Quantifying Regulatory Benefits

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This Essay makes three principal claims. First, it shows that breakeven analysis is a useful technique for adding structure to cost-benefit analysis when a regulatory benefit has not been quantified. In particular, breakeven analysis can sometimes address the judicial hostility to using nonquantified benefits as trumps. But it is a second-best approach because actually quantifying the benefit can provide far more useful information to the regulatory process. Second, the Essay argues that the categories of "quantifiable" and "nonquantifiable" benefits are not immutable. "Unquantifiable" benefits are simply benefits that have not yet been quantified. Over the last few decades, important categories of benefits that were once considered unquantifiable were subsequently quantified: the two most significant for current regulatory purposes are the "value of a statistical life" (VSL) and the social cost of carbon (SCC). Third, the Essay shows that the federal government has played a significant role in providing resources for the quantification of important categories of benefits and should be regarded as a catalyst for future efforts of this sort. Recent congressional threats to cut the funding for research in the social sciences are a worrisome development in this regard. As a result, the push for breakeven analysis is a salutary development unless it diverts attention and resources from the actual quantification of regulatory benefits.

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INTRODUCTION

In *The Limits of Quantification*, Professor Cass R. Sunstein persuasively argues that administrative agencies should engage in breakeven analysis when they are not able to quantify or monetize some or all of the benefits of a particular regulation.[1] Breakeven analysis is a technique used to determine the minimum value of the nonquantifiable benefit that would yield positive net benefits for a regulatory intervention.[2]

The Office of Management and Budget (OMB) Circular A-4, which dates back to 2003,[3] requires agencies to engage in breakeven analysis when they cannot directly estimate particular benefits. Professor Sunstein, who served with great distinction as the Administrator of OMB's Office of Information and Regulatory Affairs (OIRA) between 2009 and 2012, compellingly explores the sequence of steps that agencies should take in performing such analysis. This Essay has no quarrel with Professor Sunstein on the value of breakeven analysis or the manner in which it should be conducted. Instead, it focuses on four matters that are closely intertwined with Professor Sunstein's piece.

Part I explores the promise and limitations of breakeven analysis. It shows thatS this technique can provide useful guidance to regulatory decisions in some cases. But in many other cases, it provides no guidance at all. Therefore, breakeven analysis is far from a panacea.

Part II underscores, nonetheless, the importance of Professor Sunstein's project by showing that courts and agencies often to not take nonquantifiable

1. Cass R. Sunstein, *The Limits of Quantification*, 102 CALIF. L. REV. 1369 (2014).

2. *See* OFFICE OF MGMT. & BUDGET, CIRCULAR A-4: REGULATORY ANALYSIS 2 (2003) [hereinafter CIRCULAR A-4].

3. *See* CIRCULAR A-4, *supra* note 2, at 2.

benefits seriously or outright ignore them. Any effort to add structure to the valuation of benefits, even a partial one such as breakeven analysis, is therefore likely to improve the quality of administrative decision making.

Part III shows that the categories of quantified benefits and nonquantifiable benefits are not immutable. Indeed, important categories of benefits that were once nonquantifiable subsequently became quantified. This Part discusses how the process unfolded, or is in the process of unfolding, for five important categories of benefits. This review, in turn, gives rise to an important issue. Given that breakeven analysis is a second-best technique and that the quantified and nonquantifiable categories are permeable, how can one provide appropriate incentives for the first-best outcome—actual quantification?

On this score, Part IV shows that the federal government has played an important role in promoting the quantification of significant categories of benefits and should be regarded as an important catalyst for future efforts of this sort. The movement from nonquantifiable to quantified is not a random event. Instead, it is often the product of a government intervention—whether the funding of private studies or more direct government action. So the question of how to deal with nonquantifiable benefits inevitably leads to the consideration of the optimal governmental role in providing incentives for quantification. In this connection, recent congressional threats to cut the federal funding of the social sciences are a worrisome development. This Essay concludes by arguing that Professor Sunstein's push for breakeven analysis is a salutary development, unless it diverts attention or resources from the actual quantification of regulatory benefits.

Two threshold matters deserve brief attention. First, although the nonquantifiable element could in principle be the costs of a regulation rather than its benefits, in general, it is the latter because the costs borne by regulated entities tend to be easier to ascertain than the benefits to broad populations.[4] As a result, breakeven analysis can reduce an important antiregulatory bias.

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4. *See e.g.*, FRANK ACKERMAN & LISA HEINZERLING, PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING 40 (2004) ("[M]ost cost-benefit analyses could more accurately be described as 'complete cost-incomplete benefit' studies. Most or all of the costs are readily determined market prices, but many important benefits cannot be meaningfully quantified or priced . . . ."); David M. Driesen, *Is Cost-Benefit Analysis Neutral?*, 77 U. COLO. L. REV. 335, 339–42 (2006) (explaining that costs are often relatively easy to quantify using market data but that these estimates tend to be too high, while benefits can be "extraordinarily difficult" to quantify and monetize); Robert H. Frank, *Why Is Cost-Benefit Analysis So Controversial?*, 29 J. LEGAL STUD. 913, 928 (2000) (indicating that cost-benefit analysis can be controversial because costs are much easier to quantify than benefits, particularly in the environmental and health fields).

Moreover, there is direct evidence that benefits fail to be quantified far more often than costs in OMB-reviewed rules. In the 2012 fiscal year, there were forty-seven rules promulgated, fourteen of which accounted for the majority of the quantified economic impact for that year. Of these fourteen, only two included nonquantified cost estimates, while nine included nonquantified benefit estimates. OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, 2013 DRAFT REPORT TO CONGRESS ON THE BENEFITS AND COSTS OF FEDERAL REGULATIONS AND AGENCY COMPLIANCE WITH THE

Second, as a result of the permeability of the categories, the remainder of this Essay refers to nonquantified rather than nonquantifiable benefits. Nonquantifiable benefits are simply benefits that have not yet been quantified, but that in some cases could be quantified relatively expeditiously if the federal government chose to take the lead.

I.
PROMISE AND LIMITATIONS OF BREAKEVEN ANALYSIS

Breakeven analysis adds useful structure to regulatory decisions that otherwise would appear to be manipulable and arbitrary. Consider a situation in which the quantified benefits of a regulation are smaller than the quantified costs, but in which some additional benefits are nonquantifiable. On what basis could an agency say that the nonquantifiable benefits make the regulation justified under a cost-benefit standard? Conversely, on what basis could it say that the nonquantifiable benefits do not provide such a justification?

For example, if the quantified yearly benefits of a possible environmental regulation are $4 billion as a result of reduced mortality, the quantified yearly costs are $5 billion, and the benefits from reduced morbidity are nonquantifiable, how can the agency justify a decision to promulgate the regulation? It would not sound particularly compelling for the agency just to say, without further explanation, that the benefits that it cannot quantify are worth more than $1 billion. But if, instead, the agency can determine that one hundred thousand people throughout the country will each lose an average of two days of work a year and suffer moderate discomfort, the situation will look quite different. In that case, the regulation will be justified under cost-benefit analysis if the harm to each of these affected people is at least $50. Since this amount is less than what a worker earning the minimum wage gets paid in one day, the agency's conclusion that the regulation is justified becomes reasonable, indeed compelling, once it engages in breakeven analysis of this sort.

Breakeven analysis can also promote consistency across different regulatory decisions. Assume that in one case, an agency promulgates a regulation that would be justified under breakeven analysis as long as the benefit of a lost day of work is at least $70. In a subsequent case, the agency evaluates a possible regulation that would be justified under breakeven analysis as long as the benefit of a lost day of work is at least $60. If, having promulgated the first regulation, the agency decides not to promulgate the second one, it will have acted inconsistently and therefore arbitrarily, absent some other compelling difference between the two cases that makes the first regulation more attractive than the second.

UNFUNDED MANDATES REFORM ACT 3–4 (2013), *available at* http://www.whitehouse.gov/sites/default/files/omb/inforeg/2013_cb/draft_2013_cost_benefit_report.pdf.

But breakeven analysis, though useful, is not a panacea. It is only a second-best alternative to the actual valuation of the nonquantifiable benefit. Instead of speculating whether it is reasonable to value a day of work loss at the breakeven amount, it would be far preferable to perform the actual valuation. At most, as Professor Sunstein recognizes, breakeven analysis can provide upper and lower bounds to guide an agency's decision.[5]

For example, if a safety regulation is justifiable only if the value of a loss of a limb is at least $10 million, we can safely conclude the regulation would not pass a cost-benefit test, since the value of a statistical life, which is around $9 million,[6] would provide a useful upper bound. Assume, hypothetically, that the loss of a finger is valued at $50,000. That would be a useful lower bound. But breakeven analysis would not give any guidance on how the agency should treat breakeven values in the vast range between $50,000 and $9 million. What breakeven analysis does in this example is reduce the zero-to-infinity range of discretion into a $50,000 to $9 million range. Within this range, it provides no further structure to guide the agency's decision.

A second, perhaps more serious, limitation is that breakeven analysis is unlikely to be tractable where a regulation produces more than one nonquantifiable benefit. In each example discussed above and each example discussed in Professor Sunstein's article, only one benefit is nonquantifiable. In connection with the prior discussion involving the loss of a limb, consider a situation in which the regulation also reduces the incidence of asthma in a larger proportion of the population. If $10 million per lost limb is too high a breakeven valuation to justify the regulation when it is the only nonquantifiable benefit, does it become a reasonable breakeven valuation for a lost limb plus a decrease in the incidence of asthma among, say, a thousand people? There would now not be clear guidance on how to proceed.[7]

II.
PERILS OF NONQUANTIFICATION

This Section underscores the perils when agencies fail to make efforts to quantify regulatory benefits. As a result, breakeven analysis can have salutary effects by adding structure to an agency's justification for its regulations.

Part II.A of this Section analyzes cases in which courts have rejected the argument by agencies that nonquantified benefits could serve as trumps turning an unfavorable cost-benefit analysis into a favorable one. The results in those cases might therefore have been different if the agencies had undertaken further

5. *See* Sunstein, *supra* note 1, at 1391.

6. *See id.* at 105.

7. One might imagine more sophisticated techniques in which regulations providing multiple nonquantified benefits are analyzed using multiple regression analysis or some similar statistical technique.

efforts at quantification: either doing so directly or using breakeven analysis as a second-best alternative.

Part II.B of this Section analyzes a different set of cases—in which agencies initially accorded no weight to nonquantified benefits. The reviewing courts struck down the administrative decisions as a result of this failure. On remand, the agencies engaged in quantification efforts and then justified more protective regulatory approaches. But during the sometimes decade-long period consumed by the process of judicial review and remand, the public is exposed to suboptimally large risks. This social welfare loss could have been avoided if the agencies had engaged in quantification efforts without waiting for the courts' prodding to do so.

A. Judicial Skepticism of Nonquantified Benefits

In an important set of cases spanning decades, courts have accorded insufficient weight to the importance of nonquantified benefits in regulatory cost-benefit analysis. As a result, judicial review has often facilitated suboptimally lax regulatory outcomes. This Section examines two themes common in the case law. First, courts have sometimes invalidated regulations based on the reliance by agencies on nonquantified benefits to justify their rules. In these cases, courts refuse to defer to the agency, setting aside the regulation because the agency cannot quantify benefits that it deems to be nonquantified.

Second, on other occasions, courts have upheld the failure of agencies to include nonquantified benefits in their calculus, even though the consideration of such benefits might have supported more stringent regulation. In these cases, judicial review gives the benefit of the doubt to the agency, but leads to regulation that may be suboptimally lax.

1. Judicial Reversal of Agencies' Reliance on Nonquantified Benefits

In important cases, courts have overturned regulations in which the agency justified its action on the ground that a rule would produce significant, but nonquantified, benefits. For example, in *Corrosion Proof Fittings v. Environmental Protection Agency*, the Fifth Circuit vacated the Environmental Protection Agency's (EPA) ban on the manufacture, importation, processing, and distribution of asbestos.[8] The EPA had promulgated the rule under the Toxic Substances Control Act (TSCA), which directs the agency to regulate certain toxic substances that pose an "unreasonable risk of injury" using the "least burdensome requirements."[9]

The court held that the EPA failed to meet these two statutory conditions, in part due to deficiencies the court identified in the agency's cost-benefit

8. 947 F.2d 1201 (5th Cir. 1991).
9. *Id.* at 1214–15 (quoting TSCA).

analysis.[10] Most importantly, the court objected to the EPA's failure to calculate the rule's costs and benefits beyond the year 2000, and to treat lives saved beyond that time period as nonquantified benefits.[11] The agency argued that these benefits justified the rule's costs. It concluded that the $128–227 million cost of banning asbestos pipe, which the agency anticipated would prevent three premature deaths before 2000, was reasonable in light of its nonquantified benefits: lives saved after 2000.[12] The court rejected the EPA's approach, declaring that while nonquantified benefits may "tip the balance in close cases," the EPA could not employ them "as a trump card allowing [it] to justify any cost calculus, no matter how high."[13]

As a result, the court disregarded the asbestos ban's potentially significant but nonquantified benefits. In so doing, it did not give the agency any guidance on what might count as a "close case" or how it might proceed in future cases to avoid having the nonquantified benefits of a rule be disregarded.

Similarly, in two recent decisions, the D.C. Circuit held that the Securities and Exchange Commission's (SEC) nonquantification of important costs and benefits rendered its rules arbitrary and capricious. In *Chamber of Commerce v. Securities and Exchange Commission*,[14] the court vacated a rule requiring the chairperson and at least 75 percent of the directors of certain mutual funds to be independent.[15] The SEC had promulgated the rule in response to what it perceived as abuses resulting from conflicts of interest between shareholders and managers.[16] The Investment Company Act requires the SEC to determine whether its rules will "promote efficiency, competition, and capital formation."[17] The court held that by failing to determine the costs that the new rule would impose on mutual funds, the SEC had not met its obligation to evaluate these statutorily mandated criteria.[18] In response to the SEC's argument that it lacked sufficient data to estimate the costs of compliance, the court stated that uncertainty did not exempt the SEC from at least identifying the cost that a single fund might incur, or the range of aggregate costs in which compliance might fall.[19] Without quantifying the costs to the industry of electing additional independent directors and chairmen, the court held that the SEC could not properly account for the rule's economic effects.[20] In this case, the court focused on the agency's failure to quantify the costs of the rule. The

10. *See id.* at 1215, 1219.
11. *See id.* at 1218–19.
12. *See id.*
13. *Id.* at 1219.
14. 412 F.3d 133 (D.C. Cir. 2005).
15. *See id.* at 136–37.
16. *See id.*
17. *Id.* at 142 (quoting the Investment Company Act).
18. *See id.* at 144.
19. *See id.* at 143–44.
20. *See id.*

lack of judicial deference here suggests that the court would also have been skeptical of a rule in which the agency asserted that the nonquantified benefits outweighed the quantified costs.

More recently, the D.C. Circuit vacated another SEC rule for similar reasons in *Business Roundtable v. Securities and Exchange Commission*.[21] The SEC's rule required public companies to provide information in their proxy materials about shareholder-nominated candidates for the board of directors.[22] The SEC asserted that the benefits of the rule justified its costs, arguing that the rule would reduce the printing, postage, and advertising costs associated with proxy contests, overcome collective action problems related to candidate nomination, improve board performance, and increase shareholder value.[23] The court held, however, that the SEC had not adequately analyzed the economic effects of the rule because it failed to substantiate the benefits and quantify the costs to companies.[24] It reasoned that the SEC should have quantified the costs that companies would incur through proxy solicitation, advertising, and campaigning during contested elections.[25] Implicit in the court's reasoning is its judgment that the nonquantified benefits that the SEC predicted might have been insufficient to overcome these potential costs.

Corrosion Proof Fittings, Chamber of Commerce, and *Business Roundtable* are significant examples of judicial unwillingness to defer to agencies' reliance on nonquantified benefits, especially when agency policies will impose high costs on the private sector. The risk of judicial reversal of regulations that may very well be cost-justified should serve as an incentive for agencies to invest greater resources in quantifying the benefits of important regulations.

We do not know whether breakeven analysis would have satisfied these courts.[26] It is reasonable to speculate, however, that it would have increased the probability of affirmance in cases in which the breakeven value of the benefit was higher than a lower bound on that benefit.

2. Judicial Approval of Agencies' Disregard of Nonquantified Benefits

Courts have also upheld rules against challenges maintaining that the agency did not sufficiently weight the nonquantified benefits.[27] These decisions

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21. 647 F.3d 1144 (D.C. Cir. 2011).

22. *See id.* at 1147.

23. *See id.* at 1149.

24. *See id.* at 1148–49.

25. *See id.* at 1150–51.

26. An electronic search did not reveal any cases in which a federal court examined an agency's use of breakeven analysis (or failure to do so) in regulatory cost-benefit analysis.

27. In contrast, courts have also upheld rules in which the agency justified its regulation based on the significance it assigned to predicted (but nonquantified) public health, consumer, or environmental benefits. *See, e.g.*, Charter Commc'ns, Inc. v. FCC, 460 F.3d 31 (D.C. Cir. 2006) (upholding agency's determination that rule's nonquantified benefits—including competition,

may have resulted in suboptimally lax regulatory outcomes, as the agency's failure to quantify benefits prevented it from fully accounting for important values in its cost-benefit analyses. In these cases, judicial review would have been more meaningful and effective had the agencies quantified both the costs and benefits at stake.

In *Conservation Law Foundation v. Federal Energy Regulatory Commission*, for example, the D.C. Circuit upheld the Federal Energy Regulatory Commission's (FERC) relicensing of a hydropower operation, rejecting petitioners' contention that the nonquantified environmental benefits of establishing a minimum flow requirement outweighed the energy-related costs.[28] Under the Federal Power Act, the FERC must give "equal consideration" to the power and nonpower benefits of projects, including recreational and wildlife improvements.[29] The petitioners argued that restoring minimum stream flows to a dammed channel would create fishing and whitewater rafting opportunities.[30] The FERC refused to quantify these benefits, stating that "for non-power resources . . . the public interest cannot be evaluated adequately only by dollars and cents."[31]

The FERC did, however, quantify the costs of minimum stream flow requirements at over $900,000.[32] The court agreed that the FERC need not quantify nonpower benefits, concluding that the FERC's decision not to quantify did not mean that it had given lesser consideration to recreational and environmental benefits.[33] It stated that "[a] critical factor in the Commission's refusal to impose minimum flows was the increased power expenses that would result, not the Commission's failure to appreciate nonpower values."[34] But because the FERC never quantified the benefits of fishing and rafting, it is impossible to ascertain whether the balance it struck was a rational one, or even whether the FERC truly gave the nonpower benefits equal consideration. By crediting the FERC's weighing of quantified costs against nonquantified benefits, the court enabled it to pursue a course of action that may not have been socially desirable.

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consumer choice, and technological innovation—would outweigh its costs); Penn. Funeral Dirs. Ass'n v. FTC, 41 F.3d 81 (3d Cir. 1994) (concluding that agency's failure to quantify benefits did not undermine its conclusion that its rule would stimulate competition); Inv. Co. Inst. v. U.S. Commodity Futures Trading Comm'n, 891 F. Supp. 2d 162 (D.D.C. 2012), *aff'd*, 720 F.3d. 370 (D.C. Cir. 2013) (upholding rule based on its predicted—but nonquantified—benefits, including a reduction in shocks to the U.S. financial system and increased investor protection); Nat'l Fisheries Inst., Inc. v. Mosbacher, 732 F. Supp. 210 (D.D.C. 1990) (holding that agency need not quantify the benefits of a fishing regulation to conclude that it would be in the nation's best interest).

28. *See* 216 F.3d 41, 43 (D.C. Cir. 2000).
29. *See id.* at 45 (describing Federal Power Act's requirements).
30. *See id.* at 46.
31. *Id.* at 46–47 (quoting the FERC's order).
32. *Id.* at 47.
33. *See id.*
34. *Id.*

In *Seattle Audubon Society v. Lyons*, the U.S. District Court for the Western District of Washington expressed a similarly deferential attitude toward the U.S. Forest Service's management plan for twenty-four million acres of Pacific Northwest forests.[35] In its cost-benefit analysis, the Forest Service calculated the number of jobs affected at different levels of timber harvest, but did not quantify the environmental and recreational benefits of preserving old-growth forests.[36] Several environmental groups challenged the plan on the basis of the Forest Service's failure to quantify the positive effects of preservation, arguing that its decision was therefore biased in favor of logging.[37] The Forest Service had rejected the quantification method proffered by the environmental groups' economists, maintaining that it found environmental values difficult to quantify and that attaching greater monetary significance to the benefits at issue would not have affected the plan.[38] The court upheld the Forest Service's decision not to quantify the benefits of preservation despite its quantification of the economic effects of job loss: "The views of plaintiffs' economists that the region would be better off economically by foregoing any more old-growth cut are persuasive but subject to debate; the Secretaries did not act unlawfully in declining to adopt them."[39] As in *Conservation Law Foundation,* the court's deference toward nonquantification allowed the agency to avoid conducting a fully quantified cost-benefit analysis, which might have yielded greater protection and a resulting increase in social welfare.

B. Role of the Courts in Encouraging Quantification

In some cases, courts have overturned regulations in which agencies disregarded the benefits that they had not quantified. On remand, the agencies quantified the benefits and proposed more protective rules. This Section analyzes two important cases from the past decade to illustrate both the valuable role that courts can play in encouraging quantification, and the social welfare loss associated with the failure of agencies to quantify benefits at the outset.

In *Public Citizen v. Federal Motor Carrier Safety Administration*, the D.C. Circuit struck down the Federal Motor Carrier Safety Administration's (FMCSA) regulation of hours of service for commercial motor vehicle operators.[40] It based its decision on the agency's failure to consider the statutorily mandated factor of driver health.[41] The court also indicated that the

35. 871 F. Supp. 1291, 1324–25 (W.D. Wash. 1994), *aff'd sub nom.* Seattle Audubon Soc'y v. Moseley, 80 F.3d 1401 (9th Cir. 1996).

36. *See id.* at 1324–25.

37. *See id.*

38. *See id.*

39. *Id.* at 1325.

40. 374 F.3d 1209 (D.C. Cir. 2004).

41. *See id.* at 1216–17.

agency's failure to evaluate the costs and benefits of electronic onboard recorders (EOBRs)—devices that automatically monitor time spent driving—also called into question the rule's validity.[42]

The FMCSA had considered requiring EOBRs in its proposed rule, but ultimately did not do so even though it had not attempted to quantify the costs and benefits of the devices.[43] The D.C. Circuit held that the Interstate Commerce Communication Act of 1995 required the agency to "collect and analyze data on the costs and benefits of requiring EOBRs,"[44] rejecting the agency's argument that it could not do so because costs varied considerably and because it had not tested the devices that were available at the time.[45] The D.C. Circuit indicated that, given the powerful incentives drivers have to falsify their logbooks, requiring the use of EOBRs would likely produce substantial safety benefits.[46] It emphasized that even though cost and benefit figures may not be readily available, "[t]he agency's job is to exercise its expertise to make tough choices about which of the competing estimates is most plausible, and to hazard a guess as to which is correct."[47]

In response to the court's decision, the FMCSA proposed a new rule that required the use of EOBRs in certain types of commercial motor vehicles.[48] The agency found that EOBRs would both reduce vehicle operators' paperwork burden and enhance compliance with its hours of service regulations.[49] Although the FMCSA had initially argued that it could not discern the costs and benefits of EOBRs, its regulatory impact analysis demonstrates that quantification was in fact possible.[50]

On remand, the FMCSA relied on information from inspections, compliance reviews, and safety audits, along with data collected from operators who had already begun using EOBRs. It concluded that mandatory installation of the devices would bring about a 40 percent reduction in hours of service violations.[51] While the FMCSA was able to consider only fatigue-related crashes due to data constraints, its analysis showed that significant safety benefits would flow from reductions in just this subset of all crashes.[52]

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42. *See id.* at 1220.
43. *See id.*
44. *Id.* at 1221.
45. *See id.*
46. *See id.* at 1221–22.
47. *Id.* at 1221.
48. *See* Electronic On-Board Recorders and Hours of Service Supporting Documents, 76 Fed. Reg. 5537 (Feb. 1, 2011).
49. *See id.* at 5543.
50. *See* FED. MOTOR CARRIER SAFETY ADMIN., ELECTRONIC ON-BOARD RECORDERS AND HOURS-OF-SERVICE SUPPORTING DOCUMENTS: PRELIMINARY REGULATORY EVALUATION 15 (2011).
51. *See id.* at 20, 58–59.
52. *See id.* at 53; Electronic On-Board Recorders and Hours of Service Supporting Documents, 76 Fed. Reg. at 5548.

Confirming the D.C. Circuit's intuition, the agency's cost-benefit analysis showed that the rule would generate between $334 and $891 million in yearly net benefits.[53] Had the D.C. Circuit simply deferred to the FMCSA's assertion that it could not conduct a cost-benefit analysis, the social welfare loss would thus have been significant.[54]

The National Highway Transportation Safety Administration (NHTSA) also pursued more stringent regulation as a result of a judicial order to quantify the benefits of one of its rules. In *Center for Biological Diversity v. NHTSA*,[55] the Ninth Circuit struck down the NHTSA's corporate average fuel economy (CAFE) standards for light trucks covering model years 2008–2011. The court determined that the rule was arbitrary and capricious because the agency failed to quantify the benefits of reducing greenhouse gas emissions.[56] The NHTSA had quantified the benefits associated with decreases in other air pollutants, but had declined to value reductions in greenhouse gas emissions due to the uncertainty surrounding their harmful effects.[57] The court reasoned that while there may be a range of possible benefits resulting from greenhouse gas reductions, the NHTSA could not rely on uncertainty as a reason to assign a zero value to such reductions.[58]

In its revised rulemaking for model year 2011,[59] the NHTSA increased the stringency of the CAFE standard for light trucks from twenty-four to twenty-five miles per gallon.[60] This time, the NHTSA quantified the value of

53. *See* Electronic On-Board Recorders and Hours of Service Supporting Documents, 76 Fed. Reg. at 5547–48.

54. The FMCSA is still in the process of finalizing the rule. In 2011, the Seventh Circuit vacated a similar EOBR rule that the FMCSA had promulgated for a different subset of commercial motor vehicle operators, holding that the FMCSA had failed to consider the devices' potential to facilitate harassment of drivers. *See* Owner-Operator Indep. Drivers Ass'n, Inc. v. Fed. Motor Carrier Safety Admin., 656 F.3d 580, 582 (7th Cir. 2011). Because the second EOBR rule relied on the same technical specifications that the FMCSA utilized for the vacated rule, the agency was required to propose and seek comment on new standards. *See* Electronic On-Board Recorders and Hours of Service Supporting Documents, 77 Fed. Reg. 7562, 7563 (Feb. 13, 2012). The FMCSA has issued a notice of intent announcing its plan to proceed with both EOBR rules. *See id.* at 7562.

55. 538 F.3d 1172 (9th Cir. 2008).

56. *See id.* at 1200.

57. *See id.* at 1192.

58. *See id.* at 1200–01 ("By presenting a scientifically-supported range of values that does not begin at zero, Petitioners have shown that it is possible to monetize the benefit of carbon emissions reduction. . . . [T]here is no evidence to support NHTSA's conclusion that the appropriate course was not to monetize or quantify the value of carbon emissions reduction at all.").

59. The Ninth Circuit did not vacate the NHTSA's CAFE standards, but remanded them to the agency with directions to "promulgate new standards consistent with this opinion as expeditiously as possible and for the earliest model year practicable." *Id.* at 1227. The NHTSA did not revise the CAFE standards for model years 2008–2010 as a result of the deadlines imposed by the Energy Policy and Conservation Act. *See* Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011, 74 Fed. Reg. 14,196, 14,214 n.60 (Mar. 30, 2009). Its 2011 rulemaking included standards for both passenger cars and light trucks. *See id.* at 14,196.

60. *See* Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011, 74 Fed. Reg. at 14,201.

greenhouse gas emissions reductions, identifying three different amounts: $2, $33, and $80 per ton of carbon dioxide.[61] Because the NHTSA expected that soon thereafter a coordinated interagency effort would determine the "social cost of carbon," it chose not to identify a single value.[62] It is difficult to determine the precise role that the quantification of the benefits of greenhouse gas reductions played in the NHTSA's decision to promulgate a more stringent standard, as the Energy Independence and Security Act of 2007 imposed several changes to the CAFE process that were reflected in the revised rulemaking.[63] But the Ninth Circuit's decision, which caused the agency to assign a positive amount to a benefit that it had formerly valued at zero, is likely to have been at least partially responsible for the strengthening of the standard. The decision is also likely to have helped set in motion the process of interagency collaboration to establish the social cost of carbon (SCC),[64] which is discussed below in Part III.B of the next Section.

Center for Biological Diversity and *Public Citizen* are rare examples of cases in which the courts prodded agencies to quantify benefits that had previously been assigned no value. As a result, these agencies then promulgated more stringent regulations that increased social welfare. But this type of judicial intervention, though salutary, cannot fully correct the welfare loss that results when agencies do not initially quantify the benefits in question. Promulgating revised regulations takes a significant amount of time. Generally, many years pass before agencies can correct the problem.

For example, ten years after *Public Citizen*, the FMCSA still has not finalized its EOBR rule,[65] and the public is still waiting to receive the hundreds of millions of dollars in yearly benefits anticipated from the regulation. And because the NHTSA could not revise its CAFE standards for model years 2008–2010 in time to meet statutory deadlines,[66] the public lost out on three years' worth of reduced carbon dioxide emissions. Had the agencies quantified the benefits of their regulations at the outset, instead of waiting for a court order, their rules would have prevented more environmental damage and saved many additional lives.

Cases such as *Center for Biological Diversity* and *Public Citizen* could well be the tip of the iceberg. The vast majority of agency decisions not to

61. *See id.* at 14,346.

62. *See id.* at 14,351.

63. *See id.* at 14,200 (describing Act's changes).

64. *See* 2010 INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, U.S. GOV'T, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866, at 3–4 (2010) [hereinafter 2010 INTERAGENCY WORKING GRP.], *available at* http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf (describing how the inconsistent carbon dioxide values utilized in different agency regulations, including the Department of Transportation's (DOT) CAFE standards, led to the interagency working group's effort to identify a single value for all agencies).

65. *See supra* text accompanying notes 40–54.

66. *See supra* text accompanying notes 55–64.

quantify benefits probably escape judicial scrutiny. And even in cases in which a remand leads to the quantification of the benefits, more stringent standards, and a higher level of social welfare, the ensuing delay can have a significant negative impact on social welfare. As a result, judicial intervention is no substitute for having agencies take the lead.

III.
EFFORTS TO QUANTIFY REGULATORY BENEFITS

The evolution of regulatory cost-benefit analysis over the past several decades shows that agencies have eventually come to quantify important categories of benefits that they once considered nonquantifiable. This Section analyzes five categories of benefits that have reached different stages of methodological development. This list is not exhaustive. The discussion illustrates how economists have developed (and are developing) techniques to place monetary values on benefits that initially evaded quantification: the value of a statistical life; the social cost of carbon; ecosystem services; fear, anxiety, and stress; and option values.

Quantification of some of these benefits is now well established in agency practice; for others, accepted monetization methodologies exist, but agencies have not yet fully integrated them into their cost-benefit analyses. While there is undoubtedly room for improvement in the quantification techniques for each benefit category, quantification has nonetheless allowed these benefits to play a more influential role in agency rulemaking. Given these successes, it is reasonable to assume that more progress can be achieved. Consequently, while breakeven analysis serves as a useful tool for analyzing benefits that cannot currently be quantified, it is not a substitute for the development of methodologies to actually quantify a broader range of regulatory benefits.

A. Value of a Statistical Life

A key benefit of environmental, health, and safety regulations is the reduction in mortality risk.[67] Over the past five decades,[68] economists have developed a now widely accepted technique for monetizing this benefit, which involves determining the "value of a statistical life" (VSL). The OMB's Circular A-4, which provides guidance to agencies on conducting cost-benefit analysis, uses the following example to illustrate the concept of a "statistical life": if a regulation reduces mortality risk by one in one million for two million people, it will prevent two "statistical deaths" per year (multiplying two million

67. *See* CIRCULAR A-4, *supra* note 2, at 29 ("Since agencies often design health and safety regulation to reduce risks to life, evaluation of these benefits can be the key part of the analysis. A good analysis must present these benefits clearly and show their importance.").

68. *See* Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 COLUM. L. REV. 941, 955 & n.60 (1999) (stating that the willingness-to-pay approach to valuing mortality risks first appeared in two works published in 1968 and 1971).

by one over one million equals two).[69] Thus, the number of statistical lives saved by a regulation is the sum of mortality risk reductions anticipated throughout a population.[70]

Economists monetize the value of a statistical life through willingness-to-pay methodologies that measure "the additional cost that individuals would be willing to bear for improvements in safety (that is, reductions in risks) that, in the aggregate, reduce the expected number of fatalities by one."[71] For example, if people are willing to pay $10 per year to reduce their annual risk of death by one in one million, the value of a statistical life is $10 million.[72]

Economists use two primary methods for determining the willingness to pay for reductions in risk of death. Contingent valuation (or stated preference) studies survey participants directly, asking how much they would pay to reduce a risk.[73] Revealed preference studies infer the value people place on mortality risk reduction by measuring how they respond to risk in the marketplace (e.g., demanding greater compensation for riskier jobs ("wage-risk" studies) or paying higher prices for safety features in consumer products).[74]

Federal agencies have taken somewhat different approaches to calculating VSL for use in cost-benefit analysis. The EPA, for example, has chosen a figure of $7.4 million (in 2006 dollars) based on its analysis of twenty-one wage-risk studies and five contingent-valuation studies.[75] In contrast, the Department of Transportation (DOT), which updates its analysis every year, uses a value of $9.1 million (in 2013 dollars) based solely on wage-risk studies.[76]

The willingness-to-pay approach to calculating the value of reductions in mortality risk was not always common. Before President Ronald Reagan directed agencies to conduct cost-benefit analyses by issuing Executive Order 12,291 in 1981, many federal agencies did not value mortality risks at all.[77] Those that did tended to calculate the value of life-saving regulations through the "human capital" method, which measured the present value of lifetime

69. *See* CIRCULAR A-4, *supra* note 2, at 29.

70. *See id.*

71. *See* Memorandum from Polly Trottenberg & Robert S. Rivkin, U.S. Dep't of Transp., to Secretarial Officers and Modal Adm'rs, Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses 1 (2013), *available at* http://www.dot.gov/regulations/economic-values-used-in-analysis.

72. *See id.*

73. *See* U.S. ENVTL. PROTECTION AGENCY, BENEFITS AND COSTS OF THE CLEAN AIR ACT, 1970 TO 1990, at 44 (1997) [hereinafter EPA, BENEFITS AND COSTS]; W. Kip Viscusi, *Monetizing the Benefits of Risk and Environmental Regulation*, 33 FORDHAM URB. L.J. 1003, 1011 (2006).

74. *See* EPA, BENEFITS AND COSTS, *supra* note 73, at 44; Viscusi, *supra* note 73, at 1011; Memorandum from Polly Trottenberg & Robert S. Rivkin, *supra* note 71, at 2.

75. U.S. ENVTL. PROT. AGENCY, GUIDELINES FOR PREPARING ECONOMIC ANALYSES B-1–B-2 (2010) [hereinafter 2010 EPA GUIDELINES].

76. Memorandum from Polly Trottenberg & Robert S. Rivkin, *supra* note 71, at 4–6.

77. *See* Eric A. Posner & Cass R. Sunstein, *Dollars and Death*, 72 U. CHI. L. REV. 537, 549 (2005) (stating that agencies generally did not assign values to life until after 1981).

earnings of those expected to benefit from the regulation.[78] This approach did not fully capture the value of a life saved, however, because it ignored the value that people place on life independent of the ability to earn wages.[79] Thus, it reflected only part of the value of a reduction in mortality risk, leading to inappropriately low estimates.[80] It also produced problematic differentials in the value of life based on the age, sex, race, and educational level of regulatory beneficiaries.[81] As a result, the human capital approach left nonquantified important categories of benefits. It therefore likely led to suboptimally lax policies.[82]

Professor W. Kip Viscusi has chronicled the process by which federal agencies shifted from valuing life incompletely (or not at all) to using the more complete, willingness-to-pay method to calculate the benefit of reductions in mortality risk. Viscusi, an economist who had previously served as deputy director of President Ford's Council on Wage and Price Stability, was recruited to resolve a cost-benefit analysis conflict between the Occupational Safety and Health Administration (OSHA) and OIRA.[83] In 1982, OSHA proposed a regulation requiring the labeling of hazardous chemicals in the workplace.[84] When preparing the regulatory impact analysis required under the newly issued Executive Order 12,291, OSHA monetized the value of lives saved using the human capital method.[85] Its calculations yielded a relatively low value of life, and OIRA challenged the regulation on the basis that its costs exceeded its benefits.[86] When OSHA reassessed the value of life using Viscusi's

78. *See* Gary T. Schwartz, *The Myth of the Ford Pinto Case*, 43 RUTGERS L. REV. 1013, 1022–23 (1991) (stating that the NHTSA valued life by calculating lost earnings); Viscusi, *supra* note 73, at 1017–18 (discussing OSHA rulemaking that utilized the human capital method); Memorandum from Polly Trottenberg & Robert S. Rivkin, *supra* note 71, at 1.

79. *See* Lloyd R. Cohen, *Toward an Economic Theory of the Measurement of Damages in A Wrongful Death Action*, 34 EMORY L.J. 295, 296 (1985); Memorandum from Polly Trottenberg & Robert S. Rivkin, *supra* note 71, at 1.

80. *See* Viscusi, *supra* note 73, at 1017–18 (describing the difference in values provided by the human capital and willingness-to-pay methods).

81. A 1967 study by economists at the Department of Health, Education, and Welfare calculated the value of human life based on lifetime earnings data. The report was intended to help economists, government personnel, and program planners assess the benefits of different actions. Among twenty-five to twenty-nine-year-olds. The report valued life at $136,121 for white males, $73,767 for nonwhite males, $71,789 for white females, and $54,774 for nonwhite females. The value of life for seventy to seventy-four-year-olds ranged from $5,971 for nonwhite males to $20,801 for white females. *See* Dorothy P. Rice & Barbara S. Cooper, *The Economic Value of Human Life*, 57 AM. J. PUB. HEALTH & NATION'S HEALTH 1954, 1960 (1967).

82. *See* W. Kip Viscusi et al., *Deterring Inefficient Pharmaceutical Litigation: An Economic Rationale for the FDA Regulatory Compliance Defense*, 24 SETON HALL L. REV. 1437, 1452–53 (1994) (arguing that "none of the FAA regulations produced an efficient level of safety" because they "incorporate the present value of lost earnings as the basis for measuring benefit").

83. *See* Viscusi, *supra* note 73, at 1018, 1035–36.

84. *See id.* at 1017.

85. *See id.*

86. *See id.*; W. Kip Viscusi, *Corporate Risk Analysis: A Reckless Act?*, 52 STAN. L. REV. 547, 576 (2000).

willingness-to-pay approach, its value of life increased by an order of magnitude, causing the regulation's benefits to surpass its costs.[87] Since then, the use of VSL calculated by willingness-to-pay methods has become standard federal agency practice.[88]

B. Social Cost of Carbon

In contrast to their decades-long consideration of the value of a statistical life, agencies have only recently begun to include the SCC in their cost-benefit analyses. SCC is an estimate of the benefit from the reduction of a ton of carbon dioxide emissions.[89] Before 2008, agencies did not monetize this benefit,[90] considering it too difficult given the uncertainty surrounding climate change effects and the complexity of translating climate damages into dollars.[91] In 2008, the EPA, the Department of Energy (DOE), and the DOT all proposed rules that included monetized values of carbon dioxide ranging from $0 to $68.[92]

In the aftermath of the remand in *Center for Biological Diversity v. NHTSA*,[93] discussed in Part II.B, the Obama Administration convened the Interagency Working Group on the Social Cost of Carbon in 2009[94] to study how to monetize the benefits of reducing carbon dioxide and to achieve greater consistency among agencies. As discussed in more detail below,[95] representatives from the EPA and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury, along with several offices within the Executive Office of the President, met regularly to develop SCC values.[96]

The working group set out to attach a range of monetary values that agencies across the federal government could use to assess the damage caused by carbon dioxide emissions.[97] To carry out this task, the working group relied on three "integrated assessment models," which "combine climate processes,

87. *See* Viscusi, *supra* note 73, at 1018.

88. *See id.*; Revesz, *supra* note 68, at 955.

89. *See* Michael Greenstone, Elizabeth Kopits & Ann Wolverton, *Developing a Social Cost of Carbon for U.S. Regulatory Analysis: A Methodology and Interpretation*, 7 REV. ENVTL. ECON. & POL'Y 23, 23 (2013) (defining the social cost of carbon as a measure of "monetized damages associated with an incremental increase in carbon emissions").

90. *See* Charles Griffiths et al., *Estimating the "Social Cost of Carbon" for Regulatory Impact Analysis*, RESOURCES FOR THE FUTURE (Nov. 8, 2010), http://www.rff.org/Publications/WPC/Pages/Estimating-the-Social-Cost-of-Carbon-for-Regulatory-Impact-Analysis.aspx.

91. *See supra* text accompanying notes 55–58.

92. *See* 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 3 (describing the values agencies attributed to carbon dioxide reductions in three different rules).

93. 538 F.3d 1172 (9th Cir. 2008).

94. *See* 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 4.

95. *See infra* text accompanying notes 207–08.

96. *See* 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 3–4.

97. *See id.* at 2.

economic growth, and feedbacks between the climate and the global economy into a single modeling framework."[98]

The SCC reflects the value of global changes in agricultural productivity, ecosystem services, human health, and flood-induced property damages.[99] It does not account for damages due to noncarbon dioxide greenhouse gas emissions, such as methane.[100] Moreover, it does not sufficiently capture the risk of catastrophic impacts and important but difficult-to-quantify effects such as ocean acidification.[101] As a result, the current SCC estimates are likely too low,[102] but these shortcomings should diminish as modeling technologies improve.[103]

For carbon dioxide emissions expected to occur in 2020, the working group chose four SCC values for use in cost-benefit analyses: $7, $26, $42, and $81 (in 2007 dollars).[104] The first three values reflect the average SCC at discount rates (to translate future value into present values) of 5, 3, and 2.5 percent, respectively; the fourth figure represents the SCC value at the 95th percentile and a 3 percent discount rate, and is designed to reflect worse-than-

98. *See id.* at 5.

99. *See id.* at 1.

100. *See* Greenstone, Kopits & Wolverton, *supra* note 89, at 23.

101. *See* Greenstone, Kopits & Wolverton, *supra* note 89, at 40–44 (discussing several areas for improvement); Michael A. Livermore & Richard L. Revesz, Retaking Rationality *Two Years Later*, 48 HOUS. L. REV. 1, 24 (2011).

102. *See* Richard L. Revesz et al., *Global Warming: Improve Economic Models of Climate Change*, NATURE (Apr. 4, 2014), http://www.nature.com/news/global-warming-improve-economic-models-of-climate-change-1.14991. *See also* PETER HOWARD, OMITTED DAMAGES: WHAT'S MISSING FROM THE SOCIAL COST OF CARBON (2014), *available at* http://costofcarbon.org/files/Omitted_Damages_Whats_Missing_From_the_Social_Cost_of_Carbon.pdf (detailing the elements that have not yet been quantified by the SCC); Livermore & Revesz, *supra* note 101, at 24 (discussing shortcomings in integrated assessment models and in the interagency working group's approach).

103. The SCC has sparked significant controversy, in large part because of this tendency to underestimate the actual cost of carbon emissions due to uncertainty regarding the potential environmental effects of climate change. *See* Frank Ackerman & Elizabeth A. Stanton, *Climate Risks and Carbon Prices: Revising the Social Cost of Carbon*, ECON., no. 2012-10, Apr. 2012, at 1, *available at* http://dx.doi.org/10.5018/economics-ejournal.ja.2012-10 (arguing that the interagency working group omitted a number of potential risks of climate change and underestimated the negative effects on future generations); Jonathan S. Masur & Eric A. Posner, *Climate Regulation and the Limits of Cost-Benefit Analysis*, 99 CALIF. L. REV. 1557, 1580–83, 1596–99 (complaining that the interagency working group significantly undervalued the SCC by—among other things—excluding some secondary effects of climate change, making faulty assumptions, and using crude models, and that agency implementation has erroneously used the technical SCC value to substitute for normative, political decisions); Susan Rose-Ackerman, *Putting Cost-Benefit Analysis in Its Place: Rethinking Regulatory Review*, 65 U. MIAMI L. REV. 335, 335 (2011) (warning that cost-benefit analysis is not well-suited to the problem of climate change); Robert S. Pindyck, *Climate Change Policy: What Do the Models Tell Us?* (Nat'l Bureau of Econ. Research, Working Paper No. 19244, 2013) (complaining that government SCC estimates are nearly useless because their models lack theoretical foundations, are highly sensitive to key assumptions like discount rate, and fail to account for potential catastrophic events).

104. 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 28 (values are rounded to the nearest dollar).

expected climate impacts.[105] The working group advised agencies to consider all four values when assessing the costs and benefits of regulations.[106]

The SCC is expected to increase over time, because future emissions are anticipated to cause greater damage as physical and economic systems become increasingly climate-stressed.[107] In May 2013, the same working group issued a revised guidance[108] to account for updates to the three integrated assessment models.[109] For emissions in 2020, the SCC increased to $12, $43, $65, and $129 (in 2007 dollars and at the same discount rates).[110] The 2013 update thus significantly raised the central value (average value at a 3 percent discount rate) of the SCC, from $24 to $38 for 2015 and from $26 to $43 for 2020.[111] The increased value reflects the enhanced ability of the models to account for sea level rise and agricultural damages, climate adaptation, changes in the climate carbon cycle, and other effects.[112] Agencies have already begun using this updated value.[113]

Since the interagency working group released its 2010 guidance, agencies have used the SCC values to monetize carbon dioxide reduction benefits for at least sixteen major rules.[114] Professor Michael Greenstone and his colleagues illustrate the dramatic way in which monetizing carbon dioxide reduction benefits can change the outcome of a rule: without accounting for the SCC, the joint EPA-NHTSA fuel efficiency and greenhouse gas standards for light-duty vehicles in model years 2012–2016 would have had a net cost of $70 billion.[115] When the central value for the SCC is included, however, the corresponding benefits outweigh the costs by nearly $30 billion.[116] The interagency effort to

105. *See id.* at 28, 33.

106. *See id.* at 25.

107. *See id.* at 28.

108. ENVTL. PROT. AGENCY, FACT SHEET: SOCIAL COST OF CARBON (2013), *available at* http://www.epa.gov/climatechange/Downloads/EPAactivities/scc-fact-sheet.pdf.

109. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, U.S. GOV'T, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866, at 3–4 (2013) [hereinafter 2013 INTERAGENCY WORKING GRP.], *available at* http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf.

110. *See id.* at 2.

111. *See id.* at 12–13; 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 28.

112. *See* 2013 INTERAGENCY WORKING GRP., *supra* note 109, at 2 (describing changes made to the assumptions and capabilities of the three integrated assessment models).

113. In June 2013, the Department of Energy finalized a rule establishing new energy efficiency standards for residential microwave ovens operating in standby mode. Using the revised SCC values, the DOE predicted carbon dioxide reduction benefits between $255 million and $3.6 billion. *See* Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens, 78 Fed. Reg. 36,316, 36,318 (June 17, 2013) (to be codified at 10 C.F.R. pts. 429–30).

114. *See* Greenstone, Kopits & Wolverton, *supra* note 89, at 43.

115. *See id.*

116. *See id.*

quantify the SCC has therefore had a vitally important impact on cost-benefit analysis.[117]

C. Ecosystem Services

While monetizing the social cost of carbon has swiftly become standard agency practice, consideration of the closely related benefits provided by "ecosystem services" in cost-benefit analysis remains in the early stages of development. These services, which are defined as the benefits that people receive from ecosystems,[118] can be divided into four general categories: "provisioning services," such as water, food, and natural resources; "regulating services," such as flood control; "supporting services," such as soil formation; and "cultural services," such as recreational and religious benefits.[119] Valuing ecosystem services has long been considered difficult, as it requires both an understanding of the complex functions that ecosystems serve and monetization of benefits that are often hard to quantify.[120] Despite these difficulties, economists have made progress toward monetizing ecosystem services, using a variety of revealed preference, stated preference, and cost-based approaches to valuation.[121]

To date, agencies have not monetized the value of ecosystem services in their cost-benefit analyses, causing them to assign zero value to important ecological functions.[122] But over the past fifteen years, economists, environmental organizations, and agencies alike have expressed interest in this endeavor,[123] and there is now a significant body of academic literature on the topic.[124]

Significantly, the National Research Council has produced several reports on improving valuation and incorporating ecosystem services into decision

117. *Cf.* Jody Freeman & Jim Rossi, *Agency Coordination in Shared Regulatory Space*, 125 HARV. L. REV. 1131, 1198–99 (2012) (lauding the interagency working group process as "effective and exemplary").

118. *See* Shuang Liu et al., *Valuing Ecosystem Services: Theory, Practice, and the Need for a Transdisciplinary Synthesis*, ANN. N.Y. ACAD. SCI., Feb. 2010, at 54, 54.

119. *See id.*

120. *See* NAT'L RESEARCH COUNCIL, VALUING ECOSYSTEM SERVICES 2–3 (2004) [hereinafter NRC, VALUING ECOSYSTEM SERVICES] (discussing challenges in ecosystem services valuation).

121. *See* Liu et al., *supra* note 118, at 56–57 (describing valuation methods).

122. *See* LYNN SCARLETT & JAMES BOYD, ECOSYSTEM SERVICES: QUANTIFICATION, POLICY APPLICATIONS, AND CURRENT FEDERAL CAPABILITIES 1 (2011); U.S. ENVTL. PROT. AGENCY, SCI. ADVISORY BD., VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES 2 (2009); Liu et al., *supra* note 118, at 63.

123. *See* J.B. Ruhl & James Salzman, *The Law and Policy Beginnings of Ecosystem Services*, 22 J. LAND USE & ENVTL. L. 157, 158–61 (2007).

124. *See* Liu et al., *supra* note 118, at 72 (describing the content of 675 peer-reviewed studies on ecosystem services valuation in the past thirty years). The authors note, however, that most of these studies neglected supporting and regulating ecosystem services. *See id.*

making.[125] The EPA has also devoted considerable attention to the topic. In 2003, the EPA's Science Advisory Board formed a Committee on Valuing the Protection of Ecological Systems and Services, which has issued a report on the matter.[126] In 2006, the agency itself also issued a strategic plan for ecological benefits assessment.[127] And in 2009, the EPA's Office of Research and Development issued a report on evaluating ecosystem services in the context of implementing total maximum daily loads under the Clean Water Act.[128] While the report does not provide a comprehensive valuation,[129] it monetizes many ecosystem services, including air quality benefits, recreational opportunities, and carbon sequestration.[130] While further improvements to the EPA's model are necessary to fully capture the value of ecosystem services associated with different policies,[131] the report nonetheless serves as an important first step in incorporating ecosystem services into cost-benefit analysis.

Although significant challenges to valuation remain,[132] new methodological developments may soon make it possible for agencies to monetize a more complete slate of ecosystem services. Ecologists have developed models that can predict the impact of policies on certain ecosystem services such as pollination and carbon dioxide sequestration.[133] And while the National Research Council has noted that "the greatest challenge for successful valuation of ecosystem services is to integrate studies of the ecological production function with studies of the economic valuation function,"[134] some new projects seek to overcome this challenge.[135] For example, the Natural Capital Project (a collaboration among Stanford University, the University of Minnesota, the Nature Conservancy and the World Wildlife Fund) has

125. *See* NAT'L RESEARCH COUNCIL, APPROACHES FOR ECOSYSTEM SERVICES VALUATION FOR THE GULF OF MEXICO AFTER THE DEEPWATER HORIZON OIL SPILL: INTERIM REPORT (2012); NRC, VALUING ECOSYSTEM SERVICES, *supra* note 120.

126. *See* U.S. ENVTL. PROT. AGENCY, SCI. ADVISORY BD., *supra* note 122, at 9.

127. U.S. ENVTL. PROT. AGENCY, ECOLOGICAL BENEFITS ASSESSMENT STRATEGIC PLAN (2006).

128. U.S. ENVTL. PROT. AGENCY, OFFICE OF RESEARCH & DEV., AN OPTIMIZATION APPROACH TO EVALUATE THE ROLE OF ECOSYSTEM SERVICES IN CHESAPEAKE BAY RESTORATION STRATEGIES 1-1 (2001).

129. *See id.* at ES-9, ES-20–21.

130. *See id.* at ES-9, 1-1–2.

131. *See id.* at ES-1–1 (stating that the report should not be utilized for policy recommendations because the analytical framework does "not yet include all of the information needed for a complete assessment of the socially optimal mix of pollution controls"); *id.* at 1-7–10 (discussing limitations).

132. *See* Gretchen C. Daily et al., *Ecosystem Services in Decision Making: Time to Deliver*, 7 FRONTIERS IN ECOLOGY & ENVT. 21, 25–26 (2009) (identifying areas where additional valuation research is needed). For a summary of valuation techniques applied to ecosystem services, see Liu et al., *supra* note 118, at 56–57.

133. *See* Barton H. Thompson, Jr., *Ecosystem Services & Natural Capital: Reconceiving Environmental Management*, 17 N.Y.U. ENVTL. L.J. 460, 473 (2008).

134. NRC, VALUING ECOSYSTEM SERVICES, *supra* note 120, at 24.

135. *See* Liu et al., *supra* note 118, at 72; Thompson, Jr., *supra* note 133, at 473.

developed inVEST, a tool that models how actions will affect the location, amount, delivery, and monetary value of a host of ecosystem services.[136] InVEST is already being used to assess ecosystem services under alternative zoning scenarios in China.[137] Additional research is likely to yield further improvements in ecosystem services valuation. Just as in the case of the value of a statistical life and the social cost of carbon, the monetization of ecosystem services could enable agencies, in the relatively near future, to conduct more complete cost-benefit analyses that account for the full range of health and environmental benefits.[138]

D. Fear, Anxiety, and Stress

Like the value of ecosystem services, most agency cost-benefit analyses exclude the benefits associated with reductions in fear, anxiety, and stress.[139] Because fear, anxiety, and stress are emotional states, economists and agencies have found them difficult to monetize.[140] But these benefits can be

136. *InVEST: Integrated Valuation of Environmental Services and Tradeoffs*, THE NATURAL CAPITAL PROJECT, http://www.naturalcapitalproject.org/InVEST.html (last visited Aug. 25, 2014).

137. *See* THE NATURAL CAPITAL PROJECT, INVEST: INTEGRATED VALUATION OF ENVIRONMENTAL SERVICES AND TRADEOFFS 4, *available at* http://www.naturalcapitalproject.org/pubs/NatCap_InVEST_Brochure.pdf (last visited Aug. 25, 2014); Kerry A. Dolan, *Names You Need to Know in 2011: Natural Capital Project*, FORBES, Oct. 29, 2010, http://www.forbes.com/sites/kerryadolan/2010/10/29/name-you-need-to-know-natural-capital-project/.

138. *See* Liu et al., *supra* note 118, at 66.

139. *See* Matthew D. Adler, *Fear Assessment: Cost-Benefit Analysis and the Pricing of Fear and Anxiety*, 79 CHI.-KENT L. REV. 977, 977 (2004) (asserting that agencies "almost never enumerate and price the distressing mental states, such as fear, anxiety, worry, panic, or dread, that are causally connected to environmental, occupational, and consumer hazards and would (or at least might) be reduced by more stringent regulation").

140. *See id.* at 989 (noting the objection that "the fear states resulting from governmental choices cannot be characterized in numerical terms, and thus cannot be valued monetarily"); Cass R. Sunstein, *Probability Neglect: Emotions, Worst Cases, and Law*, 112 YALE L.J. 61, 105 (2002) ("A special difficulty here consists in the problem of quantifying and monetizing fear and its consequences, a problem that has yet to be seriously engaged in the relevant literature.").

substantial,[141] and several legal scholars have argued that agencies must measure them when conducting cost-benefit analyses.[142]

A regulation by the Food and Drug Administration (FDA), analyzed in detail in an article by Professor Matthew Adler,[143] provides insights into how agencies could approach valuing the benefits of fear reduction. In 2003, the FDA proposed a rule strengthening quality requirements for medical gloves.[144] The rule was designed to reduce the risk of HIV, hepatitis, and other diseases transmitted by blood.[145] The FDA also expected that the rule would reduce the anxiety that medical professionals experience when they await the results of blood screenings following tears in their gloves.[146]

To monetize the value of this benefit, the FDA examined the psychological and medical literature to determine the effects of anxiety.[147] It concluded that the stress caused by the uncertainty of exposure to disease could reduce one's overall sense of well-being, resulting in a health loss of 1.3 percent on the FDA's well-being measurement scale.[148] To monetize this

141. Sunstein, *supra* note 140, at 104 ("[F]ear is a real social cost, and it is likely to lead to other social costs"). Chronic stress and anxiety can have a number of very serious physical and emotional consequences. *See, e.g.*, Bruce S. McEwen, *Central Effects of Stress Hormones in Health and Disease: Understanding the Protective and Damaging Effects of Stress and Stress Mediators*, 583 EUR. J. PHARMACOLOGY 174, 174 (2008) (indicating that chronic stress is accompanied by negative changes in lifestyle behaviors, such as smoking, overeating, etc., and leads to changes in brain chemistry); Anja C. Huiznik et al., *Stress During Pregnancy is Associated with Developmental Outcome in Infancy*, 44 J. CHILD PSYCHOLOGY & PSYCHIATRY 810 (2003) (concluding that stress during pregnancy was correlated with lower cognitive function in infants at eight months); A.D.A.M., *Anxiety In-Depth Report*, N.Y. TIMES, http://health.nytimes.com/health/guides/symptoms/stress-and-anxiety/print.html (last visited Aug. 26, 2014) (indicating that prolonged stress has been linked to negative health effects like depression, heart disease, gastrointestinal problems, weakened immune system, insomnia, weight gain, and cognitive impairment).

142. *See* Robert W. Hahn, *The Economics of Airline Safety and Security: An Analysis of the White House Commission's Recommendations*, 20 HARV. J.L. & PUB. POL'Y 791, 800 (1997) (arguing that the government should analyze the cost of anxiety that people experience as a result of flight-related delays); Albert C. Lin, *The Unifying Role of Harm in Environmental Law*, 2006 WIS. L. REV. 897, 953–54 (2006) ("The EPA's failure to treat these impacts as harms has led to the undervaluing of the benefits of environmental regulation, as well as the undervaluing of research efforts that reduce uncertainties associated with toxic exposure."); Jonathan S. Masur & Eric A. Posner, *Regulation, Unemployment, and Cost-Benefit Analysis*, 98 VA. L. REV. 579, 584, 613, 616 (2012) (arguing that cost-benefit analysis should include reductions in happiness caused by unemployment, which have been estimated as high as $60,000); Sunstein, *supra* note 140, at 103–05 (stating that although it is difficult to monetize fear, regulatory interventions to alleviate it are often justified).

143. *See* Adler, *supra* note 139, at 979–81.

144. *See* Medical Devices; Patient Examination and Surgeons' Gloves; Test Procedures and Acceptance Criteria, 68 Fed. Reg. 15,404, 15,404 (Mar. 31, 2003).

145. *See id.* at 15,408.

146. *See id.* at 15,412–13.

147. *See id.* at 15,413.

148. The FDA arrived at the estimate of a 1.3 percent reduction in well-being by relying on research on a number of related topics: the degree to which stress has been shown to reduce overall well-being; the relative stress level associated with personal illness as compared to other life events; and the amount of anxiety that surrounds public health screenings and waiting for health test results. *See id.*

effect, the FDA utilized the "quality-adjusted life span" method,[149] which assigns values to different levels of health. Using a $5 million VSL, it determined that society was willing to pay $373,000 for the statistical probability of one year of perfect health, which equates to $1,022 per day.[150] Because results of blood screenings are usually available within 24 hours of the test, the FDA multiplied $1,022 by 1.13 percent, which resulted in a value of $13 for avoided anxiety.[151] Based on the number of blood screenings it expected the rule to prevent, the FDA predicted approximately $1.4 million per year in anxiety-reduction benefits.[152]

The FDA had adopted a similar approach in its 1998 rule on mammography standards, which would reduce the prevalence of false-positive tests.[153] In that rule, the FDA valued the reduction in anxiety at $12.7 million.[154] The quality-adjusted life year method has come under strong criticism for being untethered from economic theory by not relying on willingness-to-pay measures.[155] The FDA's medical gloves and mammography rules nonetheless show a way in which improvements in emotional well-being might be quantified.

For regulations that reduce the risk of exposure to carcinogens with long latency periods, the value of reductions in fear could be much higher, as exposed persons may experience anxiety for decades before learning whether their exposure has resulted in cancer. In 2000, the EPA issued a white paper on the value of avoiding fatal cancer risks.[156] Among other things, the report reviewed the costs of morbidity, fear, and dread.[157] It indicated that fear was a significant source of value for avoiding exposure to carcinogens, independent of the pain and suffering associated with cancer morbidity.[158] Although the EPA did not quantify the value of fear reduction alone, the agency estimated that fear and morbidity together doubled the value of cancer risk avoidance.[159] Because agencies have generally not analyzed these long-term fears in their

149. *See id.* at 15,411.

150. *See id.*

151. *See id.* at 15,413.

152. *See id.*

153. *See* Quality Mammography Standards, 62 Fed. Reg. 55,852, 55,963–64 (Oct. 28, 1997).

154. *Id.* at 55,967.

155. *See* RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY: HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH 80–82 (2008); Adler, *supra* note 139, at 1044 & n.180.

156. ENVTL. PROT. AGENCY, VALUING FATAL CANCER RISK REDUCTIONS (2000).

157. *See id.* at 5–6.

158. *Id.* at 5 ("[F]ear and dread of cancer risks may also affect WTP values separate from values attributed to avoiding the risk of pain and suffering.").

159. Based on the review of three scientific studies, the EPA found fear, dread, and morbidity increased the value of reductions in fatal cancer risk by two times. *Id.* at 6, 17, 24.

cost-benefit analyses,[160] further research in this area could greatly improve the quality of regulatory decision making.

E. Option Values in the Exploitation of Natural Resources

Real options represent the value of delaying decisions in the hopes of acquiring better information over time.[161] This issue is particularly important in the context of government decisions on the use of nonrenewable resources.[162] For example, in making decisions about leasing offshore oil drilling rights, the government typically conducts a cost-benefit analysis in which it compares the social welfare consequences of drilling now with those of leaving the resource in the ground forever. If the net benefits of the former option are higher, the way is cleared for auctioning the leases. But, by failing to take options values into account, agencies do not consider the possibility that the net benefits of delaying a decision might be even higher.[163] Real options are thus not

160. For example, in its arsenic rulemaking, the EPA did not monetize anxiety reduction benefits, despite widespread public knowledge of arsenic's carcinogenic effects. *See* Adler, *supra* note 139, at 978. Cancers caused by arsenic are characterized by long latency periods. *See* Y. Yuan et al., *Kidney Cancer Mortality: Fifty-Year Latency Patterns Related to Arsenic Exposure*, 21 EPIDEMIOLOGY 103 (2010).

161. Professor Michael Livermore points out that it is important to distinguish real options from two terminologically similar, but conceptually different measures. First, a real option is distinct from a financial "option," which refers to a right to buy or sell a financial instrument at a set price in the future; in contrast, a real option is a right to engage in a business venture in the future, without preset terms. *See* Michael A. Livermore, *Patience Is an Economic Virtue: Real Options, Natural Resources, and Offshore Oil*, 84 U. COLO. L. REV. 581, 586 n.13 (2013). Second, a real option is distinguishable from an option-to-use. An option-to-use refers to the value that individuals place on a guarantee that an ecosystem remain available to them in the future, regardless of whether they will actually use it. *See id.* at 600 n.65. For example, a person might be willing to pay money now to preserve the Grand Canyon simply to ensure that a visit is possible in the future, without any guarantee it will happen. *See id.* at 598. In comparison, a real option means retaining the option to decide whether to preserve or exploit the Grand Canyon in the future and does not guarantee the ecosystem is preserved. Though related, real options should not be conflated with risk aversion, which will lead parties to avoid business initiatives with net-positive expected values but high potential costs. *See id.* at 601.

162. *See id.* at 595 ("The real option character of resource extraction has been recognized by economists for decades.") (citing Kenneth J. Arrow & Anthony C. Fisher, *Environmental Preservation, Uncertainty, and Irreversibility*, 88 Q.J. ECON. 312, 314 (1974)); James L. Paddock et al., *Option Valuation of Claims on Real Assets: The Case of Offshore Petroleum Leases*, 103 Q.J ECON. 479 (1988)).

163. The Department of the Interior (DOI) proceeds in two steps. First, it creates five-year plans for lease timing, with the goal of maximizing net benefits. *See* Livermore, *supra* note 161, at 630–31. Benefits include economic value and consumer surplus, while the costs are environmental harms. *See id.* at 631–32. Although the agency is instructed to maximize net benefits through timing choices, it does not include real option value in this evaluation. Instead, it uses a constant real price of oil, and although it acknowledges the possibility of future environmental technologies, it does not account for this in its quantification. *See id.* at 631. Without accounting for these uncertainties, the agency cannot estimate option values. Second, the DOI is required to ensure that it receives "fair market value" at each auction. This evaluation is made based on the estimated selling price *at the time of the transaction*, with no comparison to possible future values. *See id.* at 617–18.

quantified in agency cost-benefit analyses.[164] Given the robust economic literature on options, there is no defensible reason for this failure.

The value of a real option is derived from the generation of information over time, thereby allowing for better decision making.[165] Uncertainty is "at the heart" of real option value: the greater the uncertainty, the greater the potential for additional information to become available and the greater the value of waiting.[166]

Professor Michael Livermore evaluates offshore oil drilling as an example of the potential utility of considering real options in environmental decision making. In this context, the Department of the Interior (DOI) decides whether and when to lease the rights to drill on lands or waters controlled by the federal government. If it decides to proceed with the leasing, it determines the reservation price. Private companies then bid to acquire these leases.[167]

In a situation in which it considered the value of real options, the DOI could choose to delay the leases.[168] The agency could thereby gain additional information on the expected price of oil or the availability of alternative fuel sources, which could help to estimate the value of drilling to society. Delay can also reveal important new information on the effects of environmental degradation and the costs of extraction, which affect the net benefits of drilling. Natural resource prices and environmental science are both fast-moving fields, so the longer the agency waits, the more precisely it will be able to estimate cost and benefits, and the more likely it will be able to accurately determine whether drilling in a particular area is cost-benefit justified.

Over the past several decades, economists have developed models to capture real option value, including in the environmental field.[169] For example, an influential model by Aviniash Dixit and Robert Pindyck calculates real option value based on uncertainty in price, assuming price changes over time.[170] Livermore explains that these traditional models can easily be adapted to ascertain real option value in offshore drilling by accounting for other

164. *See id.* at 585–86 ("[I]n leasing decisions for the vast offshore oil reserves held by the United States (and in other natural resource contexts), government agencies do not appropriately value these 'real options.'").

165. *See id.* at 595.

166. *See id.* at 605.

167. *See id.* at 593–94.

168. While there are real options associated with the decisions made by both parties, the government's decision to lease is most relevant in the regulatory context because all choices after this point are entirely in the hands of private parties. *See id.*

169. Starting in the 1970s, mathematicians and economists developed a range of modeling techniques and even practitioners guides for evaluating real option values. *See id.* at 601–02 & n.71. These models have been applied to a wide range of topics, including alternative energy and petroleum reserves. *See id.* at 602.

170. *See* AVINIASH K. DIXIT & ROBERT S. PINDYCK, INVESTMENT UNDER UNCERTAINTY 396–408 (1994)).

uncertainties in addition to price uncertainty.[171] In fact, a detailed model for real option value for offshore drilling leases from the industry perspective was already developed twenty-five years ago.[172] This model was one of the earliest adaptations of financial options to the topic of real asset options, adjusting the traditional stochastic price model to account for market equilibrium in the underlying assets to quantify the value to a firm of waiting for additional price information before leasing oil rights.[173]

To illustrate the importance of taking account of real option values, consider a simplified example. Assume the government is evaluating the leasing of drilling rights to a well that will produce fifty barrels of oil over two years and then will run dry. Oil prices remain constant at a present value of $10 per barrel. The government has estimated that there is a 99 percent probability that the total costs of drilling, including the social costs, will be $450, and there is a 1 percent probability that an oil spill will occur, leading to total costs of $4,450. Based on these assumptions, the expected value of drilling immediately is $10. Therefore, if the decision is between drilling now and never drilling, the socially desirable choice is to drill now.

Assume now the agency is expecting a new study to be released in six months, which will reveal with 100 percent accuracy whether or not the oil spill will occur. The value of drilling when costs are $450 is $50, while the value of drilling when environmental costs are $4,450 is a loss of $3,950. Therefore, the agency would not lease the plot if it finds out in six months that there will be a spill. This means that expected value for a six-month delay is $49.50, based on a 99 percent probability of leasing, which yields $50 of net benefits and a 1 percent probability of not leasing. The option value of $39.50 over the $10 value of acting immediately would be lost if the agency did not contemplate the possibility of delaying its decision.[174]

The quantification of real options could meaningfully influence the outcomes of agency cost-benefit analyses, particularly in close cases. Nonetheless, this technique has not been embraced by agencies charged with administering natural resources. Although the DOI uses elaborate cost-benefit analyses throughout the lease planning and auction process,[175] it does not take option value into consideration at any point.[176] Real option quantification, however, would be consistent with executive standards and agency guidelines, which encourage the consideration of the costs and benefits of the optimal

171. *See* Livermore, *supra* note 161, at 604.

172. Paddock et al., *supra* note 162, at 486–93 (extrapolating from financial options models to develop a valuation for industry's real options in decisions regarding offshore leases).

173. *See id.* at 479–81, 486–88.

174. This numerical example ignores the time value of money. This simplification, however, does not detract from insights generated by the example. The option in this example would have significant positive value under any reasonable discount rate.

175. *See* Livermore, *supra* note 161, at 584–85, 630.

176. *See id.* at 630.

timing of decisions.[177] As a result, the federal government should move decisively to appropriately adapt the existing real option models and to begin using them to make decisions on the exploitation of natural resources.

IV.
GOVERNMENT'S ROLE IN THE QUANTIFICATION OF BENEFITS

The question of whether a particular type of benefit has been quantified is not exogenous to the actions of the federal government. In fact, the federal government can be, and has at times been, an important catalyst for the valuation of benefits. First, over the years, the federal government has funded significant private research on quantification techniques. Its efforts, however, have been haphazard. This situation is likely to worsen in the near future because of sustained efforts by members of Congress to severely reduce federal funding for the social sciences. Second, the federal government sometimes intervenes directly to determine the value of a benefit. But here, too, the government has not been consistent, dealing with some categories of benefits but largely ignoring others.

A. Government as Funder of Research

Government agencies have occasionally used federal funds to promote quantification research. In particular, the NSF and the EPA have generally provided more funding to research quantifying environmental harms than to any other environmental economic issue.[178] For example, the EPA and the DOT relied on peer-reviewed studies to develop their VSL values, which were discussed in Part III.A. Of the twenty-three studies relied on by the EPA,[179] at

177. Section 18(a)(3) of the Outer Continental Shelf Lands Act, 43 U.S.C. § 1331 (2012), directs the DOI to consider "economic, social, and environmental values" in leasing decisions and mandates that "timing" should be based on consideration of a "proper balance" between discovery of natural resources and prevention of environmental damages. *See* Livermore, *supra* note 161, at 30–31.

178. The EPA has funded over 600 environmental economic studies between 1971 and 2011. *See* Michael A. Livermore, *Cost-Benefit Analysis and Agency Independence* 16–18 (Univ. of Va. Sch. of Law, John M. Olin Law & Econ. Research Paper No. 2013-09), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2327554. The EPA's Office of Research and Development also partners with the NSF, through which the two agencies have sponsored another 150 environmental economics studies between 1991 and 2004. *See id.* at 16. Quantification efforts have generally received the greatest amount of funding. *See id.* at 18. These include, for example, studies on the economic effects of acidification on the fishing industry, the variability of willingness-to-pay relative to income, and the monetization of the damage to infants' health through exposure to nitrates in drinking water. *Id.* at 16–17. However, research funding represents just a small portion of the EPA's overall budget. *Id.* at 17.

179. For the full list of studies relied on by the EPA, see Appendix B of the EPA's Guidelines for Preparing Economic Analyses. NAT'L CTR. FOR ENVTL ECON., U.S. ENVTL. PROT. AGENCY, GUIDELINES FOR PREPARING ECONOMIC ANALYSES, at B-1 (2010), *available at* http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-50.pdf/$file/EE-0568-50.pdf.

least six benefited from federal funding: two from the NSF,[180] three from the EPA,[181] and one from the Department of Labor.[182] The DOT, in its most recent effort to determine VSL, relied on nine additional studies,[183] three of which had been funded by the EPA.[184] The majority of the VSL studies, however, did not benefit from government funding.

Since completing his term as OIRA Administrator, John Graham has called on the federal government to intervene in quantification efforts and to direct additional funds toward research in this area.[185] In 2006, shortly after leaving the position, Graham published an article on the lessons he learned during his time at OIRA.[186] He identified nonquantification as a major concern in regulatory cost-benefit analysis. As a partial solution, Graham suggested that OIRA follow the European Commission's lead by rating the relative importance of each nonquantified cost and benefit.[187]

In 2007, Graham took a strong stance on government involvement in quantification, arguing that it should fund research efforts:

> Unfortunately, the benefit-cost framework for regulatory reform is only as powerful as the tools and data available to implement the framework. Based on my five years of experience overseeing federal regulatory agencies, I have become even more convinced than I was previously of the need for our nation to make expanded research investments in regulatory economics, science, and engineering. The

180. *See* Alan E. Dillingham, *The Influence of Risk Variable Definition on Value of Life Estimates*, 23 ECON. INQUIRY 277, 277 (1985); Henry W. Herzog, Jr., & Alan M. Schlottma, *Valuing Risk in the Workplace: Market Price, Willingness to Pay, and the Optimal Provision of Safety*, 72 REV. ECON. & STAT. 463, 463 (1987).

181. Douglas Gegax et al., *Perceived Risk and the Marginal Value of Safety*, 73 REV. ECON. & STAT. 589, 589 (1985); Shelby Gerking et al., *The Marginal Value of Job Safety: A Contingent Valuation Study*, 1 J. RISK & UNCERTAINTY 185, 197 (1988); W. Kip Viscusi et al., *Pricing Environmental Health Risks: Survey Assessments of Risk-Risk and Risk-Dollar Trade-Offs for Chronic Bronchitis*, 21 J. ENVTL. ECON. & MGMT. 32, 32 (1991).

182. Craig A. Olson, *An Analysis of Wage Differentials Received by Workers on Dangerous Jobs*, 16 J. HUM. RES. 167, 167 (1981).

183. The DOT examined eight studies from the EPA's White Paper, plus seven additional studies. They excluded six for perceived flaws in the methods or results. *See* Memorandum from Polly Trottenberg & Robert S. Rivkin, *supra* note 71, at 4–5. For the full list of DOT's sources, see the DOT memorandum on its 2013 VSL Update. *Id.* at 5–6.

184. Mary F. Evans & George Schaur, *A Quantile Estimation Approach to Identify Income and Age Variation in the Value of a Statistical Life*, 59 J. ENVTL. ECON. & MGMT. 260, 269 (2010); Mary F. Evans & V. Kerry Smith, *Complementarity and the Measurement of Individual Risk Tradeoffs: Accounting for Quantity and Quality of Life Effects*, 41 ENVTL. RES. ECON. 381, 399 (2008); W. Kip Viscusi, *The Value of Life: Estimates with Risks by Occupation and Industry*, 42 ECON. INQUIRY 29, 29 (2004).

185. *See* John D. Graham, The Evolving Regulatory Role of the U.S. Office of Management and Budget, 1 REV. OF ENVTL. ECON. & POL'Y 171, 188 (2007) [hereinafter Graham, Evolving]; John D. Graham, Saving Lives Through Administrative Law and Economics, 157 U. PA. L. REV. 395, 526 (2008) [hereinafter Graham, Saving Lives].

186. John D. Graham et al., Managing the Regulatory State: The Experience of the Bush Administration, 33 FORDHAM URB. L.J. 953, 992–93 (2006).

187. *Id.* at 993.

> information base on which we made multibillion-dollar decisions was often remarkably slim. Hence, I conclude this article with several examples of the urgent need for research.[188]

He stressed that, in the context of air pollutants, there was insufficient research on VSL, on the degree of toxicity of individual types of pollutant particles, and on the expected market responses to regulatory changes.[189]

By 2008, Graham had developed a model for government intervention in nonquantified values that integrated these rating and funding tactics and incorporated a process of centralized review.[190] He called for "more innovative approaches" to "highlight the most important nonquantified (and nonmonetized) items."[191] Graham's proposed system would begin with the European star rating system to emphasize the most significant nonquantified values, but would also include periodic interagency reviews to determine which nonquantified values were being used most frequently across all of the agencies.[192] Through these reviews, the government would determine whether a value was used sufficiently often at the aggregate level to justify centralized quantification efforts, even if the value was not used frequently in any one agency alone.[193] Graham then pressed the National Science Foundation (NSF) and other agencies to fund research that would be designated as urgent by these reviews.[194]

Contrary to Graham's suggested increase in government funding, recent events have reduced federal grants for social science research as a result of both the federal sequestration[195] and the hostility of Republican House members. As sequestration has restricted government funding across the board since March 2013,[196] research funding has also suffered. Early estimates indicated that the NSF could be forced to cut $290 million from research funding by the end of the 2013 fiscal year.[197] Budget cuts at the National Institutes of Health (NIH) were even larger, with research funding dropping 5 percent, or $1.55 billion.[198]

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188. Graham, Evolving, *supra* note 185, at 188.

189. *See id.* at 188–89.

190. *See* Graham, *Saving Lives*, *supra* note 185, at 525–28.

191. *Id.* at 525.

192. *See id.* at 525–26.

193. *See id.*

194. *See id.* at 526.

195. *See Fact Sheet: Impact of Sequestration on the National Institutes of Health*, NAT'L INSTS. OF HEALTH: (June 3, 2013) [hereinafter *NIH Fact Sheet*], http://www.nih.gov/news/health/jun2013/nih-03.htm; Jeanne Sahadi, Obama Signs Order Triggering Spending Cuts, CNN MONEY (Mar. 1, 2013, 9:49 PM), http://money.cnn.com/2013/03/01/news/economy/spending-cuts-obama/.

196. *See* Sahadi, *supra* note 195.

197. *See id.* The EPA budget had already been reduced by more than 10 percent from 2012 to 2013. U.S. ENVTL. PROT. AGENCY, FY 2013 EPA BUDGET IN BRIEF 1 (2012), *available at* http://yosemite.epa.gov/sab/sabproduct.nsf/2B686066C751F34A852579A4007023C2/$File/FY2013_BIB.pdf ("The EPA's FY 2013 Annual Performance Plan and President's Budget requests $8.344 billion, approximately $105 million below FY 2012.").

198. *NIH Fact Sheet*, *supra* note 195.

Former NIH Director Elias Zerhouni indicates that these cuts could undermine an entire generation of young scientists and their potential research advances.[199]

Hostility toward federal research grants—especially grants for the social sciences—goes beyond the direct budgetary effects of the sequester. Even before the budget crisis, Republican members of the House of Representatives were pressing to reduce research funding and restrict agencies' freedom to fund research in the social sciences.[200] For example, in May 2012, the House of Representatives passed an appropriations bill refusing to fund the NSF for political science research[201] or for its Climate Change Education Program,[202] though the bill ultimately died in the Senate.[203] During a speech at the American Enterprise Institute, Eric Cantor, then the House Majority Leader, made the party's aggressive stance on social science research clear, stating, "Funds currently spent by the government on social science – including on politics of all things – would be better spent helping find cures to diseases."[204]

These attempts to limit research in the social sciences have come to fruition, as the sequester's budget cuts were paired with a new layer of political oversight for social scientific grants. Under the Consolidated and Further Continuing Appropriations Act passed in March 2013, the NSF Director now has to certify that all research grants awarded to social scientists promote "national security or the economic interests of the United States."[205] Criticizing this restriction on agency decision making regarding research grant allotments, John Holdren, Director of the Office of Science and Technology, points out the

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199. *See* Dylan Matthew, *Former NIH Director: The Sequester Will Set Back Medical Science for a Generation*, WASHINGTON POST WONKBLOG (Feb. 21, 2013), http://www.washingtonpost.com/blogs/wonkblog/wp/2013/02/21/former-nih-director-the-sequester-will-set-back-medical-science-for-a-generation/.

200. *See* HUMAN EVENTS, *Eric Cantor: 'Making Life Work'*, HUMAN EVENTS: POWERFUL CONSERVATIVE VOICES (Feb. 5, 2013), http://www.humanevents.com/2013/02/05/eric-cantor-full-text-of-make-life-work-speech/.

201. Commerce, Justice, Science, and Related Agencies Appropriations Act, H.R. 5326, 112th Cong. § 565 (2012) ("None of the funds made available by this Act may be used to carry out the functions of the Political Science Program in the Division of Social and Economic Sciences of the Directorate for Social, Behavioral, and Economic Sciences of the National Science Foundation.").

202. H.R. 5326, 112th Cong. § 564 (2012) ("None of the funds made available by this Act may be used to carry out the activities of the Climate Change Education program of the National Science Foundation.").

203. After passing the House on May 02, 2012, the Bill died in the Senate. See *H.R. 5326 (112th): Commerce, Justice, Science, and Related Agencies Appropriations Act, 2013*, GOVTRACK.US (last visited Aug. 26, 2014), http://www.govtrack.us/congress/bills/112/hr5326.

204. For the full text and video, see HUMAN EVENTS, *supra* note 200.

205. Consolidated and Further Continuing Appropriations Act, Pub. L. No. 113-6, § 543, 127 Stat. 198, 279 (2013) ("None of the funds made available by this Act may be used to carry out the functions of the Political Science Program in the Division of Social and Economic Sciences of the Directorate for Social, Behavioral, and Economic Sciences of the National Science Foundation, except for research projects that the Director of the National Science Foundation certifies as promoting national security or the economic interests of the United States.").

importance of social science research and why political management of agency grant decisions should concern us: "Imposing such a national-interest criterion . . . would throw out the basic-research baby with the bathwater, inasmuch as basic research constitutes precisely that subset of research activity that is aimed at expanding knowledge without reference to possible applications."[206]

B. Government as a Direct Participant

In other instances, the federal government has taken a more direct lead in monetization efforts. As discussed above in Part III.B, the Obama administration created an interagency task force in 2009 to investigate methods for monetizing the benefits of reduced carbon emissions. By taking the lead in this manner, it put a quick end to the prior practice of either not valuing SCC at all or using substantially different values for different regulatory programs.[207] This process therefore served as a catalyst to ensure that agencies properly accounted for the adverse consequences of greenhouse gas emissions in regulatory decisions.

In connection with the discussion in the prior section, not only did the Obama administration lead the charge to standardize SCC values, but earlier administrations had also funded many of the studies on which the 2009 interagency working group relied. The interagency group focused primarily on three preexisting, peer-reviewed models: the DICE (Dynamic Integrated Climate and Economy) model; the FUND (Climate Framework for Uncertainty, Negotiation, and Distribution) model; and the PAGE (Policy Analysis of the Greenhouse Effect) model.[208] The DICE model was developed by William Nordhaus and was first described in a 1993 article,[209] which had been funded by the NSF.[210] The interagency working group relied on Nordhaus' subsequent books on the topic,[211] both of which had also been funded by the NSF, as well as by the Department of Energy.[212] The FUND model was designed by Richard

206. John P. Holdren, Dir. of the White House: Office of Sci. and Tech. Pol'y, Remarks at the Am. Ass'n for the Advancement of Sci. (AAAS) Sci. & Tech. Symposium (May 2, 2013) (as prepared), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/2013_holdren_aaas_remarks.pdf.

207. *See* 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 4.

208. *See id.* at 5 n.2.

209. William D. Nordhaus, Rolling the "DICE": An Optimal Transition Path for Controlling Greenhouse Gases, RESOURCE & ENERGY ECON., March 1993, at 27, 28.

210. *See id.* at 27.

211. *See* 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 5 n.2 (citing WILLIAM D. NORDHAUS & JOSEPH BOYER, WARMING THE WORLD: ECONOMIC MODELS OF GLOBAL WARMING (2000); WILLIAM NORDHAUS, A QUESTION OF BALANCE: WEIGHING THE OPTIONS ON GLOBAL WARMING POLICIES (2008)).

212. WILLIAM NORDHAUS, A QUESTION OF BALANCE: WEIGHING THE OPTIONS ON GLOBAL WARMING POLICIES ix (2008); WILLIAM D. NORDHAUS & JOSEPH BOYER, WARMING THE WORLD: ECONOMIC MODELS OF GLOBAL WARMING xii (2000).

Tol in the mid-1990s.[213] The interagency working group relied on Tol's updates to the model from 2002 and later,[214] which were also funded by the NSF.[215] Only the PAGE model did not receive U.S. government funding.[216]

In some cases, individual agencies undertook similar efforts. For example, the EPA led a concerted, centralized effort to develop a VSL for use in cost-benefit analyses in the 1990s.[217] To put itself in a better position to support its regulations during the OIRA review process,[218] the EPA assembled the Economic Consistency Workgroup (Workgroup) in 1996, tasked with formalizing and updating the Agency's economic analyses.[219] The Workgroup compiled insights from a number of sources, including its own and other agencies' existing guidelines,[220] contemporary modeling techniques,[221] and the advice of the EPA Science Advisory Board.[222] In 2000, the Workgroup published its first guidelines.[223] The EPA's proposed VSL—just over $6 million at the time—was among the guidelines' most significant measures because it was significantly higher than OIRA's valuation, which had been as low as $1 million.[224] The DOT makes similar efforts to standardize and update its VSL. Since 1993, the DOT has periodically reviewed the most recent scientific advances on the topic and issued updates to its departmental guidance on VSL.[225]

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213. *See, e.g.*, Richard S. J. Tol, *The Damage Costs of Climate Change Toward More Comprehensive Calculations*, ENVTL. & RESOURCE ECON., May 1995, at 353.

214. *See* 2010 INTERAGENCY WORKING GRP., *supra* note 64, at 5 n.2 (citing Richard S. J. Tol, *Estimates of the Damage Costs of Climate Change: Part I: Benchmark Estimates*, ENVTL. & RESOURCE ECON., Jan. 2002, at 47).

215. *See* Tol, *supra* note 213, at 66.

216. *See* Chris Hope, *The Marginal Impact of CO_2 from PAGE2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons for Concern*, 6 INTEGRATED ASSESSMENT J. 19, 33 (2006) (funding by the Great Britain Office of Gas and Electricity Markets); Chris Hope, *Optimal Carbon Emissions and the Social Cost of Carbon Over Time Under Uncertainty*, 8 INTEGRATED ASSESSMENT J. 107 (2008) (not acknowledging any financial support or funding). PAGE was originally developed for the European Commission, and is unlikely to have received U.S. government funding. *See* Chris Hope, John Anderson & Paul Wenman, *Policy Analysis of the Greenhouse Effect: An Application of the PAGE Model*, 21 ENERGY POL'Y 327, 337 (1993).

217. *See* RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY: HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH 47–50 (2008).

218. *See id.* at 49–50.

219. *See* U.S. ENVT'L PROT. AGENCY, GUIDELINES FOR PREPARING ECONOMIC ANALYSES, at i (2000) [hereinafter 2000 EPA GUIDELINES].

220. *See id.*

221. *See id.*

222. *See* REVESZ & LIVERMORE, *supra* note 217, at 34.

223. *See* 2000 EPA GUIDELINES, *supra* note 219. The guidelines were subsequently updated in 2010. *See* 2010 EPA GUIDELINES, *supra* note 75.

224. *See* REVESZ & LIVERMORE, *supra* note 217, at 50. In addition to coordinating these internal efforts, the EPA funded some of the private research that informed its VSL choice, as discussed *supra* Part IV.A.

225. *See* Memorandum from Polly Trottenberg & Robert S. Rivkin, *supra* note 71, at *i*.

In other areas, however, the federal government has not played a similar role as a catalyst for the quantification of benefits. This failure is striking in the context of the exploitation of natural resources. As discussed above in Part III.E, the underlying theoretical work to permit such a valuation based on option values has been developed extensively in the economic literature in connection with financial products and is well understood. Moreover, industry itself has applied this literature specifically to the exploitation of natural resources.[226]

In summary, the federal government has, over the past four decades, played a very significant role as a catalyst to spur the quantification of regulatory benefits, in some cases by funding academic research and in other cases by undertaking important quantification projects directly, either through individual agencies or through interagency working groups. Unfortunately, the current political climate is not propitious for the funding of academic research in the social sciences. This development is likely to slow down the process by which regulatory benefits get monetized.

CONCLUSION

Breakeven analysis is a useful technique for adding structure to cost-benefit analysis where the regulatory agency has not quantified one category of benefits. But it is a second-best technique. The most that it can aspire to do is to create upper and lower bounds that provide useful guidance for the evaluation of a benefit. If the range is relatively constrained, breakeven analysis conveys a great deal of useful information. But if the range is large, breakeven analysis might not help much. In some cases, such a range cannot be constructed at all. In others, because of the presence of multiple benefits that have not been quantified, it is not necessarily possible to tease out useful information.

The best approach is to actually quantify the benefit. Over the last few decades, a great deal of progress has been made on this front, and there are important types of benefits that are poised for progress. The categories of quantified and nonquantified benefits are not immutable. Instead, they are highly permeable. But the shift from nonquantified to quantified status is not a random one. Instead, it is highly dependent on the government's role as a funder of private research and as a direct participant in the quantification process. Efforts to bring greater attention to breakeven analysis are salutary, but they must be balanced against the possible adverse impact such efforts might have on the resources and attention the government devotes to quantification.

226. *See supra* text accompanying notes 172–73.