Co-Benefits, Countervailing Risks, and Cost-Benefit Analysis

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Abstract:

The United States has developed a strong system of impact assessment for federal regulatory policies, including attention to both the benefits and costs of such policies. One important issue that arises in this context is whether agencies should assess not only the intended target benefits identified in the authorizing legislation, but also the additional "co-benefits" or "countervailing risks" associated with rulemaking. For example, a policy aimed at reducing one pollutant may also yield co-benefits by reducing a second pollutant. In some rulemakings, the quantified co-benefits have exceeded the quantified target benefits. Critics have questioned the estimated magnitude, policy propriety, and legal basis of counting such impacts. Addressing such criticisms requires understanding the multiple purposes of regulatory analyses, which include informing policy makers and the public as well as supporting the legal basis for the rule. These purposes suggest that both the target benefits and ancillary impacts (including co-benefits and countervailing risks) should be counted in an evenhanded manner. Similarly, the full range of costs should be considered, including costs to regulated actors as well as to others and any cost savings. We argue in favor of counting the full portfolio of important policy impacts, both improvements and harms, both target and ancillary – but not endlessly. Rather, target and ancillary impacts should be assessed to the degree that the analysis improves the information available for decision making, taking into account both the value and the costs of adding of this information. Arbitrarily narrowing the scope of impact assessment (such as omitting important co-benefits, countervailing risks, or social costs) can lead to policy errors and welfare losses. Longstanding executive orders, guidance, and judicial doctrines call on agencies to consider the full suite of impacts, reflecting the substantial utility of such assessments. Our review of three recent rulemakings, however, indicates that agencies do not always consider the full range of important impacts. And, as is the case for impacts that are the direct target of the rulemaking, assessing co-benefits and countervailing risks requires careful consideration of the evidence and associated uncertainties. Executive and judicial oversight should continue to encourage regulatory agencies to count an appropriately broad portfolio of important impacts.

1.0 Introduction

The United States has developed a strong system of impact assessment for federal regulatory policies, including attention to both their benefits and costs. Regulations are generally designed to meet goals identified in authorizing legislation, although such goals are defined with varying degrees of precision depending on the statute. The supporting regulatory impact assessments (RIAs) often focus largely on the extent to which the regulatory alternatives are likely to achieve these stated goals; i.e., on the target or intended benefits of the policy.

Many commenters have warned against taking too narrow an approach that neglects side effects or "ancillary impacts," including both "co-benefits" and "countervailing risks" (Graham and Wiener, 1995). For example, a policy aimed at reducing one pollutant may also yield countervailing risks or co-benefits when that policy would also increase or reduce a second pollutant. In some cases, the co-benefits may exceed the target benefits.

Critics have questioned the estimated magnitude, policy propriety, and legal basis of counting co-benefits. Depending on the case, critics may argue, for example, that co-benefits are overstated (e.g., Cox, 2012; Smith, 2015) or that other countervailing risks and costs are neglected (e.g., Dudley and Mannix, 2018). Critics have also sometimes argued that the authorizing statute precludes consideration of co-benefits, or that the co-benefits could be better regulated through a separate policy or statute that targets them directly (Dudley et al., 2017; Gustafson, 2019).

In this paper, we examine this controversy. For ease of exposition, we use the terms "ancillary impacts" and "co-benefits and countervailing risks" to encompass both positive and negative effects of the rulemaking, regardless of whether particular impacts are categorized as benefits or costs in the regulatory analysis. We argue in favor of counting the full portfolio of important policy impacts, both benefits and harms, both target and ancillary. Arbitrarily narrowing the scope of the assessment (such as omitting important co-benefits or countervailing risks) could lead to policy errors and social welfare losses.

In Section II, on policy analysis, we argue that counting co-benefits and countervailing risks is part of sound regulatory analysis – and that such ancillary impacts should be counted in an evenhanded manner. The inclusion or exclusion of these impacts should not be arbitrary; like any impact included in the assessment, agencies must evaluate the evidence suggesting that the relationship between the rulemaking and the impact is likely causal, and explicitly address associated uncertainties. We do not advocate that every last co-benefit (or countervailing risk) should always be exhaustively assessed. Analysts should follow a systematic approach to determine which impacts should explored in detail, weighing their value to improving the policy development process against the costs associated with their assessment. Once assessed, the impacts can then be aggregated or disaggregated as needed to address questions that arise as the regulation is developed. We then survey longstanding executive orders and guidance on cost-benefit analysis, which we show call on regulatory agencies to consider these full impacts based on well-established principles.

In Section III, on legal analysis, we describe the legal basis for assessing ancillary impacts and possible legal limitations on such analysis. We find substantial legal authority for considering ancillary impacts in the Administrative Procedure Act (APA), in statutory terms like "reasonable" and "appropriate," in specific regulatory statutes, and in related judicial doctrines.

In Section IV, we examine the treatment of ancillary impacts in three case studies that address environmental policies promulgated by the Obama Administration and revised by the Trump Administration. We consider (1) US Environmental Protection Agency (EPA) and US Department of Transportation (DOT) regulations of mobile sources such as cars and trucks to reduce greenhouse gas emissions and enhance fuel economy; (2) EPA regulation of mercury emissions from electric power generation; and (3) EPA regulation of greenhouse gas emissions from electric power generation.[1] Our review indicates that agencies do not always consider all the important impacts. We also discuss limitations and uncertainties in the assessment of specific ancillary impacts that would benefit from further exploration.

In Section V, we conclude and offer recommendations. We advocate estimating the full range of important impacts, evenhandedly, to the extent caused by the policy and relevant to improving the policy process and decision . Furthermore, agencies should optimize the scope of the analysis, taking into account the value and the cost of additional information, and seek parity across impacts in the criteria for analytic rigor, quantification, and uncertainty.

2.0 Regulatory policy analysis

In this section, we discuss the rationale for assessing the benefits and costs of major regulations, including the role analysis plays in supporting sound policy choices. We also review the practical aspects of current US requirements for regulatory analysis.

We define "ancillary impacts" as impacts other than the primary goal or objective of the regulation (potentially identified in the authorizing statute), recognizing that this primary goal or objective is not always precisely defined. "Ancillary impacts" includes both positive (co-benefit) and negative (countervailing risk) effects, regardless of whether the agency chooses to categorize them as "costs" or "benefits."[2] While we focus on regulatory outcomes (e.g., reductions in risks to human health and the environment), the same principles apply to the costs of implementing the regulation, which may include both expenditures and savings imposed on regulated entities and on others.

2.1 Supporting sound policy decisions

A central goal of regulatory analysis is to support evidence-based decision making that improves social welfare. Decisions uninformed by evidence are more likely to perversely affect society. To achieve this

[1] There are many other examples of regulatory policies that may have co-benefits. For example, restricting carbon monoxide emissions from automobile tailpipes can also reduce some related suicides (Graham and Wiener, 1995). Using tradable catch quotas to conserve fisheries, instead of time-limited fishing seasons, can not only save fish populations but also reduce fatalities of human fishing boat crew members (Birkenbach, Kaczan and Smith, 2017; Pfeiffer and Gratz, 2016). Livermore and Revesz (2008) and Livermore (2019) emphasize the importance of co-benefits in many regulatory policies. These concerns affect a broad range of regulations, not solely those focused on environmental and natural resource issues. For example, regulation of food safety and nutritional content can increase the price (or affect the taste or other attributes) of the target products and lead consumers to substitute other foods, with both positive and negative impacts on health. Regulations designed to increase airport and border security can have implications for travel and the economy at large beyond those associated with reducing the risk of terrorist attacks.

[2] Whether impacts are categorized as "costs" or "benefits" is not necessarily consistent across or even within agencies. See, for example, US Department of Health and Human Services(HHS) (2016) for discussion of the challenges posed by such inconsistency and an approach for more consistent categorization.

goal, the analysis should consider all important impacts, taking into account the value and costs of conducting the necessary analysis. Omitting important impacts can yield suboptimal policy – worse outcomes and social welfare losses.

This idea is not new. Benjamin Franklin (1772) saw the crucial role of assessing all important impacts in his classic letter to Joseph Priestley:

> In the Affair of so much Importance to you, wherein you ask my Advice, I cannot for want of sufficient Premises, advise you *what* to determine, but if you please I will tell you *how*. When those difficult Cases occur, they are difficult, chiefly because while we have them under Consideration, all the Reasons *pro* and *con* are not present to the Mind at the same time; but sometimes one Set present themselves, and at other times another, the first being out of Sight. Hence the various Purposes or Inclinations that alternately prevail, and the Uncertainty that perplexes us.
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> To get over this, my Way is, to divide half a Sheet of Paper by a Line into two Columns; writing over the one Pro, and over the other Con. Then during three or four Days Consideration, I put down under the different heads short Hints of the different Motives, that at different Times occur to me, *for* or *against* the Measure. When I have thus got them all together in one View, I endeavour to estimate their respective Weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a Reason *pro* equal to some two Reasons *con*, I strike out the three. If I judge some two Reasons *con*, equal to some three Reasons *pro*, I strike out the five; and thus proceeding I find at length where the Ballance lies; and if after a Day or two of farther consideration, nothing new that is of Importance occurs on either side, I come to a Determination accordingly. And, tho' the Weight of Reasons cannot be taken with the Precision of Algebraic Quantities, yet, when each is thus considered, separately and comparatively, and the whole lies before me, I think I can judge better, and am less liable to make a rash Step; and in fact I have found great Advantage from this kind of Equation, in what may be called *Moral* or *Prudential Algebra*.

Franklin articulated not only a general method of cost-benefit analysis, but also a rationale for it based on the difficulty of having all "Reasons … present to the Mind at the same time," and the essential need to get them "all together in one View" – even if not quantified with "Precision" – because "when the whole lies before me … I can judge better, and am less liable to make a rash Step." Similarly, more modern scholars argue that this framework for a comprehensive version of cost-benefit analysis offers a *cognitive* advantage over more partial ways of thinking (Sunstein, 2000; cf. Wiener, 2006, on "warm analysis"), counterbalancing the simplistic heuristics and biases that often affect our day-to-day decisions.

The view that comprehensive assessment is needed has persisted through the decades, and is now well accepted in the academic literature. In perhaps the most cited and widely used US cost-benefit analysis text (Boardman et al., 2018), the authors note that in "[in] CBA [cost-benefit analysis] we try to consider *all of the costs and benefits to society as a whole*…*CBA is a policy assessment method that quantifies in monetary terms the value of all consequences of a policy to all members of society* [emphasis in original].

The rationale for a comprehensive approach goes well-beyond textbook discussions. Many scholars argue that good public policy requires evenhandedly considering the full portfolio of ancillary impacts,

both co-benefits and countervailing risks (Graham and Wiener, 1995; Revesz and Livermore, 2008; Wiener, 2002). Such a broad view is also reflected in guidance in other arenas. For example, when evaluating health and medical care interventions, best practice guidance advocates considering both the beneficial and adverse side effects of alternative therapies (Drummond et al., 2015; Neumann et al., 2016; Wiener, 1998). This view is shared as well by critics of partial attention to co-benefits: "In principle, a benefit-cost analysis should be 'complete.' It should include all of the significant consequences of a policy decision: direct and indirect, intended and unintended, beneficial and harmful." (Dudley and Mannix, 2018). The pervasiveness of this view suggests that such comprehensive analysis has been found to have numerous advantages over the years in supporting policy decisions.

To be sure, there are also costs of analysis, including those associated with collecting or acquiring data, utilizing staff time, and potentially delaying the policy decision. Whether incremental analytic improvements are worthwhile will depend on whether the associated costs are justified by the benefits. For example, additional analysis is not warranted if it would unduly delay an urgent choice or if the added information would not likely influence the policy debate. Thus, comprehensive analysis of ancillary impacts (like other impacts) should be tempered by a consideration of the value and costs of acquiring this information (e.g., Thompson and Evans, 1997; von Winterfeldt et al., 2012).[3]

At the same time, lack of precise quantification should not lead to ignoring an important impact. Franklin's point about the elusive quality of "Precision" and nevertheless the crucial need to judge the "whole" can be understood as a cost-benefit analysis of cost-benefit analysis: a more complete analysis could be valuable in improving the basis for the decision even if it does not have fully precise quantification. Omitting an important impact – such as a major co-benefit or countervailing risk – can be a larger error than including it with an imprecise estimate. As John Maynard Keynes is reputed to have said (perhaps originally said by Carveth Read): "I'd rather be roughly right than precisely wrong."

As is the case with Franklin's "prudential algebra," "cost-benefit analysis" (or equivalently, "benefit-cost analysis") can be used informally to refer to any process for balancing improvements and harms. It may be viewed as simply as a procedure to help decision-makers and other stakeholders recognize and balance the multiple desirable and undesirable consequences of a policy. Attempting to deal with multiple choices and impacts without a systematic approach runs the risk that decisions will be inconsistent and overly sensitive to factors that happen to appear highly salient (Franklin's "rash steps"). At the least, such analysis provides a systematic method of organizing and summarizing information about possible policy consequences and their likely magnitudes.

Nowadays, many if not most of the other sources referenced above as well as the government guidance discussed in the next section use the term "cost-benefit analysis" to refer more formally to an approach derived from the discipline of welfare economics, which aims to improve social welfare.[4] Welfare economics typically starts from the idea that each individual is the best (or most legitimate) judge of how a consequence affects his or her wellbeing. Thus value is derived from individual preferences. These preferences have typically been estimated based on their willingness to exchange money for the outcome of concern. These values are then aggregated to determine the net social effects of the policy.

[3] This approach is also invoked by the concept of "proportionate analysis" employed in European Commission regulatory analyses.

[4] This framework is explored in more detail in Boardman et al. (2018) as well as guidance documents such as EPA (2010), HHS (2016), and Robinson et al. (2019).

The logic of the aggregation is that increasing the population sum of net benefits increases the likelihood that everyone will be better off. The distribution of the costs and benefits can then be assessed separately to address issues of fairness and equity.[5]

The tools of welfare economics allow analysts to provide decision-makers with information on how people affected by a regulation are likely to value the improvements and harms they may experience. Even if the decision must be made on other grounds (e.g., due to statutory or other constraints or considerations), understanding these preferences aids in understanding consequences, sources of support and opposition, and implementation strategies. It also identifies barriers to the maximization of social welfare, such as the need for statutory or other changes.

In short, people affected by a policy care not only about whether the policy fulfills specific statutory goals, but more generally about a broad array of impacts. Decision-makers who seek to improve the welfare of those affected must therefore consider the full range of impacts, including ancillary effects. A more limited analysis leaves decision-makers and other stakeholders with an incomplete and erroneous understanding of the likely consequences of their decisions. They would not know if the missing impacts counterbalance or outweigh those that were included, or would change the relative merits of policy options – easily leading to poor decisions. A broader analysis can also encourage regulators to seek policy new options that "reduce overall risk," overcoming risk-risk tradeoffs and omitted impacts by addressing multiple risks in concert – what we have termed "risk-superior moves" (Graham and Wiener, 1995). In the next section, we discuss practical guidance on how to conduct these analyses, including systematic assessment of the degree of analysis warranted for each impact of concern.

2.2 Practical government requirements

For more than forty years, analysis of major Federal regulations has been required prior to their promulgation, as both Republican and Democratic administrations – beginning at least with Executive Orders 12044 (Carter 1978) and 12291 (Reagan 1981) – have seen practical value in regulatory analysis. The current requirements are contained in Executive Order 12866 (Clinton 1993) as supplemented by Executive Order 13563 (Obama 2011). The more recent Executive Orders 13771 and 13777 (Trump 2017a, 2017b) focus on the cost-savings associated with deregulation while also supporting continued application of the broader requirements in Executive Order 12866.

The core of the analyses addressed by Executive Order 12866 is a cost-benefit analysis. Under Executive Order 12866, agencies must assess the costs, benefits, and other impacts of significant regulations before they are promulgated, and must also assess alternatives (including the option of not regulating) if annual economic impacts (costs or benefits) are expected to equal or exceed $100 million. In its "Statement of Regulatory Philosophy and Principles," Executive Order 12866 states:

> Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people. In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative

[5] See, for example, Adler (2012), Adler (2016), and Robinson, Hammitt, and Zeckhauser (2016) for more discussion of distributional analysis.

> of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.

This statement is of central importance for several reasons.

- It limits the promulgation of regulations to areas where their use is required and justified.
- It places cost-benefit analysis in a central role in determining this justification.
- It directs the agencies to address "all" impacts, regardless of whether they are quantifiable.
- It applies an expansive definition of net benefits, including distributional effects that are related to issues of fairness and equity.

In addition, section 6 of Executive Order 12866 instructs agencies to consider all types of impacts, including both beneficial and adverse impacts on health and environment.

The US Office of Management and Budget (OMB), located in the Executive Office of the President, is responsible for reviewing major regulations and the accompanying analyses before they are finalized (via its Office of Information and Regulatory Affairs (OIRA)). It has issued technical guidance for implementing Executive Order 12866 in Circular A-4 (OMB 2003). Two major regulatory agencies (EPA, 2010; HHS, 2016) have issued substantially more detailed and technical supplemental guidance.

The OMB guidance clarifies that cost-benefit analysis provides useful information even if the decision is made on other grounds. It notes that the analysis can aid in identifying legal constraints that prevent the agency from selecting the approach most consistent with the "philosophy and principles" of Executive Order 12866. Thus the scope of regulatory analysis is seen as much broader than determining whether the regulation achieves the statute's primary goal.

Circular A-4 explicitly requires the consideration of "ancillary impacts," including "undesirable side effects and ancillary benefits." Under "Key Elements of a Regulatory Analysis" (pp. 2-3), it tells agencies to "Identify the expected undesirable side-effects and ancillary benefits of the proposed regulatory action and the alternatives. These should be added to the direct benefits and costs as appropriate." Later (p. 26), it states that:

> Your analysis should look beyond the direct benefits and direct costs of your rulemaking and consider any important ancillary benefits and countervailing risks. An ancillary benefit is a favorable impact of the rule that is typically unrelated or secondary to the statutory purpose of the rulemaking (e.g., reduced refinery emissions due to more stringent fuel economy standards for light trucks) while a countervailing risk is an adverse economic, health, safety, or environmental consequence that occurs due to a rule and is not already accounted for in the direct cost of the rule (e.g., adverse safety impacts from more stringent fuel-economy standards for light trucks).

> You should begin by considering and perhaps listing the possible ancillary benefits and countervailing risks. However, highly speculative or minor consequences may not be worth further formal analysis. Analytic priority should be given to those ancillary benefits and countervailing risks that are important enough to potentially change the rank ordering of the main alternatives in the analysis. In some cases the mere consideration of these secondary effects may help in the generation of a superior regulatory alternative with strong ancillary benefits and fewer countervailing risks. …
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> The same standards of information and analysis quality that apply to direct benefits and costs should be applied to ancillary benefits and countervailing risks.

OMB Circular A-4 and the more detailed implementing guidance issued by major regulatory agencies discuss several other issues that are relevant to the consideration of co-benefits, which we touch upon briefly here. These build on the broader conceptual discussion in the previous section, and include standing, screening, uncertainty and non-quantified effects, and distribution.

Standing: While the term "standing" has a more detailed and technical definition when applied in litigation, cost-benefit analysts typically use it to reference the need to identify whose benefits and costs will be counted. The analysis may, for example, consider impacts on only designated subpopulations, on those who reside in a specific country or region, or on both the US and other countries. OMB Circular A-4 states (p. 15) that "Your analysis should focus on benefits and costs that accrue to citizens and residents of the United States. Where you choose to evaluate a regulation that is likely to have effects beyond the borders of the United States, these effects should be reported separately."[6]

Analysts often need to consider other issues related to standing, some of which could affect ancillary impacts. For example, if the primarily goal of a statute were to reduce risks to children, but the regulation also increases or decreases risks to adults (or vice-versa), the principles introduced earlier would argue that the impacts on both children and adults should be included in the analysis.

When the question of standing raises difficult issues, the available guidance suggests it is useful to report the results at different levels of aggregation rather than trying to fully resolve these issues prior to conducting the analysis. Continuing the above example, the risk reductions that accrue to children and adults could be reported separately as well as combined to support both the assessment of net benefits and the decision making process.

Screening: The guidance recognizes that it is not always possible to fully quantify every impact of a regulation. Doing so would require time and resources as well as scientific evidence that is far beyond what is available. Even if such extensive assessment were possible, it might not be worthwhile. The benefits of devoting substantial resources to conducting a particular analysis may not exceed its costs, given that those resources could instead be used to achieve other goals. In other words, the available guidance generally recognizes that it is desirable to apply an informal cost-benefit analysis – a "value of information" (VOI) test -- to the analysis itself. This test may be qualitative, but should be systematic; involving careful consideration which effects to analyze in detail as well as the level of effort to devote to this analysis.

[6] For more discussion of international impacts and standing, see Rowell and Wexler (2014); Rowell (2015).

The guidance in OMB Circular A-4, supplemented by the more detailed guidance issued by the agencies, suggests such a systematic approach. To determine the scope of the assessment, analysts should begin by listing all potential costs, benefits, and other impacts, then use screening analysis to identify the impacts most in need of further investigation. Screening analysis relies on easily-accessible information and simple assumptions to provide preliminary insights into the direction and magnitude of effects. For example, upper-bound estimates of parameter values can be used to determine whether particular impacts may be significant. Screening aids analysts in justifying decisions to exclude impacts from more detailed assessment and in determining where additional research is most needed to reduce uncertainty. It also provides rough estimates of those impacts that are not subject to more extensive investigation.

In this context, "significant" should be defined to include impacts that are large enough to affect the determination of whether benefits are likely to justify costs. It should also include smaller impacts that are of interest to decision-makers and other stakeholders for reasons other than their magnitude.

Uncertainty and non-quantified effects: These guidance documents also recognize that any analysis involves uncertainties, including difficulties related to quantifying some potentially important effects. The challenge for the analyst is to determine how to best address these uncertainties to support decision-making. OMB Circular A-4 notes that the goal of the analysis is to inform the public about the impacts of alternative actions. This means that the analysis must help decision-makers and other stakeholders comprehend the extent to which key uncertainties – in the data, models, and assumptions – affect the main analytic conclusions, including the effects of ancillary benefits. It should help them understand the confidence they should have in the results and the likely direction and magnitude of any bias.

For example, if the best estimates suggest that benefits exceed costs for a policy, how likely is it that this conclusion would be reversed, given the uncertainty about the magnitudes of the quantified effects and the potential impact of non-quantified effects? Might these uncertainties affect the relative rankings of the policy options? Answering these questions requires quantifying impacts to the extent possible, identifying key uncertainties, and exploring them in both qualitative and quantitative terms.

There are many options for addressing uncertainty in quantified effects when additional primary research is not possible or desirable. OMB Circular A-4 discusses three approaches with increasing levels of complexity, including qualitative discussion, numerical sensitivity analysis, and probabilistic analysis. It also requires formal quantitative analysis of uncertainty for rulemakings with impacts that exceed $1 billion annually. Qualitative discussion is a necessary component of any analysis and involves disclosing key assumptions and uncertainties and discussing their implications. Numerical sensitivity analysis explores the effects of varying the values of key parameters to determine the extent to which uncertainty may substantially affect the analytic results. Probabilistic analysis relies on statistical distributions of parameter values and provides information about the spread (e.g., variance) of the likely impacts.[7]

[7] When there are gaps or inconsistencies in the empirical research, formal structured expert elicitation is another useful approach for quantifying the effects of uncertainty. Such elicitation is designed to avoid well-known heuristics and biases that can lead to poor judgment. Expert elicitation requires careful design and implementation and is often costly. However, it is informative when other methods are not sufficient to quantify the impacts of

Another challenge is addressing outcomes that cannot be quantified but may have important implications for decision-making. For example, available data may suggest that a disease affects the risk of both mortality and morbidity, but may not be adequate to estimate the change in some of these risks. In some cases, the policy may lead to effects that are less tangible and more subject to normative judgment, such as impacts on dignity, equity, or privacy.

Without quantification, it is difficult to appropriately balance the benefits associated with each policy option against its costs, or to determine the relative importance of these different types of benefits. Ignoring potentially important non-quantified effects may lead to poor decisions, but there is also a danger of overemphasizing them. In the absence of information, decision-makers and others may weight these effects in a manner consistent with their own (unarticulated and perhaps unconscious) beliefs, without sufficiently probing the rationale or the weighting. Clear presentation of the available evidence is needed to counterbalance this tendency.

Options for incorporating non-quantified effects depend on the available data and the nature of the impacts. In some cases, it may be difficult to quantify or value an impact but it may be possible to count the number of people affected or report other intermediate measures. Approaches that involve some calculation include breakeven or bounding analysis. Breakeven analysis, sometimes referred to as threshold analysis, asks "how large would the nonquantified effect(s) have to be to bridge the gap between quantified benefits and costs?" Bounding or "what-if" analysis is similar to sensitivity analysis, but typically involves wide ranges based on relatively little data or supporting evidence. More qualitative approaches include the use of figures or graphics as well as text discussions.

Distribution: The distribution of benefits and costs across groups defined by income or other measures of relative advantage is of great interest to many policymakers and stakeholders, and is emphasized in the various guidance documents discussed above. Conventionally, economists separate analysis of economic efficiency (that is, of aggregate net benefits) from distributional analysis, consistent with the conceptual framework introduced earlier. In contrast, Executive Order 12866 includes "distributive impacts" and "equity" as part of the net benefits agencies should seek to maximize, seemingly assuming that distribution would be part of the efficiency calculation.

The implementing guidance in OMB Circular A-4 follows the more traditional approach, distinguishing between the two types of analyses. It notes that: "Your regulatory analysis should provide a separate description of distributional effects (i.e., how both benefits and costs are distributed among sub-populations of particular concern) so that decision makers can properly consider them along with the effects on economic efficiency." It defines distributional effects broadly as including, for example, how regulatory impacts are divided across "income groups, race, sex, industrial sector, geography" as well as over time.

A review of several completed agency analyses found that regulatory analyses have rarely included assessment of the distribution of both costs and benefits, often either focusing solely on the degree of benefits provided to selected groups (such as children or minority and low income groups) or ignoring distribution entirely (Robinson, Hammitt and Zeckhauser, 2016). The reasons for this inattention are uncertain and complex, and beyond the scope of this paper. However, distributional impacts could be

important sources of uncertainty. See Morgan and Henrion (1990), Cooke (1991), and O'Hagan et al. (2006) for more information, and Cooke et al. (2007) for an example.

considered another form of ancillary impacts; i.e., impacts not necessarily directly related to statutory goals. In addition, if an impact is not included in the primary cost-benefit analysis, it is even more difficult to assess its distribution.

In sum, Executive Order 12866, OMB Circular A-4, and agency guidance documents all recognize that cost-benefit analysis is only one input into the decision-making process. Executive Order 12866 calls on agencies to assess whether the benefits of a policy "justify" the costs, replacing the more arithmetic term "outweigh" that had appeared in Executive Order 12291, which it replaced. This recognition in part relates to the need to take into account statutory and other legal requirements, as explicitly noted in those documents. It also stems from the need to address other normative issues, such as distribution and each person's concerns for others' wellbeing, which may not be adequately captured in the conventional cost-benefit analysis framework given its focus on individual preferences. Technical, budgetary, and political constraints also affect the decision-making process, as do the data gaps and inconsistencies that make it difficult to quantify some important impacts.

Some may argue that the appropriate way to address these concerns about overall social welfare is to change the statutes themselves, to allow a broader focus where the statute restricts such analysis. However, achieving such change is difficult, complex, and rare. Conducting broadly-focused analysis aids in identifying areas where such change might be desirable. And it enables policymakers to avoid bad decisions by conveying information on the full impact of these decisions.

The stated goal of these analyses is to explore whether regulatory costs are justified by the benefits (both target and ancillary, quantified and unquantified) and to ensure that the selected option maximizes net benefits, to the extent allowed by law. But the summary measure (net benefits) is only one of many types of information that these analyses provide. If the full range of important impacts is assessed, then they can be disaggregated in various ways to address the issues that arise in the policymaking process – including the relationship to the statutory and other goals. If no assessment is available, then these questions will likely go unanswered or addressed in a speculative or arbitrary manner.

The analytic process also often unearths substantial useful information related to effectively implementing the regulation as well as to understanding its impacts. Research conducted to support the analysis may lead, for example, to better understanding of the availability and effectiveness of relevant and emerging technologies; the characteristics of the individuals, subgroups or entities likely to bear the costs and benefits; the extent to which individuals with different characteristics are likely to be exposed to a hazard and may experience adverse health effects; and the opportunities to address ancillary impacts – co-benefits and countervailing risks – through additional complementary policies.

3.0 Legal analysis

We have argued that it is important for agency analysts to address ancillary impacts, such as co-benefits and countervailing risks, in a formal regulatory analysis. However, the weight given to ancillary impacts is not necessarily the same as the weight given to the target impacts under the relevant legal authority for the regulation. The legal significance of the ancillary impacts depends on the legal basis of the rulemaking and the limits on the agency's rulemaking authority.

In this section, we review some of the legal parameters of agency consideration of ancillary impacts. In general, we find that many key US statutes and judicial doctrines favor agencies' consideration of full

impacts in rulemakings. Statutes that require an agency to ignore ancillary impacts appear to be rare. When a statute is silent on ancillary impacts, we tend to believe that the courts would favor a comprehensive consideration of the impacts of alternative courses of action.

First, as a general matter, the US Administrative Procedure Act (APA) (enacted in 1946) may require agency rulemakings to consider all important impacts. Neglecting an important impact could be a violation of the "arbitrary and capricious" test in the APA (5 U.S.C. 706). In the recent case of Department of Commerce v. New York (2019), regarding addition of a "citizenship" question in the national Census, the Court (in an opinion by Chief Justice John Roberts) rejected the agency's stated reasoning as "contrived" and remanded to the agency for a "genuine" explanation of its reasoning. In a separate opinion joined by three other members of the Court, Justice Stephen Breyer (2019) wrote that it is arbitrary and capricious under APA section 706 for an agency to ignore an important ancillary impact of its policy. He summarized:

> In short, the Secretary's decision to add a citizenship question created a severe risk of harmful consequences, yet he did not adequately consider whether the question was necessary or whether it was an appropriate means of achieving his stated goal. The Secretary thus failed to "articulate a satisfactory explanation" for his decision, "failed to consider . . . important aspect[s] of the problem," and "offered an explanation for [his] decision that runs counter to the evidence," all in violation of the APA. Motor Vehicle Mfrs. Assn. of United States, Inc. v. State Farm Mut. Automobile Ins. Co., 463 U. S. 29, 43 (1983). These failures, in my view, risked undermining public confidence in the integrity of our democratic system itself. I would therefore hold that the Secretary's decision—whether pretextual or not—was arbitrary, capricious, and an abuse of discretion. (Breyer 2019, slip op. p.2)

Justice Breyer cited the Supreme Court's decision in State Farm (1983), which concerned DOT's National Highway Traffic Safety Administration (NHTSA) policy on airbags in cars – a case that involved multiple benefits, risks and costs. The State Farm decision has become a landmark judicial doctrine requiring an agency to give good reasons for its decisions. Thus, at the least, an agency may need to give a good reasoned explanation for its choice to omit any important impact.

Second, statutory words like "reasonable" and "appropriate" appear to require consideration of full impacts. In a recent Supreme Court case about EPA regulation of mercury (part of the mercury air toxics standard (MATS) case discussed in Section IV below), both the Justices in the majority and those in dissent appeared to agree that the words "reasonable" and "appropriate" require the agency to consider all important impacts (Michigan v. EPA, 135 S.Ct. 2699, 2015). Justice Scalia wrote for the majority: "reasonable regulation ordinarily requires paying attention to the advantages and the disadvantages of agency decisions," 135 S. Ct. at 2707. And he wrote: "'appropriate' is 'the classic broad and all-encompassing term that naturally and traditionally includes consideration of all the relevant factors,'" 135 S. Ct. at 2707 – a sentence he quoted from then-Judge and now-Justice Brett Kavanaugh in the lower court decision (quoting White Stallion Energy Ctr. v. EPA, 748 F.3d 1222, 1266 (D.C. Cir. 2014) (Kavanaugh, J., dissenting)). The Scalia opinion left undecided exactly which impacts EPA should count, notably how to treat co-benefits. Meanwhile, Justice Kagan, dissenting about the timing (i.e. when in this policy process EPA had to consider costs and benefits), nonetheless agreed that "Unless Congress provides otherwise, an agency acts unreasonably in establishing 'a standard-setting process that ignore[s] economic considerations.' … As the Court notes, that does not require an agency to conduct a

formal cost-benefit analysis of every administrative action … But (absent contrary indication from Congress) an agency must take costs into account in some manner before imposing significant regulatory burdens" (135 S.Ct. at 2716-17). And she wrote: "I agree with the majority—let there be no doubt about this—that EPA's power plant regulation would be unreasonable if "[t]he Agency gave cost no thought at all." " (135 S.Ct. at 2714). Thus, both opinions appeared to agree that, unless the statute expressly says the contrary, important impacts must be considered for an agency action to be "reasonable" or "appropriate."

Justice Scalia also made this statement: "No regulation is 'appropriate' if it does significantly more harm than good" (135 S.Ct. at 2707). Some have argued that the APA "arbitrary and capricious" test itself requires agencies to compare the full set of policy impacts and show that their policies would not yield "more harm than good" (Warren and Marchant, 1993). This test of overall net benefits may not yet have been adopted in full under the APA "arbitrary" test, although Justice Scalia has linked it to the word "appropriate." Prof. Cass Sunstein, a former administrator of OIRA, has argued that judicial review under APA 706 is increasingly requiring agencies to show that they have considered full impacts in a cost-benefit framework (although judges may differ on how searchingly to review the analytic content of such an analysis) (Sunstein, 2017; cf. Cecot and Viscusi, 2015, finding that judges are increasingly reviewing agencies' use of cost-benefit analysis, and often helpfully prodding agencies to improve their analyses). Reflecting on the two opinions in Michigan v. EPA, Prof. Sunstein observed: "If an agency ignores costs, or imposes a risk that is greater than the risk that it is reducing, it would seem to be acting arbitrarily [in violation of the APA]" (Sunstein, 2017: 16).

Taken together, the opinions by Justices Scalia, Kagan and then-Judge Kavanaugh in the mercury case, and by Justice Breyer (joined by Justices Ginsburg, Kagan and Sotomayor) in the census citizenship case, all point toward the view that ignoring an important impact (without a good reason) is arbitrary under the APA, and at odds with statutory terms such as "reasonable" and "appropriate."

Third, as discussed in Section II above, executive branch guidance including Executive Order 12866 and OMB Circular A-4 require attention to full impacts. Since it is a nonbinding technical guidance document for use by agency analysts, Circular A-4 does not have the legal significance of a statutory or rulemaking directive. However, in addition to its force inside the executive branch, Circular A-4 has been cited by courts in ruling that agencies have failed to consider important impacts, as in Center for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1198 (9th Cir. 2008). In this case, the court was concerned about NHTSA's decision not to quantify and monetize the ancillary climate benefits of federal fuel economy standards.

As discussed in Section II, regulatory analyses are meant to inform agency rulemaking, and may also provide information that informs a broader set of inquiries. Executive branch oversight is distinct from the judicial review discussed in this section. Even if a statute appears to require an agency to ignore ancillary impacts, the analysis of full impacts is valuable in informing, for example: proposals to amend the statute to embrace the full impacts; arguments to courts that the ancillary impacts should be cognizable by the agency; additional executive branch actions to ameliorate the neglected impacts (such as complementary rules or projects by the same or other agencies); actions by state or local governments, such as enacting additional requirements, requesting exemptions, or otherwise implementing the regulation; and further monitoring and evaluation by the agency and by outside researchers to track the full set of impacts as they occur.

Fourth, even if the APA and executive orders call for full impacts analysis, agency rulemaking is also governed by specific regulatory statutes. Does any statute truly preclude analysis of co-benefits, or countervailing risks, or full impacts? (Some statutes may have been held to preclude consideration of cost – e.g. Clean Air Act section 109, per Whitman v. American Trucking (2001) – but that is not the same as precluding consideration of ancillary impacts on health and environment, and moreover such cost preclusion might be reconsidered after Entergy v. Riverkeeper (2009) and Michigan v. EPA (2015).)

Arguing that only a specific subset of impacts is the "focus" of the statute (see EPA, 2019, as quoted in Gustafson 2019: 8), seems too vaguely defined in most cases to obligate the agency to exclude consideration of other impacts. If the APA means that ignoring important impacts is arbitrary and unlawful, then courts would expect that Congress should have to make a very clear statement in a subsequent statute to require otherwise.

Many statutes expressly require or authorize the regulatory agency (EPA or others) to consider full impacts. We provide several examples below.[8]

Clean Air Act (CAA). The CAA includes several sections where statutory language or its interpretation by the courts appears to require consideration of ancillary impacts. For example, under CAA 108 and 109, the lower court decision in American Trucking v. Whitman (DC Cir. 1999) (authored by Judge Stephen Williams) held that EPA must consider the full impacts of its rule because CAA 108 tells EPA to consider "all identifiable effects" of the pollutant in the air when setting National Ambient Air Quality Standards (NAAQS) under CAA 109. Furthermore, in CAA 111(a)(1) regarding new source standards, EPA is instructed to consider "nonair quality health and environmental impacts." CAA 112(d)(2) regarding hazardous air pollutants states that emissions standards for hazardous air pollutants (HAPs) "shall require the maximum degree of reduction in emissions … that the Administrator, taking into consideration the cost … *and any non-air quality health and environmental impacts and energy requirements*, determines is achievable …" (italics added).[9] It is unstated in section 112 whether other "air" impacts (beyond the HAP being regulated) must or may also be counted. Statutory silence here (plus the APA) should mean that EPA is allowed to consider other air pollutants in setting HAP standards. It would be perverse for CAA 112 to require attention to "non-air" impacts but prohibit attention to other "air" impacts caused by the same rule.

Safe Drinking Water Act (SDWA): Since the 1996 amendments, EPA must study the costs and benefits of each maximum contaminant level (MCL) under 300g-1(b)(3)(C), and "publish a determination as to whether the benefits of the maximum contaminant level justify, or do not justify, the costs based on the analysis conducted under paragraph (3)(C)." 42 USC 300g-1(b)(4)(C). Then, if EPA finds that the benefits of the MCL do not justify the costs, it "may" set an MCL which "maximizes health risk reduction benefits

[8] In addition, the National Environmental Policy Act (NEPA) calls on agencies to assess all significant environmental impacts of major federal actions. Some court decisions have interpreted NEPA, along with the APA, to reject omission of important impacts. See e.g. High Country Conservation Ass'n v. US Forest Service (D. Colorado 2014) (finding failure to quantify climate change impacts, when economic benefits were quantified, to violate NEPA and APA); Competitive Enter. Inst. v. Nat'l Highway Traffic Safety Admin., 856 F.2d 321, 326–27 (D.C. Cir. 1992) (striking down a NHTSA fuel-efficiency rule for failing to consider indirect costs in the form of vehicle safety risks).

[9] CAA 112(f)(1)(C) also states that, in its report(s) to Congress on the risks still remaining after the application of the standards under 112(d), EPA should report on, inter alia, "any negative health or environmental consequences to the community of efforts to reduce such risks." Such "negative health or environmental consequences" would be countervailing harms of regulating the remaining risk from the HAP.

at a cost that is justified by the benefits," 42 USC 300g-1(b)(6)(A). The full sentence reads: "Notwithstanding paragraph (4), if the Administrator determines based on an analysis conducted under paragraph (3)(C) that the benefits of a maximum contaminant level promulgated in accordance with paragraph (4) would not justify the costs of complying with the level, the Administrator may, after notice and opportunity for public comment, promulgate a maximum contaminant level for the contaminant that maximizes health risk reduction benefits at a cost that is justified by the benefits." 42 USC 300g-1(b)(6)(A). And, the SDWA also requires a study of *ancillary impacts* of each MCL – both co-benefits in 42 USC 300g-1(b)(3)(C)(II), and countervailing risks in 42 USC 300g-1(b)(3)(C)(VI). And EPA is authorized to set a discretionary ("may") alternative MCL to reduce these countervailing risks, in 42 USC 300g-1(b)(5): "(A) Notwithstanding paragraph (4), the Administrator may establish a maximum contaminant level for a contaminant at a level other than the feasible level, if the technology, treatment techniques, and other means used to determine the feasible level would result in an increase in the health risk from drinking water by— (i) increasing the concentration of other contaminants in drinking water; or (ii) interfering with the efficacy of drinking water treatment techniques or processes that are used to comply with other national primary drinking water regulations. (B) Establishment of level.—If the Administrator establishes a maximum contaminant level or levels or requires the use of treatment techniques for any contaminant or contaminants pursuant to the authority of this paragraph— (i) the level or levels or treatment techniques shall minimize the overall risk of adverse health effects by balancing the risk from the contaminant and the risk from other contaminants the concentrations of which may be affected …"

Clean Water Act (CWA): Section 304(b), 33 U.S.C. 1314(b), instructs EPA to consider "non-water quality environmental impact" in setting control standards for point sources of water pollution. In addition, section 304(b)(1)(B) tells EPA to consider "total cost … in relation to the effluent reduction benefits," and 304(4)(B) tells EPA to consider "the reasonableness of the relationship between the costs … and the effluent reduction benefits."

Toxic Substances Control Act (TSCA): Section 6 provision on "unreasonable risk" required EPA to consider ancillary impacts, see Corrosion Proof Fittings v. EPA, 947 F.2d 1201, 1225 (5th Cir. 1991) (remanding ban on asbestos because EPA had not considered the traffic safety risk posed by less effective alternatives to asbestos in automobile brake linings, and thus had failed to address "unreasonable risk" as required in TSCA). The new language in the Lautenberg Chemical Safety Act (LCSA) (2016), amending TSCA, says that a finding of "unreasonable risk" shall not be based on "cost," but thus it would still include ancillary risk impacts. And the LCSA says that the next step, risk management, is to be based on analysis of benefits and costs.

In summary, the APA, as interpreted by the courts, leans toward a comprehensive form of regulatory analysis that includes all important regulatory impacts. Statutes that employ general terms such as "reasonable" and "appropriate" do likewise. Some statutes expressly require analysis of ancillary impacts. And where statutes are silent on the question, courts may be inclined to favor comprehensive analysis, given the trends in judicial doctrine under the APA and related statutes.

4.0 Case studies

We undertook three case studies to determine how co-benefits and countervailing risks are being addressed in real-world federal regulatory analysis. We begin with a detailed look at EPA-NHTSA's joint rulemaking on greenhouse gas control and fuel economy of light-duty motor vehicles. We then provide

two more brief examples. The second concerns EPA's regulation of mercury emissions from electric power plants, and the third concerns EPA's regulation of greenhouse gas emissions from electric power plants.

The case studies were selected because (a) each issue was addressed in both the Obama and Trump administrations, and thus it is feasible to determine whether there are technical and policy differences in how the two administrations are handling countervailing risks and co-benefits, (b) the rulemakings in question were judged to be significant by the agencies and OMB, which means that the underlying regulatory analyses are likely to be conducted and reviewed with care. Nonetheless, the three cases are not intended to be representative of the entire practice of federal regulatory analysis or even EPA regulatory analysis under the most recent two administrations.

The issues we discuss in the following sections are complex and many are not easily resolved. Our goal is to highlight issues deserving more discussion and debate, issues that go beyond the more basic arguments for comprehensive assessment of impacts discussed earlier. As does the analysis of the target benefits, assessment of co-benefits and ancillary impacts requires careful consideration of the available evidence and associated uncertainties.

4.1 Case Study #1: EPA and NHTSA Regulation of Passenger Vehicles: Fuel Economy and Greenhouse Gas Emissions

In the 2009-2012 period, the Obama administration completed two joint rulemakings by EPA and NHTSA, with the California Air Resources Board as a collaborator, to enhance vehicle fuel economy and reduce greenhouse gas emissions from light-duty passenger vehicles. One rulemaking addressed model years 2011-2016, as required by statute; the other addressed model years 2017-2025, and was an exercise of administrative discretion. The rulemakings were responsive to three legal developments: (1) the Supreme Court's decision in Massachusetts v EPA (2007), where the Court held that EPA is authorized to regulate greenhouse gas emissions from motor vehicles under the Clean Air Act, (2) a 2007 law that modernized NHTSA's authority to regulate fuel economy through the Corporate Average Fuel Economy program, and (3) the 9th Circuit's decision in Center for Biological Diversity v. Nat'l Highway Traffic Safety Administration (2008), where the Court held that NHTSA's CAFE standards for model year 2011 did not adequately consider the benefits of reducing the greenhouse gas emissions related to climate change.

For EPA, we assume that the target risk is the climate change induced by carbon dioxide (CO2) emissions from new light-duty vehicles sold in the US; for NHTSA, we assume that the target risk is the security threats of a transportation system that is highly dependent on liquid petroleum fuels (energy insecurity). To ascertain how the Obama administration addressed countervailing risks and co-benefits, we examined EPA-NHTSA's final regulatory impact analyses in support of the 2017-2025 standards and the EPA-NHTSA's draft 2016 midterm technical review, which was used to support the January 2017 decision to retain the 2017-2025 standards. For the Trump administration, we examined the preliminary regulatory impact analysis of the rulemaking proposal with seven options, including the preferred option of freezing standards at model year 2020 levels established by the Obama administration.

4.1.2 Obama-Era Analyses

4.1.2.1 Overview

Both analytic documents from the Obama era make a quantitative case that the overall social benefits of the 2017-2025 standards are much larger than the overall social costs. It is intriguing that the quantified benefits are not dominated by reductions in the two target risks (climate change and energy insecurity).

In 2012, the single largest benefit identified by both agencies was a private benefit to consumers from reduced expenditures on fuel, which we characterize as a "co-benefit" (though that terminology is not used in the regulatory analyses). The projected savings in fuel account for the majority of the total social benefits of the 2017-2025 standards; benefits from diminished climate change and energy insecurity are dwarfed in size by the projected consumer fuel-saving benefit. In fact, the savings in fuel expenditures are projected to be so large that, over the lifetime of the regulated vehicles, they would more than pay for the quantified costs associated with the rulemaking (largely the costs of adding fuel-saving technologies to new vehicles). Another co-benefit of significant magnitude was reductions in conventional air pollution related to health-impairing smog and soot.

EPA and NHTSA reaffirmed this basic pattern of benefits and costs in its July 2016 "technical support document" (TSD) that underpinned the Obama administration's January 2017 decision to retain the model year 2022-2025 standards as they were issued in 2012 (EPA, 2017). EPA and NHTSA reported separate cost-benefit analyses, which were included in different chapters of the same Technical Support Document (EPA-NHTSA-CARB, 2016).

EPA determined that the incremental vehicle costs of the 2022-2025 standards (compared to the 2021 standards) would be about $900-$1,000 per new vehicle by 2025. However, the savings in fuel expenditures for the consumer would be so large that the payback period for the consumer would be about 5 to 6 years of vehicle ownership. When calculated over the entire lifetime of the average 2025 vehicle, the savings in fuel expenditures were projected to be $1,621 (using a 3% discount rate), assuming the EIA reference case forecast for fuel prices through 2040 (i.e., relatively low fuel prices).

EPA's present-value analysis of total costs and benefits, based on a 3% discount rate, is summarized in Table 1 below. The national costs for technology and associated maintenance are roughly $35 billion but another $8.3 billion in costs is attributable to the noise, congestion, and highway crashes induced by the rebound effect (i.e., the additional miles of travel induced by more fuel-efficient vehicles). The costs are large but the benefits in fuel-expenditure savings ($88.8 billion) are more than double the costs. The other major categories of benefits are GHG control ($18.6 billion), travel (mobility) benefits due to extra vehicle miles of travel ($9.8 billion), time savings due to fewer refueling trips ($7.1 billion), particulate matter control ($5.4 to $12.1 billion, depending on the choice of dose-response study), and enhanced energy security ($4.7 billion). Notice that the benefits from reducing the two target risks (energy insecurity and climate change), while substantial ($23.3 billion), are not as large as the technology/maintenance costs. Thus, co-benefits of various sorts are critical to making the cost-benefit case for the 2022-2025 standards.

Table 1. Summary of Benefits and Costs of Model Year 2022-2025 Fuel Economy and GHG Standards as Reported by EPA in 2016 (Billions of 2013$, Expressed in Present Value, 3% Discount Rate)

Costs
--Vehicle Technology $33.6 B
--Vehicle Maintenance $1.6 B
--Noise, Congestion, Highway Crashes $8.3 B
Benefits
--Savings in Fuel Expenditures $88.8 B
--Energy Security $4.7 B
--Mobility $9.8 B
--Time Savings from Refueling Trips $7.1 B
--Greenhouse Gas Control $18.6 B
--Particulate Pollution Control $5.4 B - $12.1 B

Source: EPA-NHTSA-CARB, 2016, Table 12.82, 12-65.

NHTSA's analysis of costs and benefits, again based on a 3% discount rate, is similar to the EPA analysis with an important exception (EPA-NHTSA-CARB, 2016, Chapter 13). In the NHTSA analysis, if the fuel-savings benefits are excluded, the remaining benefits are not sufficient to outweigh the costs. In EPA's analysis, the benefits other than fuel savings are slightly greater than the costs (EPA-NHTSA-CARB, 2016, Chapter 12).

With regard to countervailing risks, both EPA and NHTSA examined carefully what the impacts of the 2017-2025 standards might be for the safety of motor vehicle occupants and other road users. The analyses conclude that adverse safety outcomes, if they are to occur, are likely to be small compared to the other benefits and costs. The safety impacts induced by the rebound effect were larger than any safety impacts related to changes in the design of vehicles such as lightweighting (EPA-NHTSA-CARB, 2016).

4.1.2.2 Critique

We divide our evaluation of the Obama era analysis into two categories: co-benefits (valuation of private fuel savings, particulate-matter control), and countervailing risks (fleet-turnover effects, potential safety impacts). It is worth noting while this critique in part relates to information available at the time that the Obama analyses were conducted, it also incorporates research that was completed after that time (including work conducted under the Trump Administration) that provides useful insights.[10]

Co-Benefits

Valuation of Private Fuel Savings. The benefit-cost case for the 2017-2025 standards is strengthened considerably by a single category of co-benefits: the private savings in fuel expenditures experienced by motorists. Many economists are perplexed by this finding. If the private fuel-saving benefits for vehicle purchasers exceed the technology and maintenance costs, why is a regulation necessary to accomplish the gain in private net benefits? There is no obvious market imperfection on either the demand or supply side of the automotive industry. While information is not always communicated effectively and

[10] Much of the work on a regulatory analysis must be completed far in advance of the publication date, in part to allow time for the many required layers of review. This means that an analysis published in 2016 is not likely to fully incorporate the most recent research available as of that date.

consumers do not always act "rationally" (due at least in part to the decision making heuristics and biases explored extensively in the behavioral economics literature), the extent to which these problems are at issue in this case is uncertain.

Recent econometric studies reveal substantial consumer demand for vehicle fuel economy, despite relatively low fuel prices in the US (Sallee et al, 2016; Busse et al, 2013; Allcott and Wozny, 2014). All three studies show that, when fuel prices change, the average transactions prices for new and used vehicles adjust accordingly. When fuel prices rise (other factors held constant), average transactions prices for vehicles for vehicles with high fuel economy rise while transactions prices for vehicles with low economy fall. The studies suggest that the average vehicle purchaser is willing to pay for at least 75% -- and maybe more than 100% -- of the fuel savings that will occur over the lifetime of a vehicle with superior fuel efficiency. This finding is consistent with survey results suggesting that fuel economy is one of the important variables that consumers consider when they purchase a new or used vehicle. In 2015 EPA adjusted the required fuel-economy label on new vehicles to make it more clear how much money is saved over five years when consumers purchase a fuel-efficient vehicle. Thus, consumers have the information they need, if they are motivated and capable of doing so, to compute how much they save in fuel expenditures if they purchase a more fuel-efficient vehicle.

Caution is warranted in the interpretation of the recent econometric studies of consumer valuation of fuel economy. While the study designs are rigorous and the data sets are large, they address how consumers respond to changes in fuel prices, not changes in fuel-economy technology. The regulations being analyzed change technology, not fuel price. In a rational-choice framework, changes in fuel prices and technology can have an equivalent impact on the present value of fuel expenditures during a given period of vehicle ownership. From a behavioral perspective, however, equivalent changes in fuel price and technology may be perceived quite differently by the consumer (Greene and Welch, 2016).

Consumers are more familiar with changes in fuel price than with changes in technology, since consumers experience fuel prices each time they refill their tank. Vehicle purchases are much less common in the consumer's experience, especially purchases that entail major changes to propulsion systems. Many consumers – excluding the limited pool of adventuresome "early adopters" – may be reticent to purchase vehicles at a premium price that are equipped with unfamiliar engines, transmissions, materials, or entirely new propulsion systems (e.g., hybrids or plug-in electric vehicles), even when such vehicles have attractive EPA fuel-economy ratings (Carley et al, 2017).

Some natural experiments observed in recent years cast doubt on the notion that consumers are willing to pay, in vehicle price premiums, most or all of the present value of fuel savings from new technology. When Hyundai and Kia were forced to downgrade their EPA fuel-economy ratings on selected 2011-2013 models, the resulting changes in vehicle prices imply that consumers of these vehicles value savings in fuel expenditures at a much lower rate than full valuation, roughly 15-38% on the dollar (Gillingham et al, 2019). Moreover, while most hybrid-electric vehicles (HEVs) have been offered to consumers at unattractively large price premiums, a minority of HEV offerings in the US from 2004 to 2015 have estimated fuel savings that more than pay for their after-tax price premium over the lifetime of the vehicle. Nonetheless, fewer than 20% of consumers opt for the HEV option, even when the HEV is visually identical to the gasoline version of the same model and even when the HEV does not require significant compromises in other vehicle attributes such as performance and trunk space (Duncan et al, 2018). An intriguing current example is the HEV option on the popular Toyota RAV4, which has a short

payback period for its modest $700 price premium, without any apparent compromise in performance, seating capacity or other desired vehicle characteristics. Toyota reports that fewer than 25% of consumers are selecting the HEV version of the RAV4 (Neil, 2019). Thus, there are suggestive indications in the marketplace that consumers are not fully valuing the future fuel savings from new technology prior to making their vehicle choices.

Insofar as consumers do undervalue future fuel savings from new technology, the undervaluation is unlikely to be attributable to a pure information effect. Recent experiments, where consumers are provided detailed information on vehicle prices and fuel savings for alternative vehicles, show little impact of such information on both intended and actual purchasing decisions (Allcott and Knittel, 2017; Dumortier et al., 2016).

Marketing experience in the auto industry suggests that it is quite difficult to sell vehicles primarily on the basis of enhanced fuel economy. The National Research Council (2015a), based on a survey of decades of industry experience, found that the average consumer buying a new vehicle requires a payback period as short as one to four years in order to pay a price premium for fuel economy. Stated preference studies, where consumers are asked directly about the payback period, show average results around 3 years, even though the average vehicle lasts 15 years (Greene et al., 2013). A recent working paper that adopted a revealed preference framework also found that consumer valuation of fuel economy is less than half of what would be predicted by a rational-choice model, and consumer demand for incremental gains in performance is much larger than demand for fuel economy (Leard et al., 2017).

More behavioral economics research is necessary to establish a definitive approach for how federal agencies should handle private fuel savings in cost-benefit studies of future fuel-economy and GHG regulations of passenger vehicles. The mystery uncovered here is starker in the regulatory analyses of heavy-truck fuel economy, where consumers of heavy trucks, who typically travel much more than owners of light-duty vehicles, are treated in federal regulatory analyses as if they grossly undervalue the private benefits of fuel economy (Gayer and Viscusi, 2013). In the interim, it seems that agency analysts should adopt a middle-ground position between full consumer valuation of fuel economy and no consumer valuation of fuel economy, and perform sensitivity analyses with different partial degrees of consumer valuation. More generally, these concerns raise issues related to the government's role in addressing what might be considered decision making errors, as well as our understanding of whether these are in fact errors or reflect concerns not necessarily considered by researchers.[11] Regardless, these savings can be viewed as an ancillary benefit of the rulemaking, consideration of which has important implications for the analytic results.

Particulate-Matter Control. The co-benefits from particulate matter control are also based on some strong assumptions that contribute to the large magnitude of estimated co-benefits. What determines the emissions reductions is not what is happening at the tailpipe (since EPA and CARB regulations already control 99+ percent of particle emissions from the vehicle) but what is happening throughout the supply chain for petroleum fuels. The agencies use standardized estimates of the amount of particulate emissions that result from energy consumed during oil exploration and production, refining, and distribution of gasoline to retail outlets. Emissions at refineries are apparently a major contributor

[11] For a more general discussion of the implications of behavioral economics research for the conduct of regulatory analysis, see Robinson and Hammitt (2011).

(EPA, 2019). When less petroleum is consumed due to federal regulation, it is assumed that less petroleum moves through the US supply chain and thus particulate emissions decline throughout the supply chain.

A weakness in the agencies' perspectives is that US oil refineries are globally competitive and serve customers around the world. If US demand for refined products declines, it is not obvious that the amount of petroleum refined in the US will decline proportionately. In a global marketplace, the hardest hit refineries will be the high cost producers, unless they are state-owned enterprises or otherwise protected by their governments. If refineries outside the US take the hit, the pollution reductions will occur outside the US and would not typically be counted in a US-centric regulatory analysis. The agencies' perspectives make more sense if the cost-benefit analysis is performed from a global perspective – in fact, the refineries operating outside the US may have even larger rates of pollution than US refineries.

Nor do the agencies assume, as they probably should, that industrial innovation and federal, state and local regulations will gradually reduce the particle emissions throughout the petroleum supply chain during the long time horizon of the rulemaking (2025-2040). In the US, virtually all sources of smog- and soot-forming pollution are likely to come under increasing scrutiny in the years ahead due to the health impacts of these pollutants. Even the deregulation-minded Trump administration has announced intentions to further reduce particle emissions from the heavy-duty truck sector.

For emissions reductions that occur in regions of the country that are not in compliance with EPA's particulate standards, agencies need to consider how state and local officials will respond to those reductions. When officials update their state implementation plans (SIPs) for particulate matter, they are allowed – indeed encouraged by EPA – to consider them. National Research Council (2004) supplies an excellent description of the complex air quality management system established by the Clean Air Act.

In nonattainment areas, particulate emissions – both direct particles and particulate precursors -- are basically capped in SIPs, with the cap achieved over time by curbing the number of new stationary sources of emissions and gradually tightening controls on existing stationary sources. This is a painful process for state, county and local officials because it restrains the amount of economic development that can occur in the nonattainment region (since virtually all economic activity consumes energy and generates a certain amount of particulate emissions). Insofar as federal GHG controls on vehicles result in fewer particulate emissions as a co-benefit, the result may be that fewer controls will be necessary on stationary sources to achieve the overall emissions cap contained in the applicable state implementation plan. Under this scenario, the benefits from mobile source emissions reductions are not related to public health but to the additional economic development (or savings on control costs for existing sources) that will result over time. National Research Council (2006) explains the critical role that vehicle-emissions controls play in helping states and localities develop their SIPs. Insofar as the public health benefits of particulate control are much larger on a per-ton basis than the marginal costs of controlling particulate matter, then it seems that the current approach to estimating particulate co-benefits from vehicle-related GHG regulations are overstating what the actual co-benefits will be. This is a point that EPA (2019, 4-8) acknowledges but does not quantify in any way.

EPA (2019, 4-28) argues that, for particulate matter, most of the country is in attainment with the current standard, so the nonattainment areas are not crucial to the calculation. However, when a cost-benefit analysis is performed in a multi-decade time frame, it is reasonable to assume that the primary

air quality standard for fine particles will be (or at least might be) tightened, and that could bring many more states and localities into nonattainment status.

When emissions reductions occur in regions of the country in attainment with EPA's particulate standards, there is no state/local cap on particulate emissions and thus some public health benefits from vehicle regulations should occur. There is a regulatory approach called Prevention of Significant Deterioration (PSD) that may play a role in limiting increases in pollution levels in attainment areas. EPA (2019, 4-8) mentions this point but does not explore it in detail, in part because it would involve predicting how local, state and federal regulators and enforcement officials would behave in the next few decades.

In any event, there is more scientific uncertainty in attainment areas than in nonattainment areas as to what the magnitude of the health co-benefits will be. EPA (2019, 4-26) refers to this as "less confidence" in the health benefits that occur at exposure levels toward the bottom of the exposure levels in the applicable epidemiological studies. Recent studies suggest that adverse health effects from particle exposure are occurring well below EPA's primary ambient air quality standards for particulate matter (e.g., see Di et al, 2017). A careful regulatory analysis of particle co-benefits needs to consider what the magnitude of health benefits are in attainment areas, considering the possibilities of sublinear, linear and supralinear dose response curves (as well as possible strict thresholds in regions far below the EPA health standards). EPA (2019) includes some useful sensitivity analyses on these issues, showing that the shape of the dose-response function below the current standard has a large impact on the magnitude of health co-benefits.

Countervailing Risks

Fleet-turnover Effects. The Obama-era analyses are weak in their analytic treatment of how higher prices for new vehicles might impact the volume of new vehicle sales, the miles driven in used vehicles, and the scrappage rates for older vehicles. This is a potentially important issue since older vehicles are associated with larger rates of pollution and adverse safety outcomes, even when controlling for driver characteristics. It is referred to as "the Gruenspecht effect", named for Howard Gruenspecht, whose innovative doctoral dissertation at Carnegie Mellon University surfaced this question in the context of EPA's early tailpipe rules on emissions from new cars (Gruenspecht, 1982).

Considering the entire suite of 2017-2025 standards, NHTSA estimates that the average price impact is in the vicinity of $2,000 per vehicle. The incremental price impacts of the 2022-2025 standards are about $1,000 per vehicle. The average transaction price for a new vehicle in the US is about $35,000. Since 70% of new vehicles are purchased with loans, the price premiums for those purchases will presumably be built into the scheduled monthly car payments, assuming buyers are not already at their loan limit. The potential impact on new vehicle sales is complicated by the fact that the average consumer will also value the projected fuel savings to some extent, and some consumers might be more inclined to buy a new vehicle if it is more fuel efficient. The agencies need, but have not yet developed, a model of vehicle demand.

Nor did EPA or NHTSA build a formal model that links vehicle prices and fleet size to a projected fleet distribution of vehicle miles of travel (VMT) by vehicle age. A fleet VMT distribution weighted more toward older vehicles will be dirtier and less safe than a VMT distribution weighted toward newer

vehicles. Fortunately, a growing body of economics literature is available to assist agency analysts in addressing this countervailing risk (discussed further below).

Potential Safety Impacts. Early in the history of NHTSA's CAFE program, concerns were raised that stricter CAFE standards might compromise vehicle safety by inducing vehicle manufacturers to downsize and downweight their new vehicle offerings (Crandall and Graham, 1989). Insurance companies were particularly concerned that downsizing and downweighting of vehicles was increasing occupant fatality rates in crashes (IIHS, 1991). The disadvantages of smaller cars were seen as related to their inferior ability to handle crash forces and protect vehicle occupants (NHTSA, 1990).

NHTSA addressed this concern starting in 2005 by adjusting stringency based on vehicle "footprint" (roughly, vehicle width multiplied by vehicle length). As a result of the footprint adjustment, smaller vehicles face stricter fuel-economy and GHG-emission standards than larger vehicles. This adjustment has the practical effect of discouraging downsizing as a compliance strategy. Use of lightweight materials was not discouraged, since making a vehicle lighter was not penalized in the stringency of the standards.

The footprint adjustment has led to a new concern, that vehicle manufacturers might upsize their vehicles to secure a more permissive fuel economy and GHG standard. There is evidence that upsizing has been occurring in the US since the footprint adjustment was made in 2005 (Whitefoot and Skerlos, 2012; Jacobsen, 2013; Ito and Sallee, 2014; Archsmith et al, 2017; Killean, 2017; Dawson, 2018; Neil, 2018). It is not entirely clear how much of the upsizing is due to regulatory incentive and how much is due to greater consumer interest in seating capacity, leg room, crush space, trunk space, and cargo-carrying capability.

Upsizing is a concern for two reasons: it undercuts the regulatory objectives of improved fuel economy and GHG control and it raises safety issues, especially when upsizing occurs in the light-truck population. Light trucks are "aggressive" in multi-vehicle crashes, especially in collisions where light trucks collide with cars.

Neither agency prepared a quantitative estimate of how much upsizing would occur due to the 2017-2025 standards. Nor did they quantify the impacts of potential upsizing on fuel-consumption, environmental or safety outcomes.

4.1.3 Trump-Era Analyses

In July 2018 the Trump administration issued a proposed rule to relax the federal fuel-economy and GHG standards starting model year 2021. The proposal included consideration of eight relaxation options but the "preferred" option was to freeze the stringency of standards at 2020 levels through model year 2026. A related feature of the proposal, which we do not address here, was assertion of federal preemption of California's GHG and zero emission vehicle programs (or withdrawal of the CAA waiver for California's GHG standards, announced in September 2019 and quickly challenged in court).

The regulatory analysis supporting the deregulatory proposal is extensive, running over 1,000 pages. Since the final rule will be issued shortly, and there will be a revised regulatory analysis (based on peer review and public comments), we focus here on just a few of the interesting – and contentious -- issues related to countervailing risks and co-benefits, including enlargement of the rebound effect, the fleet-turnover model and issues related to upsizing.

Enlargement of the Rebound Effect. Based on an extensive literature review, NHTSA proposed to enlarge the rebound effect from 10 to 20%, meaning that fuel-efficient vehicles would be driven much more throughout their lifetimes than was assumed in the Obama-era analyses. This simple change has important impacts on the analysis: the additional travel nullifies some of the fuel-conservation and GHG-control benefits of the fuel-efficient vehicles, and it leads to indirect particle emissions throughout the supply chain for petroleum fuels. More importantly, the additional travel creates even more noise, traffic congestion, and highway crashes than was assumed in the Obama-era analyses. The adverse effects of additional travel are somewhat offset in the cost-benefit analysis by the additional private mobility benefits that motorists experience. Nonetheless, by proposing a freeze of the standards at 2020 levels, NHTSA and EPA seek to avoid the predominantly negative effects of the rebound effect that would have occurred over the lifetimes of model year 2021-2025 vehicles.

Critics of the 2018 preliminary regulatory analysis argue that the 20% rebound effect is too large, and that several recent, well-done studies suggest much smaller rebound effects than 20% (Langer et al., 2017; West et al., 2017; Knittel and Sandler, 2018; Wenzel and Fujita, 2018). It will be interesting to see how agency analysts handle the rebound effect in the final rule.

Fleet-Turnover Model. The 2018 relaxation proposal also includes the federal government's first attempt to incorporate the Gruenspecht effect into formal regulatory analysis. Tracking recent developments in the economics literature (Jacobsen, 2013; Jacobsen and von Bentham, 2015), a team of analysts at DOT's Volpe Center made a quantitative case in the 2018 proposed rule that the 2021-2025 Obama-era standards would increase the price of new vehicles, reduce the volume of new vehicle sales, and cause more miles of travel in older vehicles compared to what would have occurred under the relaxation options. The results of the fleet-turnover model have powerful influences on the cost-benefit analysis since more travel in older vehicles has a variety of perverse impacts (e.g., more noise, more pollution, more highway crashes).

Peer reviewers and public commenters have identified a variety of flaws in the first iteration of the Volpe fleet-turnover modeling (Bento et al., 2018; NHTSA, 2019). Flaws and uncertainties were identified in both the structure of the model and inputs to the model. A key weakness is the lack of logical linkages between the volume of new vehicle sales, the scrappage rate on older vehicles, total fleet size, and the extent of use of older vehicles relative to newer vehicles. While the Volpe Center analysts are to be commended for this innovation, substantial improvements in the fleet-turnover modeling will be necessary in the final rule.

Upsizing Issue. A substantial body of evidence suggests that the footprint-based federal standards have induced an upsizing trend in passenger cars and light trucks (Whitefoot and Skerlos, 2012; Jacobsen, 2013; Ito and Sallee, 2014; Archsmith et al, 2017; Killean, 2017; Dawson, 2018; Neil, 2018). Insofar as this evidence is valid, a relaxation of the stringency of the federal standards could lead to an attenuation of the upsizing phenomenon, since vehicle manufacturers would be less pressed to find compliance shortcuts. Less upsizing could be associated with substantial safety, fuel-conservation, and environmental benefits.

The 2018 proposal does not include any formal modeling of the upsizing issue, though there is an extensive analysis supporting the precise pattern of the proposed footprint standards for model years 2021-2026. Removal or redesign of the footprint adjustment is unlikely to occur in the final rule, since

that would probably require a new proposal, but the beneficial effects of less upsizing due to relaxation of stringency could be included in the final regulatory analysis.

In sum, the EPA and NHTSA fuel economy and greenhouse gas emissions regulatory analyses raise many issues related to the inclusion of impacts beyond those that are the primary focus of the regulation. Regardless of whether the impact is related to the targeted benefits or to co-benefits, regulatory analysis requires addressing gaps and inconsistencies in the scientific research and careful consideration of the associated uncertainty, as discussed in Section II. This analysis also demonstrates the diversity and importance of co-benefits and ancillary impacts, which have substantial implications for decisionmaking.

4.2 Case Study #2: Mercury Air Toxics Standard

Whether to regulate mercury from electricity generation – chiefly from burning coal – has long been controversial. It could have been regulated by EPA as a hazardous air pollutant (HAP) under CAA section 112 since the 1970 amendments provided EPA with such authority. EPA did list mercury as a HAP under section 112, but the agency exempted the source category of electricity generation. In 1990, Congress added to CAA section 112 a new provision, 112(n), requiring EPA to conduct studies and then determine whether it would be "appropriate and necessary" to regulate mercury from electricity generation. EPA (2000) made this "appropriate and necessary" determination under CAA 112(n) in December 2000, near the end of the Clinton administration.

During the George W. Bush administration, EPA attempted to shift regulation of mercury from electricity generation from CAA 112 to CAA 111, and proposed the Clean Air Mercury Rule (CAMR) under section 111. But EPA lost a court decision which held that EPA had failed to complete the required procedural steps to de-list mercury under section 112(c)(9) (New Jersey v. EPA (DC Cir. 2008)).

The Obama administration then returned to acting under section 112, and in late 2011 EPA promulgated the Mercury Air Toxics Standard (MATS). EPA estimated that the MATS would yield $4-$6 million in annual benefits from reducing mercury emissions, but thousands of times more in co-benefits from reducing fine particulate (PM2.5) emissions:

> This rule will reduce emissions of HAP, including mercury (Hg), from the electric power industry. Installing the technology necessary to reduce emissions directly regulated by this rule will also reduce the emissions of directly emitted PM2.5 and sulfur dioxide (SO2), a PM2.5 precursor. The benefits associated with these PM and SO2 reductions are referred to as co-benefits, as these reductions are not the primary objective of this rule. The EPA estimates that this final rule will yield annual monetized benefits (in 2007$) of between $37 to $90 billion using a 3 percent discount rate and $33 to $81 billion using a 7 percent discount rate. The great majority of the estimates are attributable to co-benefits from reductions in PM2.5-related mortality [which EPA said would be about 4,200 to 11,000 fewer PM2.5-related premature mortalities estimated to occur as a result of this rule]. The annual social costs, approximated by the sum of the compliance costs and monitoring and reporting costs, are $9.6 billion (2007$) and the annual quantified net benefits (the difference between benefits and costs) are $27 to $80 billion using a 3 percent discount rate or $24 to $71 billion using a 7 percent discount rate. (EPA 2012)

Industry then sued EPA, arguing that its December 2000 "appropriate and necessary" determination, preceding the MATS, had violated CAA 112(n) because EPA had not considered costs when making this initial determination. In Michigan v. EPA, 135 S. Ct. 2699 (2015), the Supreme Court held by a 5-4 vote that EPA had violated 112(n). Although the dissent disagreed about the timing (when, in the policy process under CAA 112, EPA must consider cost), all nine Justices agreed that under the word "appropriate," an agency cannot ignore important impacts such as cost (see discussion above in Section III, quoting the opinions authored by Justice Scalia and Justice Kagan). On remand, EPA undertook a reassessment and prepared a supplemental "appropriate" determination (EPA, 2016).

Under the Trump administration, EPA is now seeking to withdraw the 2016 supplemental "appropriate" determination (EPA, 2019), in part on the ground that the 2016 notice sought to promote some narrow views of cost analysis. EPA has now said that the MATS does not have a proper legal foundation, but that its repeal is inadvisable (e.g., since industry has made the compliance investments and since the agency might not be able to make the legal determinations necessary to deregulate).

Critics of the MATS have questioned the magnitude of the PM2.5 co-benefits claimed by EPA in the MATS. That is a specialized question of public health science and welfare economics, which is largely beyond the scope of this paper. One question in this debate is how to value reductions in PM2.5 that occur in areas of the country that are currently in attainment (cleaner) or nonattainment (dirtier) than the National Ambient Air Quality Standard (NAAQS) for PM2.5. This question is discussed in more detail in Section IV.A above.

In addition, critics have argued that EPA is not legally authorized to count co-benefits under CAA section 112(n). Gustafson (2019) argues that the "appropriate" determination under section 112(n) should not include other non-HAP pollutants, and that 112(b)(2) precludes regulation of "criteria" air pollutants under section 112 (an argument that applies to PM, a "criteria" pollutant under 108, but does not apply to other non-"criteria" air pollutants). But counting PM co-benefits of the MATS under 112 is not the same as regulating PM under section 112 – it is not setting an emissions standard for PM under 112. Rather, it is forecasting the response by firms to the section 112 emissions standard for mercury. Insofar as the mercury standard was made more stringent under 112 due to the counting of PM co-benefits, one might argue that PM is, de facto, being regulated under 112. However, the stringency of the MATS regulation appears to be based more on technological considerations than on cost-benefit comparison.

Moreover, as discussed in Section III of this paper, the Supreme Court in Michigan v. EPA ruled that the word "appropriate" in CAA section 112(n) requires EPA to consider the full impacts – all the "advantages and disadvantages," "all the relevant factors." Further, considering the converse scenario makes the point plain: imagine if, unlike the MATS, a hypothetical proposed policy X would reduce mercury and increase (not decrease) PM2.5, killing (not saving) thousands; clearly that countervailing risk should be counted. It would be arbitrary, inappropriate, and bad policy to ignore such an ancillary impact. It would be inconsistent to criticize EPA for counting the PM2.5 co-benefits from the MATS, but then insist that EPA must count the PM2.5 countervailing risks from policy X. The better policy and legal approach is to count both.[12]

[12] We have not yet seen a suggestion that the MATS itself might lead to other countervailing risks. Conceivably, the MATS could reduce the use of coal (hence reducing mercury and PM2.5), but increase the use of natural gas (which

4.3 Case Study #3: EPA Regulation of Greenhouse Gas Emissions from Electric Power Plants

In this case, we consider two regulatory analyses, one prepared at EPA during the Obama administration concerning what was then called the Clean Power Plan (CPP); the other prepared at EPA during the Trump administration concerning a replacement rule called the Affordable Clean Energy (ACE) rule. CPP would have required states to control GHG emissions at electric power plants, roughly to the level achieved by natural gas plants. ACE is a more limited rule that provides guidance to states on how to promote efficiency (e.g., heat-rate improvements (HRIs)) at coal-fired power plants. HRIs are efficiency measures that enable coal-fired power plants to operate with fewer CO2 emissions per unit of electricity generation (so-called CO2 intensity).

4.3.1 Obama-Era Clean Power Plan Analysis

The final regulatory analysis supporting the Clean Power Plan focuses on the target risk (carbon dioxide from fossil-fuel plants) but also ancillary risks related to emissions of sulphur dioxide and nitrogen dioxide, which are related to the formation of health-damaging smog and soot. While the performance standards in the final rule cover only CO2, the RIA argues that the rule will cause somewhat less use of coal-fired power plants, which will induce fewer emissions of SO2 and NO2 and directly-emitted particles (soot).

A provocative finding is that the ancillary air-quality benefits are much larger (by roughly a factor of three) than the benefits from reducing the target pollutant (CO2). The RIA is well designed to enable the reader to see how important the health-related air quality benefits are relative to the climate-related benefits.

Interestingly, the estimated compliance costs of the rule are larger than the benefits related to CO2 control in the scenarios that apply a large annual discount rate to future benefits (5%). When smaller discount rates are used (3% and 2.5%), the costs are frequently smaller than the climate-related benefits. Thus, the large co-benefits play an important and reassuring role in the cost-benefit case for adopting the Clean Power Plan. However, this analysis provides an example of how analytic concerns that appear unrelated to decisions about including co-benefits on the surface, such as the discount rate, may in fact play an important role in their assessment.

Missing from the final analysis is a comprehensive lifecycle accounting of the risks and benefits of replacing coal-fired power generation with natural gas and renewables. The lifecycle accounting is complex because, for example, the use of natural gas for power generation is associated with methane emissions throughout the supply chain, and methane is a highly potent greenhouse gas.[13] Moreover, the advantage of natural gas over coal is much stronger with respect to SO2 and direct-particle emissions than it is with respect to nitrogen oxide emissions.

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increases methane emissions, and methane is a highly potent greenhouse gas). Such an effect, if it is significant, would also deserve consideration. See Graham and Wiener (1995, ch. 10).

[13] For an early analysis of the countervailing risk of CO2 from coal and methane from natural gas, see Graham and Wiener 1995 (ch. 10).

Nor does the final analysis provide a formal treatment of how the reduced emissions of SO2, NOx and fine particles might impact the stringency of regulation of these same pollutants from other sources. The Clean Air Act has created an entire suite of state and federal programs related to SO2, NOx and particle control, and the states have some flexibility to adjust the stringency of their controls for some sources based on the extent of emissions from other sources.

4.3.2 Trump Era Affordable Clean Energy Analysis

The ACE regulatory analysis makes two lines of argument in support of repeal of the CPP. As a legal matter, EPA argues that it does not have the authority under the Clean Air Act to enact the CPP. As a practical matter, the Agency makes a case that the electric utility industry, as a whole, is likely to make the same magnitude of reductions in CO2 emissions without the CPP that would occur with the CPP.

The legal issues are largely beyond the scope of this paper's focus on co-benefits, countervailing risks and cost-benefit analysis. Both the CPP and ACE were promulgated pursuant to Clean Air Act section 111, which authorizes EPA to determine the "best system of emission reduction" (BSER), and under section 111(d) authorizes EPA to call on states to adopt plans setting standards for existing sources that reflect the BSER. A central point of dispute is whether CAA 111 authorizes EPA to determine the BSER for electricity generation as a system (including in the BSER the potential for shifting generation from more- to less-polluting sources and fuels, such as from coal to natural gas, as in the CPP), or only for each individual electric generating unit (as in the ACE). The CPP was issued in 2015 but had not yet gone into effect because the Supreme Court issued a stay of the CPP in February 2016, while litigation challenging the legal basis for the CPP was pending in the US Court of Appeals for the DC Circuit. After the DC Circuit heard oral arguments in September 2016, and the 2016 election, the Trump administration sought to rescind the CPP and replace it with the ACE.

The practical argument in support of CPP repeal is supported by several modeling exercises that project CO2 emissions into the 2030s with and without the CPP. It is further supported by some intriguing analyses showing that the Energy Information Administration has been consistently underestimating the rate of decline of CO2 emissions from the US electric utility sector. In summary, the RIA concludes that the anticipated benefits and costs of implementing the CPP would be essentially zero. This somewhat surprising finding is related to rapid changes in the electricity sector that have been occurring over the last decade: the collapse of natural gas prices, the increasing affordability of renewables, and the accelerated rate of retirement of coal-fired power plants. We offer no comment on the validity of this practical argument as its validity relates to industry trends and projections that we have not studied in any detail.

The central weakness of the Agency's position on repeal of the CPP is that the Agency did not consider more stringent variants of the CPP, variants applicable only to the coal sector and/or variants applicable to both the coal and natural gas sectors. While the benefit-cost case for stricter variants may have been difficult to make solely on the basis of domestic climate impacts, consideration of health co-benefits would have made the case much stronger.

The other aspect of the Trump-era RIA, which relates to our interest in countervailing risks and co-benefits, is the cost-benefit analysis comparing ACE to a business-as-usual scenario. The Agency

concludes that the benefits of ACE, which are illustrated with heat-rate improvements at a majority of coal-fired power plants, will far exceed the costs of ACE. Interestingly, the benefits of ACE do not exceed the costs without inclusion of health co-benefits. The specifics of the benefit-cost results are summarized in Table 2.

Table 2: National Benefits and Costs of ACE, Present Value of 2023-2037 Impacts, Millions of 2016$, 3% Discount Rate

Costs*	Domestic Climate Benefits**	Health Co-Benefits***	Net Benefits
$1,600	$640	$4,000-$9,800	$3,000-$8,800

*The industrial costs of adopting HRIs at applicable coal-fired power plants.
**Assuming a domestic SCC value of $8.82 per metric ton of CO2.
***Largely due to reductions in particulate pollution exposures.

Source: EPA, 2019.

In accordance with the guidance in OMB Circular A-4 (2003), the includes a sensitivity analysis where climate benefits are computed using a global social cost of carbon (SCC) value, similar to that used in the Obama administration's defense of the CPP (EPA, 2019, 7-7). If the Agency had assumed a global SCC of $63 per metric ton of CO2, the climate benefits would enlarge to $4.54 billion, well in excess of the $1.6B cost of ACE.

There is a healthy debate as to whether, in US regulatory analysis, a global or domestic SCC should be employed, reflecting the issues raised in our earlier discussion of standing (for the global view, see Revesz et al, 2017; Anthoff and Toll, 2010; for the domestic view, see Fraas et al, 2016; Gayer and Viscusi, 2016). What is clear is that the domestic SCC value in use by the Trump administration is likely to understate US interests, as it excludes the wellbeing of US citizens living outside the US, and it omits climate damages in the US that are triggered by impacts outside the US (e.g., climate damages in China and Europe may reduce demand for US goods in international trade).[14] EPA (2019, 4-6) acknowledges that more research is needed to refine the domestic SCC, and the National Research Council (2017) has put forward an ambitious, long-term research agenda on the issue.

Both President Obama and President Trump may have had plausible geopolitical reasons for how they handled the SCC, given their respective political orientations. President Obama believed that the Paris climate accords were in the interests of the US and thus he was prepared, through a global SCC, to recognize and address the climate-related damages that the US imposes on other countries as well as on itself (Graham, 2016). President Trump believed that the Paris climate accords were not in the interests of the US, and he believes that Europe and China have been taking advantage of the US for many years on a wide range of policy issues (e.g., trade, the costs of NATO and so forth). Thus, Trump may see the climate issue as only one of a larger set of issues that need to be renegotiated. From this perspective, the decision about global versus domestic SCC is an intensely political one, not just one to be addressed

[14] In addition, as noted in the above discussion of standing, OMB Circular A-4 (p.15) tells agencies to "focus on benefits and costs that accrue to citizens and residents of the United States," which includes physical impacts occurring outside the US that affect the utility of ("benefits and costs that accrue to") people inside the US; but the domestic SCC value in use by the Trump administration appears to exclude such effects on the utility of US persons. See Rowell (2015).

through science and economics (Graham and Belton, 2019). A country's anticipation of reciprocal action (or lack thereof) by other countries can influence its choice of preferred SCC along the spectrum from a fully global to a purely domestic SCC (Pizer et al., 2014; Kotchen, 2018).

The other aspect of the SCC is the appropriate social discount rate to be applied to future climate damages. The ACE analysis gives primary weight to the rates of 3% and 7%, in accordance with OMB's long-standing position in OMB Circular A-4 (2003) (see Council of Economic Advisors (2017) for more discussion), although that Circular also notes the arguments for using lower rates when regulations have intergenerational impacts. The Obama administration, in the context of SCC, reported SCC values based on discount rates of 2.5%, 3%, and 5%. There is an appendix in the ACE regulatory analysis that reports climate benefits using a discount rate of 2.5%, which is seen as addressing OMB Circular A-4's encouragement, in the context of intergenerational issues, to report some results with rates lower than 3.0%. For a useful discussion of the technical issues on discounting in the climate context, see National Research Council (2017). Whether this issue is primarily technical or political/ethical is open to debate.

A more central technical issue in the benefits analysis is whether heat-rate improvements will in fact lead to overall reductions in pollution from the nation's fleet of coal-fired power plants. Coal-fired power plants vary considerably in the efficiency of their operation (EIA, 2015) and HRIs will reduce the CO2 intensity of plant operation (EPA, 2019). However, all energy-efficiency improvements are vulnerable to what is called a rebound effect.

In this case, there is a real concern that HRIs will cause coal-fired power plants to be used more frequently and/or to last longer than they would without the HRIs. The resulting increases in coal-fired electricity generation are associated with additional pollution that can partially offset, completely offset, or overwhelm the reductions in CO2 intensity of operation. The ACE analysis does not squarely address the rebound effect, which is a serious analytic weakness, but does report that the rule is projected to cause a slight decrease in the natural gas share of power production and a slight increase in the coal share of power production.

While not specifically addressed in the regulatory analysis, the rebound effect is discussed in the preamble to the final rule. There, EPA states:

> In some instances, it is possible that certain sources increase in generation (relative to some baseline) as a result of lower operating costs from adoption of candidate technologies to improve their efficiency. The EPA conducted analysis and modeling for the ACE proposal, and found that while there were instances (in some scenarios) where a limited number of designated facilities that adopted HRI increased generation to the point of increasing mass emissions notwithstanding the lower emissions rate resulting from HRI adoption, due to their improved efficiency and marginally improved economic competitiveness relative to other electric generators, the designated facilities as a group reduce emissions because they can generate higher levels of electricity with a lower overall emission rate." (EPA, 2019).

EPA adds:

> …this [rebound] concern is not supported by our analysis. The EPA conducted updated modeling and analysis for the final ACE rule (see Chapter 3 of the RIA for more details) and confirmed that

> aggregate CO2 emissions from the group of designated facilities are anticipated to decrease (outweighing any potential CO2 increases related to increased generation by certain units)." And: "As such, any potential ''rebound effect'' is determined to be small and manageable (if necessary) and does not require any specific remedy in the final rule. However, if a state determines that the source-specific factors of a designated facility dictate that the rebound effect is an issue that should be considered in setting the standard of performance, that is within the state's discretion to consider in the process of establishing a standard of performance for that particular existing source. (EPA, 2019).

There is a significant literature exploring the potential magnitude of the rebound effect in the electric utility sector (Linn et al, 2014; Keyes et al, 2018; Keyes et al, 2019). For national CO2 emissions, this literature suggests that the rebound effect will nullify most but perhaps not all of the climate-control benefits of HRIs. At some plants and in some states, the rebound effect on CO2 is predicted to overwhelm the CO2 intensity gains but this geographical variation is not a central concern for a pollutant that mixes globally. In the long run (2050), there is little or no national net CO2 reduction from the ACE compared to no policy (Keyes et al. 2019: Table 1). And most of the affected coal plants are expected to have been retired at that point.

More concerning is the finding that the rebound effect for sulfur dioxide and nitrogen oxides is also significant, and will produce variable impacts on health-damaging smog and particle pollution around the country (Keyes et al. 2019). Since the health impacts of coal-plant pollution are local and regional in nature, this is an issue that requires disaggregated analysis. And, since the health co-benefits of CO2 controls at coal plants loom larger in cost-benefit analysis than the direct climate-control benefits, this is a countervailing risk that should have been addressed more directly in the ACE RIA. As we discussed earlier, in a different context, EPA's targeted regulatory programs for smog and soot may or may not address these concerns.

5.0 Summary and Recommendations

Both the basic principles of good policy analysis and the legal framework underpinning our regulatory system suggest that comprehensive assessment of all important impacts is essential. Without such assessment, we lack the information needed to understand the extent to which the regulatory options, including the option of no action, are likely to improve the well-being of society. Available guidance provides substantial technical support for determining how to best conduct such assessment. It explores issues such as determining standing, conducting screening analysis, and exploring the implications of uncertainty and nonquantified effects.

However, estimating impacts is challenging, regardless of whether the impacts related to the primary goal of the rulemaking or to ancillary effects. Our review of three recent regulatory analysis reinforces the importance of carefully considering the available evidence and associated uncertainties. It also emphasizes the importance of the technical details of the analysis. Decisions about how to combine and use the available evidence, and about standard parameters such as which discount rates to apply, can have significant implications.

Our analysis suggests two sets of recommendations. The first set relates to the need for evenhandedness -- for not unduly overweighting or underweighting categories of impacts. Good regulatory analysis should:

- Assess both target impacts and ancillary impacts (side effects).
- Assess both positive and negative ancillary impacts (co-benefits and countervailing risks or harms).
- Not count only co-*benefits* while neglecting countervailing *harms*; nor vice-versa, counting only countervailing harms while neglecting co-benefits; count both.
- Not argue against counting co-*benefits* and then demand counting countervailing *harms or costs;* count both.
- Not argue against counting co-benefits of one type of policy, e.g. *environmental* policy, and then demand counting co-benefits of other (*non*-environmental) policies; treat them alike.
- Not count only the costs imposed directly on regulated entities; include the costs imposed on others, whether individuals or entities, for profit, nonprofit, or government, as well as the cost-savings.
- Apply the same standards of analytic rigor (e.g., parity in quantification and uncertainty) to all impacts, weighing the relative importance of the impact relative to the cost of assessment when determining the scope and level of detail of the analysis.

Second, more generally, our analysis leads to several recommendations that go beyond the details of the assessment, addressing how the analysis is used in the policy making process.

1. Regulators should choose policy options that seek to maximize societal net benefits (considering distributional equity), to the extent feasible given statutory and other constraints.
2. Where co-benefits are significant, regulators should consider the alternative of regulating co-benefits directly, including under a different statutory provision or by a different agency, if that would yield greater net benefits than counting the co-benefit as an ancillary impact of the initial rule. Likewise, regulators should consider regulating countervailing harms in addition to the target benefit, so as to overcome the tradeoff by reducing multiple risks in concert, and thereby yield risk-superior moves that increase societal net benefits.
3. Regulators should review these assessments over time (retrospectively and/or periodically) to improve the accuracy of ex ante forecasts, and to update the policies to improve societal net benefits.
4. Executive and judicial oversight should encourage regulatory agencies to count an appropriately broad scope of important impacts.

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