THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Public Interest Comment[1] on

The Environmental Protection Agency's Proposed Rule

Increasing Consistency and Transparency in Considering Benefits and Costs in the Clean Air Act Rulemaking Process

Docket ID No. EPA-HQ-OAR-2020-0044

RIN: 2010-AA12

AUGUST 3, 2020

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REGULATORY STUDIES CENTER

The George Washington University Regulatory Studies Center improves regulatory policy through research, education, and outreach. As part of its mission, the Center conducts careful and independent analyses to assess rulemaking proposals from the perspective of the public interest. This comment on the Environmental Protection Agency's proposed rule, *Increasing Consistency and Transparency in Considering Benefits and Costs in the Clean Air Act Rulemaking Process*, does not represent the views of any particular affected party or special interest, but is designed to evaluate the effect of EPA's proposal on overall consumer welfare.

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[1] This comment reflects the views of the author, and does not represent an official position of the GW Regulatory Studies Center or the George Washington University. The Center's policy on research integrity is available at http://regulatorystudies.columbian.gwu.edu/policy-research-integrity.

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Introduction

In this Notice of Proposed Rulemaking (NPRM), EPA seeks to codify procedures that will ensure adequate consistency and transparency in applying Benefit-Cost Analysis (BCA) to rulemakings under the Clean Air Act (CAA). Note that EPA also has more detailed substantive *Guidelines For Economic Analysis*, which are currently under review by the agency's Science Advisory Board. This comment focuses on three aspects of the NPRM. Part I responds to EPA's question about the legal authority for the NPRM, and suggests that the agency examine several broader sources of authority in addition to the CAA. Part II affirms the general principle that EPA should consider – consistent with the agency's legal jurisdiction – the full range of benefits and costs that flow from its decisions, and it points out some of the "boundary drawing" challenges, including co-benefits, that can distort the results of a BCA. Part III explores a longstanding problem with the way discounting is done in Regulatory Impact Analysis, and proposes a correction. The discounting problem originates in OMB Circular A-4; but, while it is doing housekeeping on its BCA procedures, EPA should take this opportunity to engage with OMB and try to correct it.

I. EPA's Legal Authority

EPA's NPRM commits the agency to preparing a BCA for significant rules under the CAA, "using the best available scientific information and in accordance with best practices from the economic, engineering, physical, and biological sciences." It includes "additional procedural requirements to increase transparency in the presentation of the BCA results, while maintaining the standard practices of measuring net benefits consistent with E.O. 12866."

At the same time, the NPRM recognizes that the use of BCA in rulemaking must be governed by legal principles, as well as by economic and scientific principles. This is important, and it is often forgotten by economists who make generalizations about BCA without considering the legal context of a particular rulemaking. For example, as discussed further below, it is not possible to decide how to treat non-domestic benefits without considering the agency's statutory authority. Absent an explicit legislative command, a domestic regulatory agency cannot presume that it has the authority to take actions that are contrary to the interests of the United States in order to advance some other countries' interests.

The NPRM relies primarily on the CAA for its authority, but it also asks about other potential sources of legal authority: "The EPA solicits comment on whether additional or alternative sources of authority are appropriate bases for this proposed regulation." There are several potential sources of authority, in addition to the Clean Air Act.

Executive Orders

The preamble includes an excellent discussion of the long history of Presidential Executive Orders mandating that agencies conduct Regulatory Impact Analysis (RIA). These Executive Orders and associated OMB guidance underlie many of the requirements detailed in the NPRM. It is worth noting that there is precedent for the promulgation of binding procedural rules based solely on the authority of Executive Orders. In May, 1977, President Jimmy Carter issued Executive Order 11991, directing the Council on Environmental Quality (CEQ) to issue procedural regulations for compliance with the National Environmental Quality Act (NEPA), and directing federal agencies to comply with CEQ's regulations. In *Andrus* v. *Sierra Club*,[3] the Supreme Court took favorable notice of those CEQ regulations and, in dicta, asserted that they warranted deference by the courts. For over forty years now, federal courts have enforced those NEPA regulations – which, much like EPA's NPRM, seek to standardize the procedures for producing analysis in support of agency decisions.[4] Of course, any such procedural rules must be consistent with the governing statutes. But, with that caveat, it is reasonable to cite EO 12866 and the other EOs mentioned in the NPRM as legitimate sources of authority for the issuance of binding procedural regulations governing the conduct of agency analysis.

Administrative Procedure Act

The preamble also includes a useful summary of federal court decisions that have, over the last couple of decades, increasingly viewed some form of BCA as not only desirable in rulemaking, but even mandatory. Sometimes the opinions will cite specific statutory language as implying the need for benefit and cost balancing, and sometimes they will cite the "arbitrary and capricious" provision from the Administrative Procedure Act (APA). This evolution of BCA jurisprudence has been explored by many authors[5] – most thoroughly by Cass Sunstein, who ties it firmly to an evolving understanding of the APA as applied to modern regulatory decisions.[6] While agencies (the Department of Justice excepted) typically have not attempted to codify APA compliance procedures, it is reasonable to view EPA's NPRM as drawing its legal authority, in part, from the APA as interpreted by the courts.

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[3] 442 U.S. 347 (1979).

[4] For further discussion of the NEPA precedent, see Brian Mannix and Bridget Dooling, "Codifying the Cost-Benefit State," available at https://regulatorystudies.columbian.gwu.edu/codifying-cost-benefit-state.

[5] John D. Graham & Paul R. Noe, A Paradigm Shift in the Cost-Benefit State, The Regulatory Review (Opinion) (Apr. 26, 2016), https://www.theregreview.org/2016/04/26/graham-noe-shift-in-the-cost-benefit-state/.

[6] Cass Sunstein. 2017. "Cost-Benefit Analysis and Arbitrariness Review." Harvard Environmental Law Review 41:1–41.

Beyond the APA, however, I believe there is a constitutional principle that is implicated. When an administrative agency exercises its properly delegated discretion to impose costs on a subset of the citizenry, it has an obligation to explain why. Indeed, it has an affirmative duty to demonstrate that it is acting in the public interest, by describing beneficial effects of its action and showing that they outweigh the harmful effects.[7] Congress is under no such obligation to explain its actions or to use BCA; but if it delegates discretionary decisions to an administrative agency, that agency is obliged to show that it is exercising its discretion in the public interest.

While Sunstein primarily relies on the APA as a statutory basis for BCA jurisprudence,[8] he also explores the nondelegation canon of interpretation.[9] Courts rarely strike down statutes as violating the nondelegation doctrine, but they routinely apply the nondelegation canon to read statutes as *not* delegating particular authorities, absent a "clear statement" in the text.

In a 2000 article[10] Sunstein listed a series of "nondelegation canons" of interpretation, as an alternative to the classical nondelegation doctrine. Rather than requiring courts to vacate overly broad or ambiguous statutes, these interpretive nondelegation canons take the form of "clear statement" doctrines that limit administrative agencies' authority to act contrary to certain established legal principles.[11]

Eighteen years later, after a series of Supreme Court decisions increasingly favorable to benefit-cost balancing, Professor Sunstein revisited and expanded upon the "cost-consideration canon" as an application of what he now calls "The American Nondelegation Doctrine."[12]

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[7] Brian Mannix, "Benefit-Cost Analysis as a Check on Administrative Discretion," Supreme Court Economic Review, 24 SCER 155. Note that the full text of this article was included in my comment on EPA's ANPRM.

[8] Cass R. Sunstein, The Cost-Benefit Revolution 147-70 (2018); Cass R. Sunstein, *Cost-Benefit Analysis and Arbitrariness Review*, 41 HARV. ENVIR. L. REV. 1 (2017).

[9] We use "nondelegation doctrine" to refer to those cases when the Supreme Court finds a statute facially unconstitutional. "Nondelegation canon" refers to an interpretive rule obligating courts, and agencies, to read a statute as *not* delegating particular powers unless there is a clear statement in the text.

[10] Cass R. Sunstein, *Nondelegation Canons*, 67 U. CHI. L. REV. 315 (2000).

[11] Professor Sunstein describes his nondelegation canons as a judicial presumption, absent a clear statement of statutory authority, against administrative actions that: (1) raise constitutional doubts; (2) preempt state laws; (3) apply statutes retroactively; (4) violate the rule of lenity; (5) involve extraterritorial applicability; (6) intrude on tribal sovereignty; (7) waive sovereign immunity; (8) provide exemptions from taxation; (9) promote anticompetitive practices; (10) restrict veteran's benefits; or (11) incur grossly disproportionate costs. He does not list the exercise of eminent domain, but it appears to fit squarely within his paradigm: agencies may not condemn property without a clear statement of authority.

[12] Cass R. Sunstein, *The American Nondelegation Doctrine*, 86 GEO. WASH. L. REV. 1181 (2018). That terminology has not caught on, and we continue to call this a nondelegation canon.

As we have seen, the cost-consideration canon holds that unless Congress explicitly says otherwise, an agency must consider costs in deciding whether and how to proceed. The canon has a long history; it grows out of a series of cases in the D.C. Circuit, first allowing and then mandating consideration of cost. In an important decision involving mercury regulation, all nine members of the Supreme Court converged on the new canon.[13]

The BCA nondelegation canon instructs courts to read statutes to require agencies to balance benefits and costs, absent a clear statement in the statute to the contrary. Sunstein's articulation of the cost-consideration canon thereby tethers BCA to Article I of the Constitution and to basic separation-of-powers principles, rather than just to statutory or common law.

Time and again, it imposes sharp constraints on the administrative state, not by applying the heavy artillery of the Constitution or the requirements of the Administrative Procedure Act, but by requiring clear congressional authorization for agency action—and by insisting, not rarely, that such authorization cannot be found.[14]

While it may not deploy the "heavy artillery" (i.e., courts setting aside statutes), the nondelegation canon is nonetheless a constitutional principle. The requirement that agencies act in the public interest unless directed otherwise is inherent in the nature of the executive authority. Agencies cannot use their discretion to impair life and liberty of citizens unless they can demonstrate that doing so serves some larger public purpose. BCA is a fact-finding exercise by which agencies meet that burden.

But the "clear statement" nondelegation canon does not just constrain agencies. It also helps define the Legislative power. Congress exercises its authority as a representative body; as such, it must be held accountable to the electorate for the laws it enacts. By requiring a "clear statement" in the statutory text, especially when the statute is not obviously in the public interest, the nondelegation canon helps to distinguish between government actions that are legislative in character, and those that are executive.

We may get additional guidance from the courts on the boundaries that apply to the administrative agencies. Meanwhile, it is pretty well established that acting in the public interest, as demonstrated by BCA, is a necessary condition for the faithful execution of the laws. EPA's NPRM can fairly be viewed as establishing procedures for complying with constitutional requirements for separation of powers.

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[13] *Id.* at 1197 (referring to *Michigan v. EPA.*).

[14] *Id.* at 1207-08.

II. Drawing Boundaries on the BCA

The General Rule: All Costs and Benefits Should be Counted

The economic principle underlying BCA has long been clear.

> [BCA] strives to be complete—including, with appropriate weights, all of a decision's consequences: remote as well as proximate, indirect as well as direct, diluted as well as concentrated, delayed as well as immediate, improbable as well as probable, unintentional as well as intentional.[15]

The problem is that an exhaustive BCA is simply intractable. Agencies need to put boundaries on the analysis in order to get the job done. Considerable professional judgment is needed to design a BCA so that it captures all of the important consequences of a decision, and excludes those that are trivial or irrelevant. Unfortunately, this is not always done in a neutral manner. The agency will naturally be seeking to support and defend its regulatory action, and there is a strong temptation to be selective about what gets included and what gets excluded. We used to talk about the "unintended side effects" of regulation, but now the "co-benefits" terminology suggests that agencies are looking for the *good* side effects far more diligently than they look for the *bad* side effects. There is no easy formula to ensure that a BCA remains balanced, but there are a few important guidelines to consider.

Jurisdiction and BCA Standing

The first boundary to acknowledge is the agency's jurisdiction – as a domestic regulatory agency, EPA's jurisdiction is the United States. Its legal authority allows it to regulate – and thereby to impose costs on – persons in the United States. In estimating benefits, it must use the same scope of analysis. The CAA has specific provisions for handling cross-border pollution. But the general rule is that domestic costs need to be justified by domestic benefits. Congress has the power to give foreign aid; domestic agencies cannot do that without specific legislative direction.

Using a domestic footprint for costs and a global footprint for benefits could easily lead to absurd results. An agency could decide to ban motor vehicles or electricity, for example, because billions of people around the world expressed a substantial willingness-to-pay to see the United States do that to itself! This does not mean that global benefits should never be calculated. They may be useful to Congress as it considers legislation, or to an international forum to help inform treaty negotiations. But global benefits cannot be used to justify a domestic regulation that is

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[15] Brian Mannix, "Employment and Human Welfare: Why Does Benefit-Cost Analysis Seem Blind to Job Impacts?" in *Does Regulation Kill Jobs?* Edited by Cary Coglianese, Adam M. Finkel, and Christopher Carrigan

demonstrably harmful to domestic interests, unless the agency has an express "clear statement" that Congress has ordered exactly that result.

BCA Boundaries and Agency Bias – Co-Benefits and the Choice of Tool

One recent controversy involves the use of particulate matter (PM) co-benefits to justify rules that are not primarily directed at reducing PM. While such co-benefits should in principle be counted, they should *not* be counted without also counting the associated costs. And there is good reason to expect those costs will be even larger than the corresponding co-benefits. EPA has the authority to set a NAAQS for PM emissions. Generally, we would expect that limiting PM directly will achieve any given level of PM reductions at a lower compliance cost than would be achieved by limiting some other pollutant. So choosing to use an *indirect* method of achieving PM reductions will incur additional net costs.

This is a good reason to be skeptical about co-benefits that are attributed to the use of a second-best regulatory tool, when a first-best tool is readily available. But there may be good reasons why those co-benefits are legitimate. For example, the agency may be looking at what economists call a "joint-cost problem." One set of costs – e.g., installing scrubbers at power plants – may achieve multiple agency objectives. If different pollutants are regulated in separate rulemakings, there needs to be some mechanism to allocate the joint costs across multiple BCAs. And, because the efficient frontier will involve balancing *marginal* benefits and costs, a simple allocation rule will not suffice.

In such cases, it might make more sense to do some of the BCA in the context of a strategic plan, where the agency is able to look across the range of available tools and multiple objectives, and choose the combination of actions that makes the most sense.

BCA Boundaries and Agency Bias – Substitutes and GE Effects

It becomes especially important to use a broader analysis, including general equilibrium (GE) analysis, when co-benefits are being generated by significant substitution effects. For example, if regulation of mercury emissions is causing a reduction in PM emissions because the analysis predicts a net reduction in coal combustion, then it becomes necessary to ask what is replacing that coal. If it is natural gas fired generation, then are there any dis-benefits associated with a greater use of natural gas? If it is increased hydroelectricity, then do dams have any harmful effects?

The danger is that while regulating one pollutant, the agency will take credit for reducing all the other pollutants that correlate with it, but will fail to account of increases in all the pollutants that correlate with the substitutes that are stimulated when one type of source is discouraged.

III. Tackling the Discount Rate Dilemma

The Unbearable Lightness of OMB Discounting Guidance

In its NPRM "EPA proposes that the Agency must explain any departure from the best practices form the BCA described in Circular A-4." There is one area where Circular A-4 falls short of describing the best practice, however; and that is in the use of discount rates to calculate the Net Present Value of net benefits.

OMB's guidance on regulatory analysis directs agencies to evaluate regulatory benefits and costs using two standard discount rates, 3 percent and 7 percent, but it gives little insight on how to use them other than to try both. The initial draft of OMB's first such guidance, published in 1988, did include specific instructions on how to use two rates simultaneously, but those instructions were deleted in the editing process. Below, this comment recreates those original instructions, and explains how they help to resolve many of the misunderstandings about discounting that have developed since then.

A Tale of Two Discount Rates

OMB's guidance on Regulatory Analysis, Circular A-4 (which incorporates by reference its more general guidance on discounting, Circular A-94) offers two discount rates for regulatory agency use.

> As a default position, OMB Circular A-94 states that a real discount rate of 7 percent should be used as a base-case for regulatory analysis. The 7 percent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy. . . It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector. . .

> The effects of regulation do not always fall exclusively or primarily on the allocation of capital. When regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower discount rate is appropriate. . . If we take the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around 3 percent in real terms on a pre-tax basis.

> For regulatory analysis, you should provide estimates of net benefits using both 3 percent and 7 percent. [Circular A-4, pp. 33–34]

The OMB Circulars recognize that using 3 percent alone (the Social Rate of Time Preference, SRTP), or using 7 percent alone (the Rate of Return to Capital, RRC), are both analytically incorrect. Neither method is supported by economic theory, and displaying two wrong answers is not especially helpful. So OMB offers agencies another option, the shadow price of capital.

Or Maybe Just One Discount Rate, But with a Multiplier

The theoretically preferred method of discounting for regulatory analysis uses just the SRTP for discounting future values; and it accounts for the scarcity of capital, not by using a higher discount rate, but by applying a shadow price of capital.

This Shadow Price of Capital (SPC) approach achieved a consensus among economists after a conference held by Resources For the Future in 1977, which resulted in a conference volume edited by Robert Lind (hereinafter, "Lind-82").[16] As EPA notes in its own *Guidelines for Preparing Economic Analysis*, "Lind (1982a) remains the seminal source for this approach in the social discounting literature." OMB agrees:

> Using the shadow price of capital to value benefits and costs is the analytically preferred means of capturing the effects of government projects on resource allocation in the private sector. To use this method accurately, the analyst must be able to compute how the benefits and costs of a program or project affect the allocation of private consumption and investment. OMB concurrence is required if this method is used in place of the base case discount rate. [Circular A-4, Section 8.b.(3)]

When using the SPC approach, all costs and benefits are discounted using the SRTP, but mandated capital costs are first multiplied by the SPC, which is equal to the RRC divided by the SRTP. (See Lind-82 for the explanation.) Using OMB's 7 percent and 3 percent the SPC = 7/3 or 2.33, but in 1982 the SPC worked out closer to a factor of three or four. Despite widespread dissatisfaction with OMB's policy of two alternative discount rates, and recognition that the SPC approach is more rigorous, agencies have not embraced it. Apart from having to ask OMB permission to use SPC, agencies may be wary of the "capital cliff" that it presents. That is, if a million-dollar cost is deemed to be a *capital* cost, it suddenly becomes two or three or four million dollars! This is such a sudden jump in regulatory costs that agencies are reluctant to include SPC in regulatory analysis. Instead, they continue to produce two incorrect calculations, using the two discount rates separately.

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[16] Lind, R.C., ed. *Discounting for Time and Risk in Energy Policy*. Washington, DC: Resources for the Future, 1982.

A Multitude of Myths About the Two Discount Rates

The long practice of using discounting methods that are officially approved, but known to be analytically incorrect, has caused a number of misunderstandings to develop among producers, as well as consumers, of regulatory impact analysis.

Myth 1. OMB's 3% and 7% represent a range; the correct rate lies somewhere in between.

No, OMB's two discount rates represent empirically derived estimates of two different "prices," that apply to two different goods. It is not right to treat think of them as a range.

Myth 2. If we calculate an NPV at 3% and 7%, the true NPV will likely lie in between.

This is not quite right, either. EPA mistakenly embraces this view in its own *Guidelines*:

> In most cases the results of applying the more detailed "shadow price of capital" approach will lie somewhere between the NPV estimates ignoring the opportunity costs of capital displacements and discounting all costs and benefits using these two alternative discount rates. [EPA *Guidelines for Economic Analysis*, p. 6-19]

With a complex temporal pattern of benefits and costs, including capital costs, there is simply no reason to think that the math will work out this way. Although "ignoring" the opportunity costs of capital will result in an underestimate of total costs, using the 7 percent RRC to discount all costs and benefits could result in either an overstatement or an understatement of the correctly calculated NPV. In some cases the NPV of costs will appear too low; in other cases the NPV of benefits will be undervalued.

Myth 3. Consumption costs should be discounted at 3%, and capital costs at 7%.

Heck no! Remember that capital costs have a higher opportunity cost than pure consumption; discounting them at 7 percent would make them appear smaller relative to other costs!

Myth 4. Benefits that flow from a capital investment should be discounted at 7%.

This is a very common practice and is consistent with OMB guidance. It is directionally right (compared with Myth 3), but it is still analytically incorrect. Keep in mind that multiple alternative policies, with different costs and benefits, are being compared in an RIA. Suppose there are two options to eliminate a particular workplace hazard: one is a costly change in operating procedures, the other is a piece of capital equipment. If both options effectively eliminate the hazard, the analysis should not pretend that the benefits are different. There will be extra costs associated with capital investments, but those should appear on the *cost* side of the ledger. The NPV of benefits alone should not be affected by how we choose to purchase them.

Myth 5. Use of the SPC approach requires a General Equilibrium (GE) analysis.

This is not true. *Explaining* why there are two different discount rates for different categories of cost required a general equilibrium analysis (See Lind-82), but agencies should not need a GE model to *apply* those prices in the microeconomic analysis of a particular rule – see the Mazur method below.

Myth 6. The SPC approach overstates capital costs because it assumes a dollar-for-dollar displacement of private capital, instead of a partial displacement.

This is not necessarily so. If we relax the dollar-for-dollar assumption, we cannot be sure that the correct answer would be a *partial* displacement; we might find a capital displacement well above 100 percent. Very often, regulatory requirements for capital investment are contingent requirements: *if* you have a widget factory, *then* you must also have a widget-wastewater treatment facility. Just as there is an excess burden of taxation, there can be an excess burden of regulation, so that each $1 of regulatory mandates for capital expenditures will displace substantially *more* than $1 of private capital investments. Indeed, it might even be true that noncapital costs imposed by regulation can reduce the incentives for private capital investment; or, in rare cases, increase them. These questions are worth exploring, but the answers are likely to be much more complicated than in the case of taxation, because tax authorities generally are trying to maximize net revenue and (equivalently) minimize excess burden. In non-tax regulatory programs there will be a variety of considerations that make it difficult to generalize about the magnitude of capital displacement or excess burden. Meanwhile, a dollar-for-dollar displacement seems like a reasonable default assumption. In any case, we should be careful to maintain the distinction between prices (the discount rate) and quantities (amount of displaced capital), rather than try to adjust one to compensate for assumed misestimates in the other.

Myth 7. The SPC approach should not apply to an open economy like the U.S., which can easily borrow overseas.

It is true that the Lind-82 treatment is based on a closed-economy model, in which the supply of capital is constrained and therefore carries a shadow price. We can think of this shadow price as capturing the "positive externalities" of scarce private investment, which mostly take the form of extra tax revenues to domestic governments. But when U.S. companies borrow overseas, some of those positive tax externalities are exported, rather than displaced. (Remember that foreign investors will be expecting real financial returns; they are not investing their funds simply to give the U.S. safer workplaces or cleaner waters.) From the point of view of a domestic BCA, those exported externalities still represent a loss; the shadow price (when our supply of capital is constrained) has simply been replaced by a real price (when we go out and buy more capital abroad). The full treatment of these effects would require a complex analysis of tax structures across the world and their interactions, as well as the varying rates of saving in different economies

and cultures. This may be a good project for OMB, CEA, and Treasury to pursue, but it is not a project to undertake within the confines of an RIA. For RIA purposes, agencies should assume that the empirically derived OMB guidance on discount rates accurately captures the underlying costs to the U.S. economy.

Myth 8. This is too hard!

No, no! Deriving the SRTP and the RRC is a complex undertaking, but using them correctly in a regulatory analysis is relatively simple. Read on.

The Mazur Method

OMB's original *Regulatory Impact Analysis Guidance* appeared as Appendix V in the *Regulatory Program of the U.S. Government* (April 1, 1988 – March 31, 1989). The first footnote read:

> This appendix was mainly written by Michael Mazur as one of his last projects before his untimely death last year. Those who knew Mike will appreciate his hard work and careful analysis that made this guidance possible.

This 1988 guidance introduced OMB's two discount rates, but it omitted critical instructions that Mike Mazur had drafted, shortly before his death in 1987, about how to use them properly.

Doing the Two-Step: First Amortize, then Discount.

Mazur gave a simple two-step procedure for using the two discount rates in a BCA:

First, using the RRC, amortize any capital costs over the expected lifetime of the capital. This will produce a consumption-equivalent stream of future dollar values.

Second, using the SRTP, discount the amortized capital costs back to the present, along with all of the other consumption-equivalent costs and benefits.

The Mazur-87 method has several advantages. It is easy to do, and easy to understand what's going on. It does not require the use of a GE model. And it avoids the "capital cliff" that produces a sudden jump in costs whenever capital investment is mandated. For short term capital commitments, the NPV using the Mazur-87 method becomes indistinguishable from consumption. As the duration of the capital commitment gets longer, the additional opportunity costs grow larger.

For *very* long-term capital investments the Mazur-87 approach is identical to the Lind-82 SPC approach. Indeed, Mazur's methodology makes it clear that the major weakness of the simple SPC was not that it assumed 100 percent displacement of private capital, but that it implicitly assumed

permanent displacement. The simple SPC errs by ignoring the time dimension of capital commitments, which is the essential feature that distinguishes them from consumption.

I should note here that Lind-82 is a book with over 450 pages, and its chapters explore the time dimension of capital commitments, different categories of capital investment, and many other analytical wrinkles can that affect discount rates and the SPC. By pointing out faults of the "simple SPC method" that OMB adopted, I do not mean to criticize the very rich analyses in Lind-82. The simple SPC, applied to all capital costs, represents just one possible approach under a very restrictive set of assumptions, and it has turned out to be impractical. Mike Mazur's proposed modification, effectively using a time-dependent SPC, does not resolve all the questions about the true social cost of capital mandates, but it makes the SPC approach more practical as well as more accurate.

Envisioning a Time-Dependent Shadow Price of Capital

The easiest way to envision the Mazur method is to use it to calculate the NPV of one dollar of capital cost incurred today, amortized over *n* years. The result is effectively a graduated, or time-dependent, SPC.

The graph below uses an SRTP of 3 percent, and an RRC of 12 percent. The simple SPC would be 12/3, or a factor of four. That is represented by the horizontal orange line in the graph; it does not change its value as a function of *n*. The blue line is the Mazur-87 SPC; it varies as a function of *n*, the duration of the capital displacement.

Illustration of the Mazur-87 SPC: *y = The NPV at 3% of ($1, amortized at 12% over n years).*
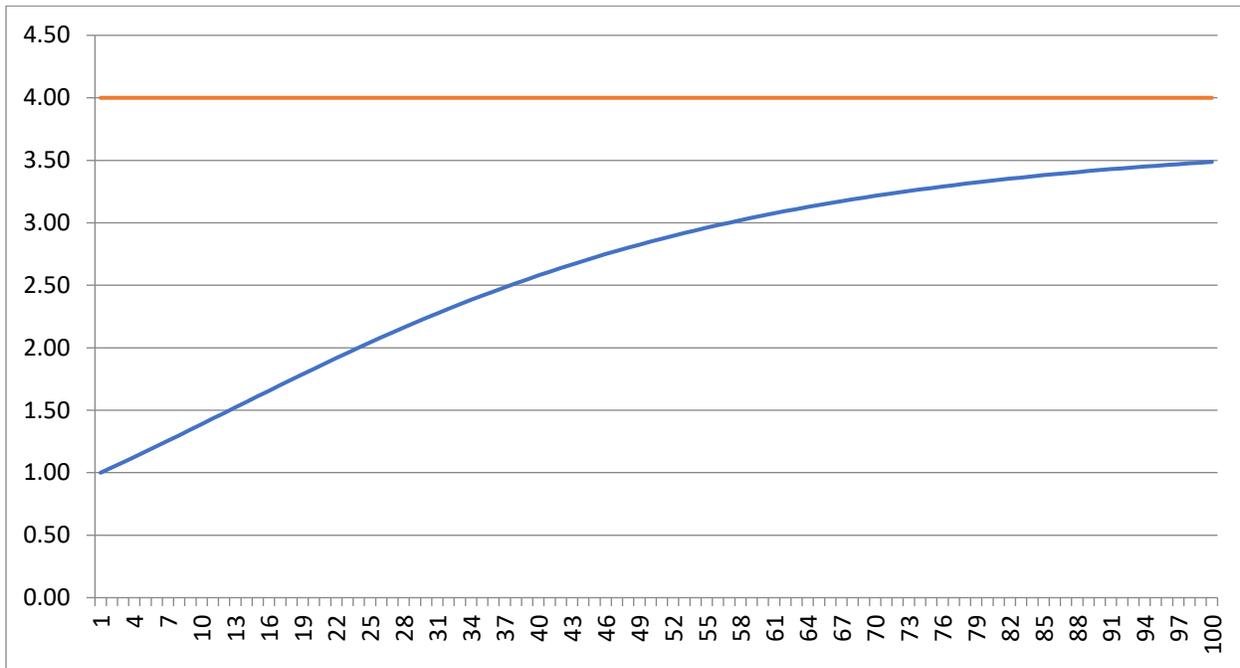
Notice that, with an SRTP of 3 percent and an RRC of 12 percent, the simple SPC is a fixed factor of 4, as shown by the orange line in the graph above. That is, if $1 of cost is treated as a capital cost, its value goes up to $4. Capital costs are quadrupled, regardless of their duration. In contrast, Mazur-87 discounting generates a time-dependent SPC that gives us exactly the same answer – but *only* if the capital commitment is infinitely long! Even after a century, the factor is only 3.5 rather than 4. For a more typical twenty-year capital investment, the Mazur-87 SPC (using these same discount rates) is a factor of less than 2. And for a one-year capital investment, the Mazur SPC is a factor of one – in other words, the capital cost is essentially consumption.

All this is exactly what we should expect. The time-dependent Mazur-87 SPC is well behaved in all the ways that other methods are not. It makes it clear that the weakness of the simple SPC is not that it assumes 100 percent displacement, but that it effectively assumes *perpetual* displacement. By relaxing that assumption, Mike Mazur made the SPC a much more realistic, as well as more usable, methodology.

This is not to say that it answers all questions about discounting. Indeed, it raises some new ones. Given this framework, are we confident we have the right two discount rates? Do they depend on whether the capital costs are imposed on households (e.g., in buying a new car) or on firms? How do we decide the applicable duration? Should we consider the lag (which may be very long) between the time the capital cost is incurred and the time the associated benefit is realized? These questions are challenging, but not prohibitive. We have been discounting the wrong way for far too long; it's time to start doing it right.