatory analyses comes from changes in mortality. See Colmer, J. (2020). "What is the meaning of (statistical) life? Benefit–cost analysis in the time of COVID-19." *Oxford Review of Economic Policy* 36.

[37] Herd, Pamela, and Donald P. Moynihan. *Administrative burden: Policymaking by other means*. Russell Sage Foundation, 2019.

[38] https://www.whitehouse.gov/omb/information-regulatory-affairs/burden-reduction-initiative/

[39] For example, on IRS tax return form 1040, the average burden is assessed for the average taxpayer to be 6 hours for recordkeeping, 2 hours for tax planning, 4 hours for form completion and submission, and 1 hour for all other time uses. The monetized value of this 13-hour time burden is estimated to be $270. IRS "1040" (2023) https://www.irs.gov/instructions/i1040gi.

estimates that solely focus on the time to fill out paperwork to a broader estimate of the total time required to interact with the program. Similarly, monetization of time costs could be improved. Wages are commonly used to monetize time burdens. However, using wages to value time ignores non-wage compensation and might not accurately capture the welfare effects of time burdens for individuals facing binding constraints on their time use.[40] Research is needed both on refinements of approaches that begin from wages and on alternative approaches.[41]

Second, research could help enlarge the set of administrative burdens that are quantifiable and monetizable. For example, methods from sociology used to assess the presence of psychological burden could be combined with economic methods for eliciting WTP to reduce those burdens.

Third, research could help elucidate the link between changes in administrative burden, program participation, and the economic endpoints associated with that participation. This research area would benefit from the increased attention to alternative economic endpoints and methods for assessing the WTP for programs discussed above.

The workshop participants also discussed ways that research on public benefit programs could be more informative for regulatory BCA. One commonly voiced request was for more work that evaluates the effect of changes in programs—either the size of the program or in attributes of the program—rather than research that evaluates the overall effect of the program's existence. Influential, high-quality research on public benefit programs often focuses on the introduction of the program to gain econometric identification.[42] To help promote more well-identified research on intensive-margin changes in public benefit programs, agencies can consider designing the rollout of those intensive-margin changes to help generate sources of econometric identification.

Figure 4. Effects of Public Benefit Programs Workshop

This is a group photo of participants at the effects of public benefit programs workshop on the Navy Steps at the Eisenhower Executive Office Building, Washington, DC. Photo credit: Aaron Kearsley, HHS

Progress in 2024

The workshop was an informative opportunity for federal agencies and the research community to increase awareness of agency needs and to highlight the state of the science on this topic. Key areas ripe for increasing input into BCA were identified, including methods and estimates to better quantify and monetize time-based burdens to understand costs associated with public benefit programs, alternative approaches to treating all payments as transfers, and methods from sociology that could be used to assess the presence of psychological burden and combined with economic methods for eliciting WTP to reduce those burdens.

[40] Whillans, Ashley, and Colin West. "Alleviating time poverty among the working poor: a pre-registered longitudinal field experiment." *Scientific Reports* 12, no. 1 (2022): 719.

[41] OMB Circular A-4 (2023), 52.

[42] See, for instance, Hoynes, Hilary, Diane Whitmore Schanzenbach, and Douglas Almond. "Long-run impacts of childhood access to the safety net." *American Economic Review* 106, no. 4 (2016): 903-934; Hoynes, Hilary, Marianne Page, and Ann Huff Stevens. "Can targeted transfers improve birth outcomes? Evidence from the introduction of the WIC program." *Journal of Public Economics* 95, no. 7-8 (2011): 813-827.

Insights for Researchers and Agencies for Producing Policy-Relevant Research

Objective, high-quality research plays an important role in informing agency decision-making. However, when conducting BCAs, agency needs on the Frontier topics are not being fully met due to a number of misalignments between what's needed by agencies and what's being provided by researchers. The SFBCA endeavors to increase the policy relevance of academic research by identifying data gaps that can be addressed that will be useful to future regulatory and other analysis via identification of, and making progress on, frontiers focal topics. Additionally, there is a need to facilitate the use of existing (or future) research to inform regulatory analyses, which can be termed the 'discoverability' of research. To increase discoverability, researchers can take multiple actions to increase the policy relevance of their scholarship, including engaging in the regulatory notice and comment process as well as commenting on RIAs, providing relevant information in requests for comments, engaging with government analysts as part of a broader research community, and engaging with science advisory committees (e.g., Federal Advisory Committees), among others. This section describes actions that researchers can take to make it more likely that their work will be informative for agencies; discusses challenges that come from the incentives that researchers face; proposes ways that agencies and leaders in academia, including journal editors and referees, can work to better align researcher incentives; and provides examples of how research has successfully informed agency analyses. These recommendations reinforce and build on those found in the 2023 SFBCA report.[43]

How Researchers Can Make Their Work More Relevant to Benefit-Cost Analysis

The following discussion provides tangible steps that researchers can take to make their work more informative in agencies' regulatory analysis, including the BCA that is integral to rulemaking.[44] It is not an exhaustive list of actions, but can provide some initial steps for researchers interested in improving the application of their research in regulatory analysis. Some of these actions impose little extra burden on researchers, while others may require more effort. Some actions, such as improving data and code availability, are independently being incentivized in the research community to satisfy other goals. Therefore, many of the most important steps a researcher can take to make their research more helpful for agencies are already considered good scientific practice.

[43] Subcommittee on Frontiers of Benefit-Cost Analysis. "Advancing the Frontiers of Benefit-Cost Analysis: Federal Priorities and Directions for Future Research." (2023): 33-38. https://www.whitehouse.gov/wp-content/uploads/2023/12/FINAL-SFBCA-Annual-Report-2023.pdf

[44] For further guidance on producing policy-relevant research, see Oliver, Kathryn, and Paul Cairney. "The dos and don'ts of influencing policy: a systematic review of advice to academics." Palgrave Communications 5, no. 1 (2019): 1-11; Ahmed, Shagufta, Gopi Shah Goda, Michelle Hahn, and Preeti Hehmeyer. "Following the rules: Connecting academic research to policy."

Consider the audience: An important foundation for informative research is to consider agencies as part of the audience for research papers. Many of the recommendations below flow from this viewpoint. Considering the agency as an audience member applies both to the empirical output of a paper and to the way the paper is written. Simulations, case studies, or other illustrations that augment the main body of a paper can be useful either as inputs into agency analyses or to aid understanding and communication. Bear in mind that within an agency, interdisciplinary teams often work on analyses. Therefore, it can be helpful for an economics paper, for example, to include a readily understandable version of a model to help agency economists communicate the idea of the paper to non-economist

Box 1. Opportunities for Engagement in the Federal Rulemaking Process. *This discussion is intended to be illustrative rather than comprehensive.*

Engagement opportunities frequently begin well before agencies draft regulations. For instance, agencies often accept comment on their learning agendas, which are plans for identifying and addressing priority questions relevant to their programs, policies, and regulations. Agencies also frequently take public comment on requests for information or advance notices of proposed rulemaking in which they seek input on the direction of regulatory programs. Agencies sometimes provide for other engagement opportunities such as workshops. Agencies publish their regulatory plans in the Unified Regulatory Agenda, which researchers could consult in assessing what policy or research questions or outputs to prioritize.

Engagement opportunities continue as the rulemaking process ensues. During the initial drafting of regulatory analyses, agencies review existing research and can (subject to the Paperwork Reduction Act and other relevant authorities) reach out to researchers for further input or clarification. At times, agencies may release an advance notice of proposed rulemaking, specifying further input they are seeking from the public. Next, an agency issues a proposed rule. The public has an opportunity to comment on these proposed rules and their accompanying regulatory impact analyses (RIA). Public comments provide a structured and helpful opportunity for engagement by researchers. In public comments, researchers can highlight relevant, existing research or comment on the appropriateness of the research used by the agency. If researchers are commenting on a rule's RIA, they should say so explicitly in the public comment to help agency economists find the relevant comment.

By law, agencies must review and respond to all relevant and significant comments before finalizing a rule. Once the final rule is released, researchers can provide helpful input by conducting evaluations or retrospective reviews of the effects of the rule. These evaluations are especially helpful for agencies if they both assess the effect of a regulation and compare the findings to the expected effects of the rule as indicated in the agency's prospective regulatory impact analysis. Agencies can aid retrospective analysis by structuring the roll-out or implementation of rules so that ex post assessment is easier to conduct. There are also longer-term ways for researchers to engage with rulemaking, such as consulting SFBCA reports and working for agencies on temporary assignments. *Box 3. Where Can Researchers Find Out What the Government Needs to Know?* provides links to many of these resources. To learn more about OIRA's recent efforts to support public engagement in the rulemaking process see https://www.whitehouse.gov/omb/information-regulatory-affairs/broadening-public-engagement-in-the-federal-regulatory-process/.

colleagues.[45] Alternatively, some researchers or their academic units publish short policy-focused briefs or blog posts as companions to technical articles to orient the non-specialist reader to their findings.

The research analysis, findings, and characterizations that an agency needs for their own analysis or decision might differ from the results that make a paper attractive for publication in a peer-reviewed academic journal (see the section *Challenges to Aligning Researcher and Agency Incentives* below). By keeping both an academic and agency audience in mind, researchers can improve the policy-relevance of their work. For example, updates to the Social Cost of Greenhouse Gases have benefited from recent publications in economics and science journals that both made progress on important academic research questions and provided informative inputs for BCA.[46] Researchers can also consider a tailored publication that is geared toward elaborating on a policy-relevant part of a larger research project. Journals such as *PLOS One*,[47] the *Journal of Benefit-Cost Analysis*,[48] and the *Journal of Policy Analysis and Management*[49] are peer reviewed but use different criteria than a typical academic journal—focusing less on methodological innovation or novelty—providing a more welcoming venue for policy-related research.[50]

Show the work: Researchers can make their studies more useful by "showing their work" in a variety of ways. Detailing how different assumptions affect estimates,[51] producing subgroup estimates, and other steps aimed at promoting transparency can help make research papers more useful to agencies. In general, it can be helpful for researchers to keep in mind that the specific analyses or conclusions highlighted in a research paper are unlikely to be exactly what an agency needs for BCA, so providing a wider range of outputs—and unpacking what went into a paper's output—can help agencies get the information they need.

Showing one's work can take multiple forms. For example, for an econometric analysis, researchers could include reproducible outputs containing models run using alternative controls or subsamples so that the agency can assess how estimates change as assumptions or samples change. This approach is

[45] For an example of such a paper in the context of BCA, see Bergstrom, Theodore C. "Benefit-cost in a benevolent society." *American Economic Review* 96, no. 1 (2006): 339-351.

[46] See, e.g., Carleton, T., Jina, A., Delgado, M., Greenstone, M., Houser, T., Hsiang, S., Hultgren, A., Kopp, R.E., McCusker, K.E., Nath, I., Rising, J., Ashwin, A., Seo, H., Viaene, A., Yaun, J., and Zhang, A., "Valuing the Global Mortality Consequences of Climate Change Accounting for Adaptation Costs and Benefits." *The Quarterly Journal of Economics* 137 no. 4 (2022): 2037–2105 and Rennert, K., Errickson, F., Prest, B.C., Rennels, L., Newell, R., Pizer, W., Kingdon, C., Wingenroth, J., Cooke, R., Parthum, B., Smith, D., Cromar, K., Diaz, D., Moore, F., Müller, U., Plevin, R., Raftery, A., Ševčíková, H., Sheets, H., Stock, J., Tan, T., Watson, M., Wong, T., and Anthoff, D., "Comprehensive evidence implies a higher social cost of CO2." *Nature* 610 no. 7933 (2022): 687-692.

[47] https://journals.plos.org/plosone/

[48] https://www.cambridge.org/core/journals/journal-of-benefit-cost-analysis

[49] https://onlinelibrary.wiley.com/journal/15206688

[50] PLOS ONE describes its criteria this way: "Unlike many journals which attempt to use the peer review process to determine whether or not an article reaches the level of 'importance' required by a given journal, PLOS ONE uses peer review to determine whether a paper is technically rigorous and meets the scientific and ethical standard for inclusion in the published scientific record." https://journals.plos.org/plosone/s/reviewer-guidelines

[51] See recent research suggesting explication and adoption of common assumptions - Shand, R., & Bowden, A. B. (2021). Empirical Support for Establishing Common Assumptions in Cost Research in Education. Journal of Research on Educational Effectiveness, 15(1), 103–129. https://doi.org/10.1080/19345747.2021.1938315.

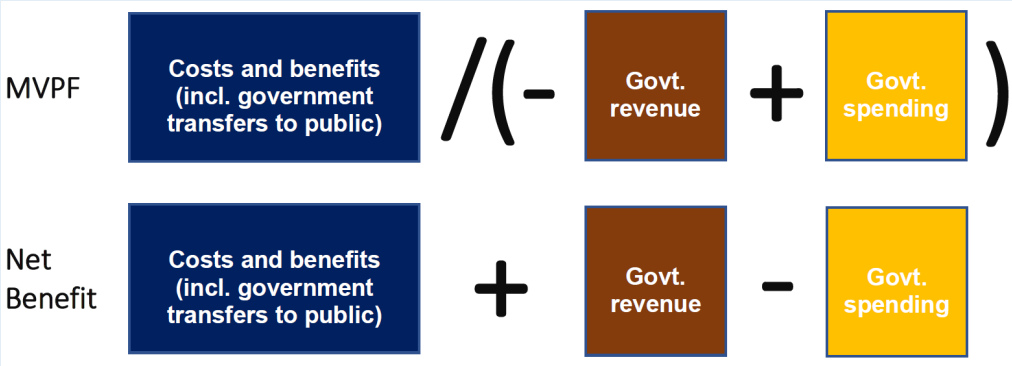
Box 2. Benefit-Cost Analysis and Quotient Metrics

The preferred procedure for measuring net benefits in federal regulatory BCA is clearly defined by Circular A-4: subtract the dollar denominated costs from the benefits to produce a *sum* of the net social benefits. The net benefits metric simplifies the evaluation process by reducing the need to distinguish between cost savings and benefits, government and non-government costs, or other potentially ambiguous categories of effects. However, in academic research, it is common to report other welfare metrics when evaluating government policy that do not adhere to this sort of net benefit summation. These include the Benefit-Cost Ratio (BCR), the Incremental Cost Effectiveness Ratio (ICER), and the Marginal Value of Public Funds (MVPF). In recent years, there has been renewed interest in the topic among academic economists, advocating variously for the traditional net benefits metric[1] or the MVPF.[2] This box explains how researchers' choices about reporting different welfare metrics may enhance or limit a study's usefulness in federal BCA.

To see the contrast between net benefits and quotient metrics—whether MVPF, BCR, ICER, or any other—consider an example in which a change to a higher education program improves productivity when the affected students participate in the labor market. Some of the productivity gain is likely to be reaped by the government as taxes (with the public's loss of taxes on increased earnings exactly offset by the government's gain of taxes on increased earnings). In a net benefits metric, all society-wide net productivity gains should be included as benefits. In the MVPF the additional tax revenue would be included in the denominator as a negative cost that lowers the *net* "price" of the program and would, similarly, be embedded in other quotient metrics like the BCR. From the perspective of federal analysis, reporting *only* a quotient metric could render a study less useful, or even unusable.

Circular A-4 notes that taxes often fall under the guidance to either exclude a government transfer from benefit tallies *and* from cost tallies (i.e., to include the impact in a separate transfer category) or to treat each side of a government transfer symmetrically (i.e., to add together the increase in tax revenue caused by the policy (benefit) with the decrease in money that stays in the taxpayer's pocket (cost), netting to zero change in the overall system). As the diagram in this box shows, only the net benefit approach, which adds together net social benefits of a regulation with government costs and government revenue effects, is invariant to the inclusion of government transfers—exactly because it treats them symmetrically. If a regulatory alternative, Rule A, performs exactly as another alternative, Rule B, but causes one more dollar in tax revenue to be collected (in a simplified example without any distortionary or other behavior-change effect on society), then that transfer will alter the calculation of the MVPF, as shown in the diagram. But that transfer will not alter the calculation of net benefits in the federal approach to BCA. That is intentional, by design, and consistent with the recommendations of Circular A-4.

Box 2. Benefit-Cost Analysis and Quotient Metrics (continued)



Source: original graphic

Regardless of the conceptual framework that a researcher chooses to highlight (BCR, MVPF, or any other summary metric), the researcher should separately report each term of their calculation to make it most likely to be useable in a policy analysis. For example, the Policy Impacts Library[3] focuses on MVPFs but also reports some inputs to the MVPF calculation. (Further disaggregation would be useful.) Separately reporting program expenditure, fiscal effects, and non-transfer societal benefits and costs—within a study itself or in appendix materials—would help agencies use research findings according to agency-specific protocols and government-wide guidance.[4]

1. García, J.L. and Heckman, J.J., 2022. Three criteria for evaluating social programs. *Journal of Benefit-Cost Analysis*, 13(3), pp.281-286.
2. Hendren, N., and B. Sprung-Keyser. 2020. "A Unified Welfare Analysis of Government Policies." *Quarterly Journal of Economics*, 135(3): 1209–1318 and Hendren, N. and Sprung-Keyser, B., 2022. The case for the MVPF in empirical welfare analysis.
3. https://policyimpacts.org/policy-impacts-library/
4. Circular A-4's discussion of "includ[ing] all the important costs to society" cites studies that "warn about numerous inconsistencies" in the ICER literature (p. 6). By contrast, thorough accounting in research studies, regardless of whether they use ICER, MVPF or another summary metric, would likely be facilitated by the transparency measures recommended in this report.

also consistent with the increasing focus on making replication materials and data from research papers more widely available. For example, EPA BCAs of regulations to reduce lead exposure have relied on studies that estimated several variations of the dose-response relationship between children's lead exposure and IQ loss using different functional forms, blood lead metrics, and lead exposure levels.[52] Furthermore, EPA's approach for estimating the effect of the IQ losses on lifetime earnings is based on a study that estimated effects separately for men and women.[53,54]

Providing a richer set of outputs can help an agency find the results that they need. In a regulatory analysis context, studies that produce important inputs like demand elasticities can be even more useful if they report estimates over space, time, or other subgroups. Analyses that report heterogeneity in effects across demographic or socioeconomic groups can be helpful for agencies examining distributional impacts. These types of analyses could be reported in online appendices as a supplement to the main paper.

Researchers should also consider that their work, especially in valuation, might be used as an input to a meta-analysis or other aggregation method. These methods require clear reporting of quantitative information about the study, but this information is often lacking. For example, a meta-analysis of stated preference studies calculating the value of a statistical life had to eliminate 13% of the observations in its initial dataset because the original studies did not report the risk reduction being valued—a crucial part of the studies.[55] In other cases, studies may be inappropriate for inclusion in meta-analysis because of missing information regarding standard errors. Researchers should also make any survey instruments they use available.

While aggregated results typically provide greater statistical power, more disaggregated reported results may allow agencies to adapt and incorporate researchers' estimates across disparate agency rules, conventions, and statutory requirements. For example, certain federal laws restrict the use of QALYs as a measurement of health impacts in decisions regarding Medicare coverage and reimbursement decision-making.[56] However, studies that report QALY gains as an aggregate measure of changes in life expectancy and quality of life may be useful in some analyses if each of these two components are also reported separately. If the authors additionally report the estimated impact on life years without quality-adjusting them, the results may be combined with a Value per Statistical Life Year to monetize changes in life expectancy. Similarly, changes in quality of life, measured as a change in health utility scores, can sometimes be used to value morbidity risk reductions or other non-fatal health effects when other estimates are not available. In reporting a stream of future benefits, one could report non-discounted benefits in each year rather than showing only discounted annual results or net present value. Offering these alternative presentations of the findings would allow agencies to apply

[52] Lanphear B., R. Hornung, R. J. Khoury, et al. (2005). Low-level environmental lead exposure and children's intellectual function: an international pooled analysis; Crump, K., C. Van Landingham, T. Bowers, D. Cahoy, and J. Chandalia. 2013. A statistical reevaluation of the data used in the Lanphear et al. () pooled-analysis that related low levels of blood lead to intellectual deficits in children. Critical Reviews in Toxicology 43(9): 785-799.

[53] Salkever 1995, Updated estimates of earnings benefits from reduced exposure of children to environmental lead, *Environmental Research* 70: 1-6.

[54] In addition, EPA has cited a study that allowed earnings effects to vary with age, gender, and race/ethnicity and presented estimates using different discount rates with multiple appendix tables showing the data. Lin, Lutter, and Ruhm, 2018, Cognitive performance and labour market outcomes, *Labour Economics* 51: 121-135.

[55] OECD 2012, The Value of a Statistical Life: A Meta-Analysis. https://one.oecd.org/document/ENV/EPOC/WPNEP(2010)9/FINAL/en/pdf

[56] *See* 42 U.S.C. § 1320e-1(c)(1), (e).

the estimates in a variety of contexts. See *Box 2. BCA and Quotient Metrics* for an example of breaking apart a composite estimate to make the results more useful for agencies conducting BCA.

Evaluate external validity: External validity is the extent to which a study's findings are applicable beyond the context of the original sample. It is useful for authors to expound on the external validity of their studies to help agencies determine the appropriateness of the research in a regulatory analysis. For example, when a study focuses on a particular geographic region or sample that is not inherently nationally representative, authors could provide discussion on whether and how they would extrapolate findings to a broader (e.g., national) population, what adjustments would be appropriate, and what caveats are important to note within their study. It is particularly helpful to provide a benefit-transfer function, which maps from covariates to an adjusted value rather than only the adjusted costs or benefits.

Discuss retrospective vs. prospective analysis: Empirical estimates in published research are often backward-looking (or retrospective), while regulatory economic analysis is typically forward-looking (or prospective). Additionally, economic studies often evaluate large, discrete events, such as the first, historic implementation of a program or policy. However, applying such analysis forward to analyze incremental changes—e.g., a marginal tightening or loosening of attainment criteria or an expansion of a public benefit to an additional small fraction of the population—can be difficult. To the extent that researchers can give guidance on the marginal impacts for small changes or the ranges of dose-response relationships that would be consistent with their findings, it may help agencies apply their results in new contexts. OMB Circular A-4 notes that it is most appropriate to apply existing estimates to a new policy context when the estimates and the policy context are similar in terms of the change in magnitude of the good or service and whether the effects are permanent or reversible.[57] Researchers can also be particularly helpful when conducting retrospective analysis of the costs and benefits of a regulation or other agency action. Retrospective analysis can help agencies measure the benefits and costs of existing regulatory programs, assess the accuracy of their prior prospective analyses of those programs, and identify effects that can be taken into account during future analysis that may inform program adjustments.

Engage with agencies at multiple stages: Researchers have multiple opportunities to engage with agency analyses. Seeking out these opportunities can help ensure that research outputs are better targeted to the needs of policymakers. Researchers can gain an understanding of upcoming research needs through a variety of sources. SFBCA reports, including this one, gather collections of research topics and focal areas that are of interest to agencies. Similarly, agency Learning Agendas (or evidence-building plans) contain research and policy questions that agencies would like to make progress on, both in the context of BCA and more broadly.[58] Agencies often invite public comments before completing their learning agendas. Upcoming regulatory actions that agencies plan to take in the near and long term are published in the biennial Unified Agenda.[59] The Unified Agenda is a key resource for academic researchers to gain an early understanding of future agency actions and related research needs. All of these resources can help researchers get a head start on the needs that agencies might have or identify more "evergreen" research areas where agencies routinely seek support from the research community. Researchers can also engage in dialogue with agency economists and other experts at professional conferences and workshops.

[57] Circular A-4 at 38.

[58] https://www.evaluation.gov/evidence-plans/learning-agenda/.

[59] https://www.reginfo.gov/public/do/eAgendaMain.

As an agency starts to develop analyses, researchers can engage in more targeted engagement. One of the simplest ways to undertake this kind of mid-process engagement is by submitting public comments to the docket for a proposed rule.[60] Agencies normally must issue regulations as proposals and invite public comment; when they do so, they typically provide supporting analyses such as (when applicable) BCAs, environmental impact statements, and technical support documents. Agencies must consider all relevant, significant comments received on a proposed rule and its supporting analysis. Such comments can help identify areas where an agency can improve its analysis or—at least as important—can point out where good analysis is being done. It might not come as naturally to academics, but comments that are supportive of good analysis can be as helpful as critical comments, as an agency weighs how to evaluate the totality of public comments. OMB has recently developed a list of best practices for developing public comments which may be useful for researchers.[61]

One way to get hands-on experience with agency analyses and increase one's understanding of the policymaking process is to engage in opportunities to temporarily join agencies or engage with agencies through fellowships. Fellowships exist specifically to connect researchers with agencies. Some of these fellowships, like the SeaGrant administered by NOAA,[62] are geared toward students and allow the students to be mentored by agency representatives and present their work to relevant agency representatives. Other opportunities, like ORISE fellowships[63] and the Presidential Management Fellows program,[64] are offered by multiple agencies and can be utilized by researchers at different points in their careers. In addition, Intergovernmental Personnel Act (IPA) agreements allow people working at institutions of higher education to gain temporary assignments at federal agencies.[65]

Working directly with agencies via cooperative agreements is another approach where there are common research interests and an increased degree of collaboration. An example is AmeriCorps' cooperative agreements[66] under which the agency works directly with academic institutions (and often their community partners) to study national service and civic engagement. Some of this research has direct policy relevance and has contributed to the existing knowledge from which AmeriCorps' ROI studies are built. A specific example is where researchers were able to demonstrate how AmeriCorps VISTA members help to increase volunteer and fundraising capacities of nonprofits providing the first step in understanding the direct impact of VISTA members in nonprofits.[67]

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[60] Dockets can be found here: https://www.regulations.gov/.

[61] https://www.whitehouse.gov/wp-content/uploads/2024/10/Public-Comment-on-Federal-Regulations_Final.pdf

[62] https://seagrant.noaa.gov/

[63] https://www.zintellect.com/Home/AboutORISE

[64] https://www.pmf.gov/

[65] See https://www.opm.gov/policy-data-oversight/hiring-information/intergovernment-personnel-act/. IPA Agreements can also be utilized by individuals working for State and local governments or Indian tribal governments.

[66] See https://americorps.gov/funding-opportunity/national-service-civic-engagement-research-competition-notice-funding-0 for more information.

[67] See Messamore, Andrew, Pamela Paxton, and Kristopher Velasco. 2021. "Can Government Intervention Increase Volunteers and Donations? Analyzing the Influence of VISTA with a Matched Design." Administration & Society 53(10):1547-1579.https://journals.sagepub.com/doi/abs/10.1177/00953997211009885

Box 3. Where Can Researchers Find Out What the Government Needs To Know? *This discussion is not exhaustive.*

The Unified Regulatory Agenda: https://www.reginfo.gov/public/do/eAgendaMain
This page links to agency-specific regulatory agendas and preambles. These agendas focus primarily on rules that the agency expects to propose or finalize within the next twelve months. For rules at the proposal stage, researchers can contribute by offering public comments in response to the proposal that, for instance, containing original research or point agencies to relevant existing research. Importantly, agencies also list long-term regulatory plans in the Unified Regulatory Agenda, which can be accessed by following the link to "Current Long-Term Actions." These describe regulations which will not be proposed for at least twelve months, and potentially much longer. This longer lead time gives researchers even greater opportunity to engage in original research aimed at influencing the regulatory process. Lead times for such regulations are frequently long enough (often several years) that there is time for an academic working paper or publication to have influence.

Evaluation.gov: https://www.evaluation.gov/evidence-plans/learning-agenda/
The Evidence Act requires agencies to produce new learning agendas every four years. As of this writing, there are 24 agency learning agendas and 3 cross-government learning agendas, all linked from the page given above. While these documents vary by agency, they frequently list well-defined research questions and agency plans to answer analyze them. In some cases, learning plans describe corresponding opportunities for grant funding or collaboration with an agency. Evaluation.gov also provides the searchable Learning Agenda Questions Dashboard, a searchable: https://www.evaluation.gov/learning-agenda-questions-dashboard/. Agencies often invite public comment before amending their learning agendas.

SFBCA: https://www.whitehouse.gov/omb/information-regulatory-affairs/frontiers-of-benefit-cost-analysis/
This report, and other SFBCA reports, describe long-run agency knowledge needs in detail. Interested researchers are encouraged to contact relevant agencies or the SFBCA (Frontiers@omb.eop.gov) to join ongoing efforts, or to ensure a planned project is not redundant.

Challenge.gov: https://www.challenge.gov/
This portal offers prizes for contributions to government initiatives. Some are for research or research-adjacent work.

Rules in Early Stages of OIRA Review:
https://www.reginfo.gov/public/do/eoAdvancedSearchMain
Reginfo.gov provides information on regulations as they make their way through the OIRA review process. Rules in earlier stages of the process—"Prerule," "Proposed Rule," or "Notice"—either are taking public comments or will do so in the near future. The comment period that follows OIRA review offers researchers an opportunity to 1) bring existing research to bear; or 2) submit original research results. Agencies are required to respond to such significant comments, and comments from stakeholders are often and they can be influential.

Additional resources include **Grants.gov**: https://grants.gov/ and **Regulations.gov**: https://www.regulations.gov/

Challenges To Aligning Researcher and Agency Incentives

The incentives faced by academic researchers when publishing research can work against producing informative and policy-relevant research. This section describes these incentives so that agencies, universities, and journals can better understand the constraints that researchers face and work to align incentives with agency needs where possible.

A central goal of scientific research is to produce new, generalizable knowledge. Academic journals reflect this goal by heavily weighting novelty in choosing what to publish. Researchers themselves are also motivated by a desire to push the research frontier. These incentives and motivations mean that detailed, context-specific applications or studies are often not well-rewarded through publication or citation in comparison to the time and effort they take. This focus can be at odds with producing results that are especially relevant for agencies. For example, agencies benefit from values that are robustly estimated using well-established methods but in a new setting (e.g., the context of the policy being evaluated) or values that have been replicated across multiple studies and data sets. For RIAs valuing foodborne illnesses across various FDA food safety regulations,[68] FDA economists used a study on an economic welfare-based method using QALYs and dollars to estimate health costs.[69] Another example is an article that updates fatal and non-fatal value per statistical case estimates for COVID-19 that vary by case severity;[70] it was applied by HHS in BCAs of several COVID-related policies, including the Administration for Children and Families (ACF), "Vaccine and Mask Requirements to Mitigate the Spread of COVID-19 in Head Start Programs" Interim Final Rule, "Removal of the Vaccine Requirements for Head Start Programs" Proposed Rule, CMS "Medicare and Medicaid Programs, and Omnibus COVID-19 Health Care Staff Vaccination" Interim Final Rule.[71]

As noted above, many practices of good science are also helpful for improving the policy relevance of research. These practices can be time-consuming for researchers, but trends in terms of the use of scientific studies in policy settings are positive. For example, release of well-documented replication code and data is increasingly required by academic journals. Also, releasing datasets as stand-alone publications is increasingly rewarded in many academic fields (and increasingly required by funding agencies like the NSF) even if it is still not as well incentivized as novel research.[72]

Many federal government researchers face similar challenges to their academic peers, as they have performance review processes that prioritize publications. At some agencies, a panel of peer reviewers develop and evaluate performance standards for research-grade scientists. This approach ties career

[68] Requirements for Additional Traceability Records for Certain Foods final rule, 87 FR 70910, November 21, 2022. Available at: https://www.fda.gov/about-fda/economic-impact-analyses-fda-regulations/requirements-additional-traceability-records-certain-foods-final-rule-regulatory-impact-analysis.

[69] Minor T, Lasher A, Klontz K, Brown B, Nardinelli C, Zorn D. The Per Case and Total Annual Costs of Foodborne Illness in the United States. Risk Anal. 2015 Jun;35(6):1125-39. doi: 10.1111/risa.12316. Epub 2015 Jan 2. PMID: 25557397.

[70] Robinson, L., Eber, M., & Hammitt, J. 2022. "Valuing COVID-19 Morbidity Risk Reductions." *Journal of Benefit-Cost Analysis*, 1-22. doi:10.1017/bca.2022.11.

[71] ACF Vaccine and Mask Requirements to Mitigate the Spread of COVID-19 in Head Start Programs Interim Final Rule, November 30, 2021, 86 FR 68052. ACF Removal of the Vaccine Requirements for Head Start Programs Proposed Rule, June 26, 2023, 88 FR 41326. CMS Medicare and Medicaid Programs. Omnibus COVID-19 Health Care Staff Vaccination Interim Final Rule, November 5, 2021, 86 FR 61555.

[72] See, e.g., the journal *Scientific Data*.

advancement to an incentive structure not unlike non-federal researchers.[73] Providing incentives within the evaluation process that reward science that both is of publishable quality and is useful for—and used by—agency analysts for BCA could increase the quantity of government research useful for decisions.

Agencies can take actions that would help incentivize more research on frontiers focal areas. Grants directed toward funding progress on focal areas can help attract research attention. Even in the absence of direct grant funding, agencies have multiple tools. Specifically:

- **Access to data**: Agencies have responsibilities under the Evidence Act to broadly increase access to open data. It may be possible to provide researchers with access to non-open data in a partnership that advances a focal area. Agencies can also provide guidance to researchers on how to best utilize a public, government-created dataset.[74] At the same time, researchers should understand that granting data access can be challenging and that sometimes researchers have more ready access to certain private-sector datasets. An example of data available is the Centers for Medicare & Medicaid Services database.[75]
- **Citations:** Some research fields strongly reward citations, but it is difficult for researchers to know when agencies are citing their papers because RIAs and other government documents are not typically indexed by citation databases. Efforts to make it easier for researchers to discover agency citations of their work would reward researchers whose work is used to inform policy.
- **Engagement with researchers**: Many researchers are motivated to make their work policy relevant. By engaging with researchers early in the production of their research projects, agencies can improve the likelihood that the resulting research papers are relevant to agency needs. Engagement earlier in a research process reduces the cost to researchers in terms of gathering relevant datasets, tailoring analyses, and writing papers in a well-targeted and digestible way. This guidance is the corollary to the advice in the section *How Researchers Can Make Their Work More Relevant to Benefit-Cost Analysis* that researchers should engage at multiple points in an agency's analytical process. The SFBCA is, itself, working to expand the ways that researchers can engage with agency counterparts. As discussed in the section *Progress on Frontiers Focal Areas*, SFBCA has hosted workshops to bring together researchers inside and outside of the government along with other agency representatives to make progress on focal areas identified in the 2023 report.
- **Alerting researchers ex post**: Even in the absence of direct engagement with researchers whose work is used to support federal analysis, agencies can reward researchers for their efforts through outreach noting how the researchers' work has been used. Such information can be useful for tenure and promotion materials where a researcher might want to show their broader impacts, and they may be otherwise unaware or less able to craft a compelling narrative.

Journals have played an important role in improving the policy-relevance of research and can continue to aid these efforts.

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[73] See, e.g., Final report on the assessment of the U.S. Geological Survey's bureauwide Research Grade Evaluation (RGE) process | U.S. Geological Survey (usgs.gov) for a description of the RGE process.

[74] For an example of such an event, see, e.g., Graduate workshop: Data-driven environmental economics research from the EPA | Brookings.

[75] The Centers for Medicare & Medicaid Services (CMS) makes data files available to certain stakeholders as allowed by federal laws and regulations as well as CMS policy. See CMS' Virtual Research Data Center at https://www.cms.gov/data-research/files-for-order/data-disclosures-and-data-use-agreements-duas.

- **Further promotion of good scientific practice**: As described elsewhere in this section, many practices of good, open science that are increasingly being adopted by journals also help to make research more useful for agencies. Efforts like publishing replication packages, releasing the data underlying estimates, and verifying that code or programs successfully reproduce the results from the paper all contribute to increasing the trust that agencies can place in research. They also make it easier for agencies to generate relevant analyses if the estimate that is most needed is not directly published in the research paper.
- **Consideration of agency needs when evaluating research**: Just like researchers can keep agencies in mind as a potential audience for their research, journal editors can consider agencies as a consumer of academic journals. This can be done by editors as they review papers, by selecting agency researchers to be part of the peer review process, and by recruiting agency researchers to join editorial boards when legally appropriate.

Finally, research institutions can work to better incentivize or promote policy-relevant work. University leaders can help incentivize policy engagement by faculty, for example by considering policy relevance when reviewing promotion or tenure packages or by considering IPA agreements, as discussed in the section *How Researchers Can Make Their Work More Relevant to Benefit-Cost Analysis.*

Box 4. A Researcher's Checklist for Policy-Relevant Research. *Not all items will be relevant to a given paper.*

☐ Publish replication code and data to a journal repository or an independent repository. Code and data that do not require expensive proprietary software are generally preferred. The replication package should cover any online appendices. Well-commented code is preferred. *While replication packages are helpful, they are often not sufficient for an agency to make use of a paper's results.*

☐ Clearly describe the baseline or counterfactual relative to which effects are estimated.

☐ If data used in the analysis cannot be shared in a replication package, then provide a complete set of descriptive statistics of those data.

☐ Provide substantial evidence that the findings are robust and are not overly reliant on a small number of data points. Conversely, if any outliers in the data were removed from the analysis, provide complete data on all of those outliers and full explanations for why they were removed.

☐ Report standard errors and/or variance-covariance matrices for *all* quantitative results. This facilitates analysis of uncertainty and meta-analysis.

☐ Provide disaggregated results (e.g., marginal effects, elasticities) in an appendix. Disaggregation in time (often by year) and by income decile or quintile is particularly valuable. Disaggregation on other dimensions of interest (e.g., gender, race, if relevant) is encouraged.

☐ Provide non-monetized, undiscounted effects. This will allow continued use of the results under changes in monetization (e.g., a new value of a statistical life) and discount rates.

☐ Show results under different plausible assumptions, e.g., functional forms of utility or production.

☐ Address external validity quantitatively. Provide not only benefit-transfer (or cost-transfer) results, but also a transfer function mapping from covariates to an adjusted value.

☐ Where applicable, evaluate whether positive and negative changes in a variable of interest have effects of similar magnitude.

☐ If original data were collected, survey instruments should be included in an appendix or replication package.

☐ Provide details on non-monetized undiscounted, and non-inflation-adjusted effects. This will allow continued use of the results under changes in monetization (e.g., a new value of a statistical life), discount rates, and inflation. When not possible, report any steps taken in sufficient detail so as to allow for replication.

☐ Research content, including literature reviews and quantitative material, should demonstrate cross-disciplinary awareness, if relevant (e.g., inputs and context discussion for a cost-effectiveness study of a health policy intervention should draw from biomedical, policy, and economics).

☐ When reporting dollar figures, include the dollar-year and how the amount has been adjusted for inflation (if at all).

☐ Retain source code and internal documentation of analytic choices that may not rise to the level of documenting in paper and supporting material (e.g., decisions like approaches to raw data cleaning or compilation).

Emerging Frontiers Focal Areas

The *Progress on Frontiers Focal Areas* section described progress on focal areas from the 2023 SFBCA report. Participants from SFBCA agencies reiterate that these focal areas—both the five primary focal areas and the two cross-cutting areas of analyzing distributional effects and analyzing risk—remain important areas where continued research could materially improve the quantification and monetization of the effects of agency actions. The SFBCA considered several candidate topics that also meet criteria determined by the SFBCA for prioritization: benefits and costs with potentially significant effects on public well-being, relevance to analyses of many upcoming agency actions, and potential for expanded quantification or monetization. One new focal topic was identified, a cross-cutting theme—Multi-Market Analysis. In addition, Appendix A provides the full list of topics that were identified by agencies.

New Cross-Cutting Focal Area: Multi-Market Analysis

Description and Significance of Effects

Agencies have long recognized that regulations may create benefits and costs beyond the market in which they intervene most directly. Ignoring such changes in related markets may lead to substantial errors in BCA, both in estimating net benefits and in characterizing the distribution of welfare changes across people and entities in the economy. Mechanisms for interactions between markets include prices, expectations, and others. Changes through any of these mechanisms potentially affect individuals' decisions and welfare.[76] For example, an increase in the stringency of air pollution regulation could lead to wage and employment changes in air-pollution-intensive industries, which could also have implications for wage and employment changes in other industries.[77] Even if secondary-market effects do not need separate accounting (from the welfare analysis in the primary market), after reaching a new equilibrium, there can be non-negligible unaccounted effects in the secondary market during the transition to that new equilibrium.[78] In the past, such changes in related markets have sometimes been ruled out based on the assumption of no price changes, without empirical evidence to support that assumption.

When the effects of a regulation are expected to impact markets beyond the regulated sector, a multi-market approach can sometimes be used to extend a single-market, partial equilibrium representation of the directly regulated sector to include closely related markets. These may include markets that represent the upstream suppliers of major inputs to the regulated sector, downstream producers who use the regulated sector's output as an input, and producers of substitute or complementary products.

[76] Just, R.E., D.L. Hueth, & A. Schmitz, *The Welfare Analysis of Public Policy*, Cheltenham, UK: Edward Elgar (2004); Ashley, E.M., "Welfare Analysis with Multiple Markets, Multiple Market Failures or Suboptimal Policy Calibration," *Journal for Economic Educators* 24.1 (2024): 1-12.

[77] Walker, W. Reed. "The transitional costs of sectoral reallocation: Evidence from the clean air act and the workforce." *The Quarterly Journal of Economics* 128.4 (2013): 1787-1835.

[78] See, for example, the questions about the market for cage-free eggs posed in Department of Agriculture, *Regulatory Impact Analysis and Initial Regulatory Flexibility Analysis: Organic Livestock and Poultry Standards Proposed Rule AMS-NOP-21-0073; RIN 0581-AE06* (2022), https://www.regulations.gov/document/AMS-NOP-21-0073-0005.

Box 5. Intersections between Frontiers Focal Topics and Regulatory Modernization

Current OMB guidance to federal agencies is contained in OMB's Circulars A-4 and A-94. This box highlights important intersections of OMB guidance with the frontiers focal areas. One direct connection between Circular A-4 and the SFBCA is through the **distributional effects** focal area. Circular A-4 points out that distributional effects may arise for numerous reasons, including group-specific baselines, group differences in characteristics, and attributes of proposed policies. Such heterogeneity plausibly exists both in the cross section and over time. Relationships between group attributes and distributional effects are potential topics for SFBCA investigation. The extent to which such relationships may be generalized or extrapolated to other settings—distributional benefit transfer—is a closely related question of both research and policy interest. In some cases, investigation of distributional effects requires following a policy stimulus from one market (e.g., timber) into another (e.g., the labor market for paper-manufacturing workers). The 2023 SFBCA report highlighted specific data gaps that impede distributional analysis, e.g., information on Tribal Nations and Indigenous Peoples.

Circular A-4 recognizes that group choice in a distributional analysis may depend on the rulemaking agency, the context of a particular rule, and available data. Income may be an important dimension in a variety of contexts. Academic research informing this focal area may have a role to play in discovering groups particularly affected by a given class of regulations. Academics may be able to contribute to data collection, or collaborate with agencies to design data collection that responds to distributional concerns. There may be needs for new data and methods even for variables commonly used in distributional analysis, like income. For example, to be relevant in policy analysis, an income measure might need adjustment for family structure, or taxes and transfers.

Given a set of groups, Circular A-4 makes several recommendations including the use of group-specific baselines. Researchers may contribute to such baselines through both measurement (data collection) and methods, e.g., imputation or estimation. Distributional analysis should cover, where feasible, all regulatory alternatives under consideration and analysis should allow for heterogeneous responses by different groups. For example, if a regulation decreases the price of a consumer good, different groups may increase consumption of that good by different amounts. That is, group-specific demand curves may exhibit different elasticities, or different groups may begin at different points on a single demand curve. Research may facilitate this kind of analytic flexibility, either by directly estimating heterogeneous responses or by studying extrapolation procedures that map from a smaller number of direct estimates into a larger number of groups. Presenting a distributional analysis is potentially more challenging than presenting an analysis that includes limited or no details about distributional effects. Circular A-4 recommends developing and presenting maps, for example, when distributional effects by geography are being studied. Scholars could inform this focal area by studying the effectiveness of different graphical presentations in conveying the results of a distributional analysis.

Box 5. Intersections between Frontiers Focal Topics and Regulatory Modernization (continued)

Circular A-4 describes in detail how income-based weights may be used to account for diminishing marginal utility; "Analyses applying weights that account for diminishing marginal utility will be more informative in proportion to the quality of the evidence on the distribution of benefits and costs experienced across the population."[1] Frontiers research may play a role in supplying such evidence, importantly about both benefits and costs, or increasing granularity. It may also contribute to refinements in recommended weighting procedures, e.g., by creating new evidence on how rapidly marginal utility declines as income grows, or by examining functional forms for utility different from the constant-elasticity specification described in Circular A-4. Future research into proxy-based and other indirect distributional approaches would fit naturally into the work of the SFBCA.

Uncertainty is another intersection between Circular A-4 and the SFBCA, especially in the focal topic of wildfire and extreme weather and the cross-cutting topic of risk analysis. Agencies should seek to quantify uncertain costs and benefits, but this can be difficult to do. SFBCA collaborations may contribute to the construction of new data sets and the development of modeling techniques. The Circular recognizes both qualitative analysis and expert elicitation (e.g., Delphi methods) as valuable approaches, and here too SFBCA may contribute to advances. In cases where statistical variability is difficult to assess with frequentist approaches, Bayesian approaches may provide a compelling alternative. SFBCA may provide a point of entry for Bayesian methods where they have not previously been used. Particular emphasis is placed in Circular A-4 on accounting for risk aversion (or, more generally, risk preferences) when valuing changes in uncertain outcomes. This is likely to be especially necessary when such changes are large and affect individuals, rather than larger entities like firms or governments. While there is a large academic literature on eliciting risk preferences, doing so presents numerous challenges. An individual's risk preferences may vary over domains and time. Even given stable risk preferences, it can be challenging to devise a survey instrument that incentivizes truthful responses, is not unduly burdensome, and is comprehensible to respondents. Work to measure risk preferences and model their implications for policy is likely to remain an evergreen topic within the SFBCA. Circular A-4 recommends certainty equivalents as an approach to risk aversion. Intuitively, a certainty equivalent is the amount of sure money that an individual is indifferent to given a gamble. Changes in uncertain outcomes produced by a policy can be mapped into changes in certainty equivalents. Such changes in certainty equivalents, in turn, can be used to rank different policy options. The SFBCA could provide a forum for working out the practical difficulties of measuring and comparing certainty-equivalent policy effects, both retrospectively and prospectively.

Covariances between uncertain baselines and policy effects may also interest SFBCA participants. For example, because of diminishing marginal utility, a policy that produces a large consumption increase when baseline consumption is low may be preferred to a policy that produces a large consumption increase when baseline consumption is high. This type of analysis is common in finance, but is not frequently employed in BCA.

In describing the Wildfire and Extreme Weather focal area, the 2023 SFBCA report gives a catalog of uncertain (risky) phenomena: "…natural hazards and extreme events, like wildfires,

Box 5. Intersections between Frontiers Focal Topics and Regulatory Modernization (continued)

floods, hurricanes, sea-level rise, drought, earthquakes, and extreme heat and cold." As discussed above, Circular A-4 recommends quantifying these uncertainties. Research in relevant natural sciences continue to advance the study of weather and other natural systems related to fire. There have been significant recent developments in using artificial intelligence to forecast weather, and in coupling traditional general circulation models with artificial intelligence for short-range weather forecasting and long-range climate modeling. In some cases, SFBCA may provide a conduit for new research like this to enter BCA.

As described in the 2023 SFBCA report, the most common agency challenges in this area are in quantifying and monetizing the effects of federal actions that bear on risks from extreme weather. Such actions may be ex ante, such as information campaigns or investments in resilience. They may be ex post, such as disaster relief. Sometimes the principal obstacles are data gaps, which are discussed in the 2023 report. SFBCA may have a role to play in measuring risk preferences particular to extreme weather (e.g., flooding), because risk preferences may be domain-specific and domain-specific elicitation techniques may be required. Beliefs about risk—as opposed to objective risk measures—may be relevant to BCA of regulatory alternatives, and therefore they should also be studied within this frontiers focal area. Research suggests that beliefs over extreme weather risks suffer from various human biases, e.g., recency bias.

Given a reasonable approach to risk preferences, Circular A-4 suggests the use of certainty equivalents to evaluate costs and benefits of regulation. For many regulations related to extreme weather, certainty equivalents will allow monetization. It is worth noting, however, that Circular A-4 does not insist exclusively on certainty equivalents. For large, risk-neutral entities, for example, expected value calculations over uncertain extreme weather may be appropriate. The SFBCA can provide a forum in which government experts and academics collaborate to implement A-4-recommended approaches to extreme weather to improve BCA.

Circular A-4 guidance on transfers is directly relevant to the frontiers focal area on Effects of Public Benefit Programs. The most general point made by the Circular is that analysts should attempt to improve upon the starting presentation indicating that a transfer has exactly offsetting effects on different groups. The SFBCA IWG on Effects of Public Benefit Programs has been exploring the analytical consequences of relaxing this assumption. More specifically, Circular A-4 gives a number of questions that identify transfers, including "Are effects naturally dollar-denominated? If not, the impacts in question are unlikely to be transfers."[1] The SFBCA IWG on Public Benefits Programs has studied, and continues to study effects that are not naturally dollar-denominated, including those on physical and mental health, and mortality. The Circular also asks, "Do estimates depend on behavior change? If so, the impact for which the estimates have been developed is less likely to *purely* be a transfer." Again, the IWG is interested in a variety of behavioral changes induced by transfer programs.

1. Participation in this Subcommittee (see list earlier in the report) does not necessarily indicate that all listed individuals believe distributional weighting to account for diminishing marginal utility of income is the preferred approach.

Vertically or horizontally related markets will be affected by changes in the equilibrium price and quantity in the regulated sector. As a consequence, they will experience equilibrium adjustments of their own that can be analyzed in a similar fashion.[79] A general equilibrium approach, which captures linkages between markets across the entire economy, is most likely to add value when both cross-price effects across markets and pre-existing distortions (e.g., taxes, regulations, market power in other markets) are expected to be significant.[80]

Interactions or feedbacks in other markets cut across the existing frontiers focal areas. For example, changes to wildfire insurance regulation may affect not only insurance premia and availability, but also housing prices and markets for construction labor and equipment. The cross-cutting focal area on distributional analysis also intersects with multi-market analysis, as the 2023 SFBCA report made clear: "To characterize the distribution of costs of an action, agencies aim to consider not just how costs may vary across different types of affected entities, but also how entities may pass-through costs to owners, employees, beneficiaries, or consumers."[81] This focal area considers "multi-market" analyses, which are broader than a single market and may extend to consider all markets jointly (general equilibrium) where appropriate. In this section, we highlight some of the challenges to multi-market analyses that agencies identified.

Current Challenges

Multi-market modeling and general equilibrium modeling, in particular, requires consistent, high-quality data on all economic actors in the economy. To defensibly parametrize these models, data over a sufficiently long historical time period is typically needed to estimate key parameters to adequately describe economic behavior. Often, however, the data needed for multi-market analysis may be absent, incomplete, or lack necessary spatial and temporal resolution. Even where regulation-induced price changes in adjacent markets can be estimated, welfare changes in those markets can be difficult to quantify. Estimates of supply and demand elasticities may be unavailable and difficult to estimate directly. Elasticities available in the scientific literature may require adjustment, but the needed adjustments or the methods for performing them may be unclear.

In addition, it may be challenging to estimate and represent regulations that fall on narrow segments of the economy – on specific industries, production processes, or locations – within a broader economic framework. Publicly available data are often available only in relatively aggregate form and therefore

[79] Just et al. (2005) detail methods for evaluating partial equilibrium welfare changes across multiple related markets (see also Bullock 1993). Estimating welfare is only possible when the relevant relationships among the sectors (e.g., cross-price elasticities) are correctly specified. Pizer and Kopp (2005) and Kokoski and Smith (1987) provide additional discussion of when these methods are suitable for estimating social cost. Bullock, D. 1993. Welfare Implications of Equilibrium Supply and Demand Curves in an Open Economy. American Journal of Agricultural Economics, 75(1): 52-58. Kokoski, M. and V.K. Smith. 1987. A General Equilibrium Analysis of Partial Equilibrium Welfare Measures: The Case of Climate Change. *American Economic Review,* 77(3): 331-341. Just, R., D. Hueth, and A. Schmitz. 2005. *Welfare Economics of Public Policy: A Practical Approach to Project and Policy Evaluation.* Northampton, MA: Edward Elgar Publishing. Pizer, W. and R. Kopp. 2005. "Calculating the Costs of Environmental Regulation," in Handbook of Environmental Economics, ed. K.G. Mäler and J.R. Vincent, Volume 3. Amsterdam: North-Holland.

[80] EPA. 2017. Science Advisory Board Advice on the Use of Economy-Wide Models in Evaluating the Social Costs, Benefits, and Economic Impacts of Air Regulations. September 29.

[81] 2023 Frontiers Report, at 26.

may preclude assessment at a more disaggregated scale (e.g., lack of state-to-state trade flows data; lack of supply and demand elasticities for narrowly defined markets). Linking of detailed sectoral models with economy-wide models may help bridge this gap in such instances, though operationalizing this approach is also challenging and requires careful calibration and expertise.

General equilibrium models are typically not designed to characterize transitions between equilibria. As such, they miss potentially important adjustment costs, such as those arising from unemployment. The literature on models that explicitly characterize short-term labor market transition costs is small and still emerging. Models that characterize longer-term structural unemployment are also a still emerging area.[82]

Highly detailed multi-market modeling can be complex. There is a fine balance between adequately representing important aspects of economic behavior and introducing so much complexity into a model that it is not clear what mechanisms drive results, and the effort provides little yield in improved estimates and insights. The required inputs of expert time and computational resources to apply such models are significant. Sensitivity analyses around key parameters and representation of key aspects of the regulatory action, as well as adequate characterization of model uncertainties, is essential but can further add to the time and resource burden of multi-market analysis. Multi-market analysis also requires decisions on which markets will be considered. Such analysis therefore tends to be context-specific. This limits the use of standardized templates and processes, making analysis more costly.

Finally, many multi-market models primarily focus on characterizing costs. How to account for the potential interaction between benefits and costs is a frontier area in research. For example, most general equilibrium models do not explicitly represent how changes in mortality and morbidity risks induced by a regulation (e.g., one that improves access to health care or environmental quality) can affect behavior. If such changes in risk are represented, they are typically operationalized through the labor endowment (more time is available for work and leisure). However, changes in mortality and morbidity risks may also change the bundles of goods and services households purchase, as well as the way spending decisions are allocated over time.

Relevant Federal Guidance and Examples

The most relevant guidance in Circular A-4 is titled “Partial and General Equilibrium Analysis.” Circular A-4 indicates that multi-market analysis may be particularly useful when a regulation causes price effects in other markets.[83] It does not indicate that general-equilibrium analysis should always be performed: “In practice, BCAs may combine elements of a partial equilibrium analysis and elements of a general equilibrium analysis.”[84] Computational or data constraints may make general-equilibrium analysis infeasible. When deciding on the scope of analysis, Circular A-4 notes: “In determining the

[82] EPA. 2017. Science Advisory Board Advice on the Use of Economy-Wide Models in Evaluating the Social Costs, Benefits, and Economic Impacts of Air Regulations. September 29.

[83] Circular A-4 does not use the term “multi-market,” but it does distinguish between partial-equilibrium analysis of a single market, partial-equilibrium analysis of multiple markets, and general-equilibrium analysis. This report groups partial-equilibrium analysis of multiple markets and general-equilibrium analysis under “multi-market analysis.” If a regulation causes noteworthy changes in time or services that are not allocated through market mechanisms, effects are nonetheless likely to manifest themselves in at least one market; partial-equilibrium analysis of a single (highly related) market may be encouraged by the spillover-related patterns of thought that are also associated with multi-market analysis.

[84] Circular A-4, at 41.

appropriate analytic approach, the nature and extent of relationships between the effects in different markets is more important than the size of the markets, though regulations affecting a larger market may also be more likely to have important effects in other markets."[85] Hybrid analytic approaches are permissible, e.g., a quantitative analysis of multiple connected markets coupled with a qualitative discussion of general-equilibrium effects. Natural or physical systems can be considered as analogous to linked "markets," as in integrated assessment models. In the event an analyst pursues a full general-equilibrium analysis, Circular A-4 recommends against fiscal closure rules which inappropriately affect the outcomes of the analysis (e.g., directly interact with pre-existing market distortions unless prescribed by the policy), preferring lump-sum transfers; it also suggests distributional analysis of such transfers. Additionally, A-4 recommends against allowing parameters chosen within a model (e.g., discount rates) that may conflict with detailed guidance in other sections of the Circular. Also relevant is the directive in Circular A-4 to account for market power in BCA when it is relevant. The directive mentions, in particular, effects of regulation on both "upstream" and "downstream" markets from the existence of market power, or changes in its degree.

Advancing This Frontier

Some agencies have long used multi-market analysis but are continuing to develop their analytical practices. Other agencies have traditionally employed single-market, partial-equilibrium analysis but are interested in the potential application of multi-market analysis. The examples below are a non-exhaustive list of activities that the federal government may pursue in coming years.

- **Multi-market benefit-cost analysis of environmental regulation.** EPA has developed and peer reviewed a computable general equilibrium (CGE) model of the U.S. economy, SAGE, for use in regulatory and other applications. SAGE includes four regions and five representative households by income quintile to also allow for the analysis of the distribution of social costs. EPA recently used SAGE to evaluate the social costs and their distribution across households for the proposed and recently finalized Greenhouse Gas Standards and Guidelines for Fossil Fuel-Fired Power Plants rule[86]. EPA is also working on consumer demand models for aggregate goods and services differentiated by income to allow for greater refinement in the representation of elasticities in the SAGE model.
- **Contribute to open-source research consortiums for economic modeling.** While SAGE is an open-source CGE model with code and documentation publicly available, it currently relies on underlying data that requires a license. The EPA is actively supporting the Wisconsin National Data Consortium (WiNDC), which pulls together data from various federal statistical agencies, to provide open-source subnational economic accounts as an alternative data source for general equilibrium modeling and other multi-market analysis applications and intends to migrate SAGE to WiNDC in the near future.
- **Outside experts.** Outside experts brought in under Intergovernmental Personnel Agreements can help supplement agency capacity.

[85] Circular A-4, at 42.

[86] USEPA, 2024. *Regulatory Impact Analysis for the New Source Performance Standards for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units; Emission Guidelines for Greenhouse Gas Emissions from Existing Fossil Fuel-Fired Electric Generating Units; and Repeal of the Affordable Clean Energy Rule.*

Conclusion

Progress on the identified focal and cross-cutting topics will continue to increase awareness of these topics and facilitate connections between agencies and the research community towards progress. The frontiers of analysis will continue to evolve. Agency analysts are already beginning to confront the challenges of quantifying and monetizing costs and benefits of federal actions related to new consumer products and markets (like autonomous vehicles), evolving technologies, and growing threats. In future Annual Reports, and through future public engagement, the SFBCA will continue to explore new frontiers and to help agencies and the broader research community collaborate on new paths toward expanded quantification and monetization—all with the goal of more transparent and robust federal decisions.

Appendix

Table 1. Additional Effects Identified by Agencies. In addition to the focal effects discussed in this Report, agencies identified other effects that could benefit from expanded analysis. These effects are listed here.

Specific Effect	When not fully monetized, some agencies reported including the effect as…	Specific challenge or lack of information…
Regulation-induced reduction in risks from rare events	Qualitatively described	Estimated baseline risk for rare events, estimated risk reduction from regulation
Reduced fear when regulations reduce risk of terrorist attack	Qualitatively described	Method to quantify fear and its social costs, as opposed to material effects of violence
Positive externalities from reduced fear in the context of immigration processes	Qualitatively described	Data on affected populations, estimates of behavioral changes
Changes in labor market participation from immigration regulations	Partially quantified	Data on jobs and industries of affected immigrants, analytical resources
Increased feelings of dignity and belonging from immigration regulations	Qualitative described	Data on feelings of dignity and belonging and their social benefits
Effects on rental housing markets (as opposed to owner-occupied), including capitalization and sorting	Quantified with benefit-transfer from owner-occupied markets	Data, parameterized sorting models for affected populations
Less than full compliance with existing and proposed regulations	Mixed approaches	Data on compliance rates by agency, regulated industry, regulatory stringency, regulatory design, and other factors
Costs of personal protective equipment for workers, including discomfort and lost productivity	Qualitatively described or partially monetized	Data on frequency of use of personal protective equipment by industry linked to measures of productivity and worker wellbeing
Long-run effects of reductions in lead exposure without complete elimination of exposure	Partially monetized	Data
Changes in business practices and employee training intended to reduce discrimination	Qualitatively described	Data, methodology for estimating effects
Changes in public health literacy due to labeling regulations	Qualitatively described or not included	Data, methodology for estimating effects, estimates of behavioral changes
Enhanced accessibility and dignity[87] from travel/transportation regulations	Qualitatively described	Data on WTP for accessibility, dignity, and comfort

[87] Circular A-4 notes that "It is possible to conceptualize a WTP or WTA for certain such impacts [related to human dignity], but [they] may have value over and above" an individual's WTP or WTA.