Comment on
Rulemaking on the Social Cost of Carbon
with Special Reference to the Discount Rate[1] [2]
June 5, 2023
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Summary

This comment addresses an overarching methodological issue and the treatment of risk in discounting in the EPA proposals on the social cost of carbon. While there is much in the proposal that is an advance over earlier approaches, the current proposal is flawed because of its treatment of risk. [3]

Methodological overview

While this comment is primarily about the treatment of investment risk, a short methodological point should be emphasized. Most federal rules or analyses rely upon relatively stable science and economics. Consider areas such as environmental regulation (with the Clean Power Plan), drug regulation (such as the Pfizer-BioNTech COVID-19 Vaccine), financial regulations (such as regulations on the Volcker Rule), health care (various rules implementing the Affordable Care Act). These apply standard principles of science and economics to new issues and usually have ample precedent. In a phrase, good federal regulatory practice applies established science to new policies. This was the approach taken by earlier federal analyses of the social cost of carbon, which

[1] File is "Comment on Rulemaking for Discounting-060223b.docx".

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[3] Many of the suggestions in this comment are drawn from the background document for the DICE-2023 model, Lint Barrage and William Nordhaus 2023. For a more extensive treatment in the DICE model, see Lint Barrage and William Nordhaus 2023a.

used well-established models and surveys to establish the framework of the findings.

The new approach completely discards the standard regulatory approach. None of the established integrated assessment models are used to give synthetic and integrated analyses. Most important, the discounting framework uses a new, and as will be argued below seriously flawed, approach to incorporating risk and discounting into the analysis.

There are several issues raised by the new approach. One is the lack of transparency. Even for those who are experienced researchers in the field, there is no succinct summary of the key modeling and empirical assumptions. References are made to other documents and computer programs, and these are difficult to absorb, lie behind journal firewalls, or involve technical computer code. The analyses are spread across different documents and are inconsistent.

More questionable is the research methodology. The analysis is not just gathering and synthesizing existing research and information, as was the case in the earlier analysis on the SCC. It attempts to advance the art of integrated assessment modeling, uncertainty analysis, and discounting. This seems not only extremely difficult for a federal regulation or analysis, but also exceptionally subject to making selective assumptions to reach desired conclusions. It is also reversible with changes in approaches because it does not have the legitimacy of settled science. There are few cases where a comparable recent analysis or rulemaking – involving potentially trillions of dollars of investments – was based on devising new analysis rather than reflecting settled science.

These regulations necessarily rely upon cost-benefit analysis. Cost-benefit analysis is a critically important and valuable tool, particularly for complex regulations that involve costs and benefits over time, in many different sectors, and involve different inputs and outputs. The federal government should ensure that its cost-benefit analyses use established social and natural sciences. Analyses also must deploy the proper balancing of the need for the best information with the requirements that information be transparent, be adequately understood and reviewed, and have passed the test of time and peer review. Those requirements have not been met in the current analysis of the discount rate.

Empirical and theoretical background on investment risk

The balance of this comment suggests that the "move the frontier" approach has encountered a major obstacle because of the flaw in dealing with investment risk.

CCAPM models

The modern treatment of investment risk in an economic-growth framework relies on the consumption capital asset pricing model (CCAPM). The basic CCAPM models go back to Samuelson and Merton, with applications by Breeden. The core assumptions of the CCAPM model are the same as the optimal growth models of the Ramsey-Cass-Koopmans variety ("Ramsey model") used in the theory of long-run economic growth with the addition of both risk-free and risky investments.[4]

However, it is clear that the standard CCAPM model cannot explain the risk premium on risky assets. The implication is that models, such as those used to justify the EPA discount rate for climate investments, that take seriously the proper treatment of risk cannot use the Ramsey model with uncertainty, equivalent to the CCAPM model, without considering and correcting for the extremely small risk premium inherent in that model.

Modern investment and finance theory recognize that the appropriate benchmark rates of return (discount rates) to use for investments in the public and private sectors are dependent upon the non-diversifiable risk properties of the investments. The current proposed analysis of discounting does not adequately reflect this in its core proposal. The issue is that the correction for risk relies on a model (the consumption capital asset pricing model or CCAPM) that has clearly failed to reproduce the risk-return properties of existing financial and real markets. By relying on the CCAPM approach, the EPA approach significantly underestimates the necessary risk premium on

[4] This Ramsey model is drawn from Ramsey 1928; Cass 1965; and Koopmans 1965. It is used in many IAMs such as the DICE model in Nordhaus 1992 through Barrage and Nordhaus 2023a; and Stern 2007; and underpins the discussion in the EPA discussion in *Oil and Gas* (2022).

investments that have returns that are significantly correlated with aggregate market and economic risks.

Before discussing the analytical issues, it will be useful to review the relevant data for the United States. A broad consensus exists that the risk-free real return on investments in US dollar securities is low, in the range of 0 - 2% per year for long-term investments (in instruments such as Treasury Inflation Protected Securities) over the last three decades. Additionally, there is little debate that the returns to risky financial assets (such as US stocks or a blended portfolio of risky US assets), as well as the returns to risky real assets (such as US corporate capital), are substantially higher than the risk-free rate. For example, the real return on a value-weighted portfolio of US corporate securities and real estate was 7% per year period from 1928 to 2022. The average post-tax real rate of return to US corporations has averaged around 8% per year over the period from 1948 to 2022. These data suggest a risk premium on financial and real corporate capital of at least 6% per year.[5]

A short description of the modern analytical foundation of discounting is the following: The theoretical approach to dealing with risk in making investment decisions is to examine the correlation of the risk of a project (here, primarily environmental investments) with the undiversifiable risks of the economy. Note that in this discussion, I abstract from any further issues raised by taxes, inflation, international finance, governmental regulations, and market imperfections.

If the risks are uncorrelated with the economy's undiversifiable economic risks, then it would be appropriate to use a risk-free rate of return. If the returns are perfectly correlated with the economy's undiversifiable risks, then it would be appropriate to use the rate of return associated with investments carrying the average risk in the economy. For a risk profile that is intermediate in size, then, roughly speaking, it is appropriate to use a risk premium that is the economy-wide risk premium times a "beta" that reflects the correlation of the risk with the risk in the economy as a whole.

This approach implies that, in the CCAPM approach, the risk premium on a risky asset, defined as the expected return on a risky asset less the risk-free

[5] The data in this paragraph are drawn from the background described in footnote 3.

return, is proportional to the covariance of its return and consumption in the period of the return. That proportion is the CCAPM beta.[6]

An analogous concept, called the "climate beta," applies when the risky asset is an investment in climate policy, such as to reduce GHG emissions.[7] An important issue, applying this approach, concerns the value of the climate beta. Unlike other investments, the returns to climate investments have no historical track record on which to examine their risk properties. In the absence of historical evidence, this literature examines the elasticity of climate damages with respect to a change in aggregate consumption using the CCAPM model structure. The "data" are synthetic ones based on IAM model projections.

Intuition might hold that the climate beta is negative because shocks such as unfavorable damage functions or uncertainties about climate sensitivities would lead to climate damages that are negatively correlated with consumption. However, some research indicates that the uncertainties about overall productivity growth tend to dominate other uncertainties in the long run and that the impact of productivity shocks will lead to a positive correlation of damages and consumption. The limited research on the value of the climate beta suggests that climate investments largely share the risk structure of normal investments, and that the climate beta is in the range of 0.6 to 1.0. This would suggest a lower return on risky climate investments than on normal capital.

The theoretical advantage of the CCAPM approach is that it is widely accepted and internally consistent, and it is also consistent with the extended Ramsey model used in many climate studies. However, a fatal flaw in using it for setting discounting policy is that empirical applications have shown that the CCAPM approach vastly underestimates the risk premium that should be applied to risky investments. The finding is known as the "equity-premium puzzle," but in this context, it is the "capital-premium puzzle," applying to the difference between the return on risky *capital* rather than the return to risky *equity.* As the empirical data above indicate, the capital-premium puzzle holds with equal force as the equity-premium puzzle.

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[6] See the references by Samuelson 1975; Merton 1969, 1975; and Breeden 1979 in the list of references.

[7] See the references by NAS 2017; Dietz et al. 2018; Nordhaus 2018; Barrage and Nordhaus 2023; and van den Bremer et al. 2021.

As a first approximation, analysis using the CCAPM approach finds that, using standard estimates of risk aversion, the model predicts a capital or equity premium around 1/30th of the empirical risk premium seen in the US economy. The inability of the CCAPM model to explain the equity or capital premium has been the subject of intensive research for almost four decades. While there are many proposals for dealing with the puzzle, none has succeeded in the standard framework. [8]

The EPA Proposals

There are several documents that discuss cost-benefit analysis and the role of discounting. The proposed A-4 circular (EPA 2023) has a high-level discussion that proposes using 1.7% per year as the "social rate of time preference," which it describes as "the rate at which society is willing to trade current consumption for future consumption." It recommends using this as the "default" rate for the social rate of time preference, and implicitly for discounting, for up to 30 years. This is equivalent to assuming that the default is the risk-free discount rate.

The analysis in the draft A-4 circular does not deal with the CCAPM procedure or the climate beta, which would be necessary to imply the assumed default. Indeed, the "beta" concept is not mentioned in the A-4 draft. In light of the discussion in this Comment, there is no evidence adduced in the draft A-4 circular that would lead to selecting as a default discount rate the risk-free rate of return rather than the returns associated with average investments.

However, the most relevant analysis for this comment and for federal policy on climate change is the discussion in the *Supplementary Material … Oil and Natural Gas* (hereafter *"Oil and Gas"*). [9] This analysis contains a technical discussion of the background for deriving discount rates in situations of risk.

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[8] The literature generally deals with the "equity premium puzzle," with Rajnish Mehra and Edward C. Prescott 1985. For a comprehensive treatment, see Rajnish Mehra 2008. This comment uses the "capital premium puzzle" rather than that on equity to emphasize that it applies to the return on capital more generally.

[9] See EPA 2022, especially pp. 62-63, Table 2.4.2, and section A.3.

The modeling in *Oil and Gas* depends upon different modules for discounting and damages, but this comment focuses on the discounting module. The exact calculations are not provided in the document, but the methods are relatively clear.

The CCAPM framework presented in *Oil and Gas* specifically underpins the use of the low discount rates (1.5%, 2%, and 2.5% per year) used in discussing climate policy. The parameterizations used by EPA are calibrated to reproduce the assumed risk-free discount rates. Some simple calculations using the Ramsey framework can replicate the discount rates shown in Table 2.4.2. The discount rates in Table 2.4.2 closely match the calculated deterministic (zero-risk) discount rates for the assumed parameters of ρ (the pure rate of time preference) and η (defined as the elasticity of marginal utility with respect to consumption but also the RRRA) with a consumption growth of 1.5% per year.

If we apply the framework in *Oil and Gas* with the estimated climate betas described above, the model will greatly underestimate the appropriate discount rate. Using the Mehra-Prescott quantification,[10] the maximum risk premium for climate investments (with the climate beta = 1) in the EPA-adopted model would be 0.2% per year instead of the observed 6% per year. For any elasticities in Table 2.4.2, the discount rate will be virtually identical to the risk-free discount rate for any climate beta in the [0,1] range.

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[10] There are alternative derivations of these numbers. The most common is that the risk premium is $\eta\sigma^2(g_t)$, where $\sigma^2(g_t)$ is the variance of the growth rate of consumption. The assumptions from Mehra and Prescott 1985 are the following, where these figures are gross rates of return. Risk free rate (Rf) = 1.008; mean return on equity (E{Re}) = 1.0698; mean growth rate of consumption (E{x}) = 1.018; standard deviation of the growth rate of consumption (σ{x}) = 0.036; mean equity premium (E{Re} − Rf) = 0.0618. Derived in Mehra and Prescott 1985.

Summary

EPA's assumptions for discounting are flawed because they ignore modern approaches to non-diversifiable risk. Without any evidence to support the assumption, EPA assumes in circular A-4, without any evidence presented, and with some evidence to the contrary, that as a default, regulations induce investments that have zero non-diversifiable risk.

Given the inappropriate attention to modern treatments of non-diversifiable risk, the low discount rates that EPA has proposed for as a default in general and for climate investments in particular are inappropriate for the kinds of investments that are being considered – these being natural-gas turbines, power plant investments, subsidies for wind and solar projects, energy conservation projects, and other similar climate-related investments. To the extent that these investments have climate betas in the neighborhood of ½, which is consistent with or perhaps slightly lower than current estimates, the appropriate discount rate would be the real risk-free rate of in the order of 1% per year plus a risk premium of 3% to 4% a year, for a total discount rate on climate-related investments in the neighborhood of 4% to 5% a year.

Many of the other considerations in the EPA proposal are important, such as declining discount rates, equity weighting, consistency in modeling, and the like. But the error of using a model that ignores the equity/capital premium puzzle is by far the most important concern and leads to the extremely low discount rate used in EPA's calculation of the social cost of carbon.

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