DISAGREEMENT AND DESIGN: SEARCHING FOR CONSENSUS IN THE CLIMATE POLICY AND INTERGENERATIONAL DISCOUNTING DEBATE

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ABSTRACT

Current approaches to discounting in climate policy present a seemingly intractable problem. While it is widely recognized that choice of discount rate in climate models can easily dwarf the effect of other parameter inputs, there is at present a very wide disagreement, both in law and in economics, about the appropriate discount rate to use. This Paper provides a framework for achieving a workable consensus range for acceptable discount rates in climate models. It does so by emphasizing three factors previously ignored in the literature. First, it demonstrates that the choice of discount rate should be tailored to the type of climate model at issue, distinguishing particularly between policy evaluation models and optimization models. Second, it suggests that some disagreement in these debates is fundamental (reflecting deep unbridgeable differences in views about the proper scope of the market), while some disagreement is not. By focusing attention on the non-fundamental sorts of disagreement, it becomes possible to shrink the consensus range of plausible discount rates. Third, this Paper argues that some of the current disagreement about the choice of discount rate for modeling purposes on the front-end can actually be better addressed through elements of program design on the back-end.

Most of the enlightened debate about policy responses to climate change is no longer directed to the question of whether to take action, but rather to the questions of how much to spend on the problem and how quickly to do so.[1] This debate about urgency, in turn, has played out as

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[1] *See, e.g.*, David Weisbach & Cass R. Sunstein, *Climate Change and Discounting the Future: A Guide for the Perplexed*, 27 YALE L. & POL'Y REV. 433, 456 (2009).

the latest chapter in a longstanding and spirited debate on the proper approach to the question of "intergenerational discounting."[2] The resolution of the discounting debate is supposed to tell us how to weigh benefits and costs that arise in different time periods. This is central because addressing the problem of climate change requires the taking on of costs now, or at least in the relatively near term, in order to reap benefits in the future, possibly the quite distant future. Proponents of high discount rates place lower current value on future benefits and thus advise moving relatively slowly.[3] Proponents of low discount rates offer the opposite advice.[4]

The results one reaches regarding the urgency of climate change vary wildly depending on one's assumptions about discount rate. No consensus seems to be emerging, however, regarding an appropriate discount rate to apply. These points hold true across both the disciplines of economics and of law. If one turns to the economics literature, one finds a range of proposed discount rates that run from approximately 1% to approximately 6%.[5] Over the time spans covered in climate change models, these differences can dwarf other parameter assumptions.[6] This lack of consensus regarding discount rates is not for want of effort. In the words of Martin Weitzman, which perhaps invoke only mild hyperbole, economists have written "thousands" of papers on the topic.[7]

To a similar effect, two prominent legal scholars have recently undertaken to write a "primer" for this debate to help the understandably "perplexed" observer.[8] But if one turns to the legal literature, matters seem to be no better regarding an emerging consensus. Although legal scholars, who are spared the acid test of running their arguments through formal models, typically stop short of defending a discount rate with numerical precision, it is not difficult to map the views of legal scholars onto the full range of views espoused by economists. Thus, legal scholars tend to fall

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[2] *See id.* at 434.
[3] *Id.* at 434–36.
[4] *Id.*
[5] *See* Nicholas Stern, *The Economics of Climate Change*, 98 AM. ECON. REV. 1, 12–17 (2008) (explaining bases for defending discount rates as high as 6% and as low as 1.5%).
[6] *Cf.* Kenneth J. Arrow et al., *Intertemportal Equity, Discounting, and Economic Efficiency*, *in* CLIMATE CHANGE 1995: ECONOMIC AND SOCIAL DIMENSIONS OF CLIMATE CHANGE 125, 130 (James P. Bruce et al. eds., 1996) (noting that high discount rates yield low present value estimates of climate damage far in the future and providing the numerical example that $1 billion of damages 200 years hence with a discount rate of 7% equates to damages of only $1300).
[7] *See* Martin L. Weitzman, *A Review of* The Stern Review on the Economics of Climate Change, 45 J. ECON. LIT. 703, 714 (2007).
[8] Weisbach & Sunstein, *supra* note 1, at 436.

into certain methodological camps which align with different points on the spectrum of plausible discount rates.

This state of affairs is highly problematic. With an issue as politically charged as climate change, the great danger is that policymakers and politicians are free to refer to the rate that will lead to an independently desired outcome, which can be anything from doing very little right now to incurring large expenses immediately.[9] My goal in this Paper is to ameliorate this dynamic, though not (as other scholars have done) by defending any particular approach to discounting for "climate policy."[10] One strategy in existing treatments in the law review literature is to move the debate forward by drawing a basic distinction between questions of allocative efficiency and distributive justice.[11] Once one is clear about that distinction, then the proper approach to discounting is supposed to follow. The basic shortcoming of this approach is that there is no agreement about which sort of question "climate policy" implicates. Or, more specifically, there is no agreement about whether it is possible to cleave off questions of efficiency from distribution.[12] Thus, we remain inevitably at an impasse.

My approach in this Paper, therefore, is to recast this seemingly intractable problem into a series of relatively more tractable discrete questions, with the goal of increased conceptual clarity and of a move towards greater consensus over an acceptable range of discount rates. The general theme underlying my approach is that the chief role of the discount rate in climate policy is as an input into various mathematical models, which are (i) heterogeneous in approach and (ii) of contested policy relevance. I do not mean to suggest that the distinctions drawn in the existing literature regarding discounting in climate policy are unimportant. To the contrary, they are central. The issue, though, is how these distinctions map onto *particular* models and how any particular model ultimately feeds into the policymaking process.

Regarding model heterogeneity, most climate models take the form of a so-called "integrated assessment model" (IAM).[13] Such models

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[9] *Cf.* Chris Hope, *Integrated Assessment Models*, *in* CLIMATE CHANGE POLICY 77, 94 (Dieter Helm ed., 2005) (describing degree of influence of economic models on policymaking as not surprising given their ability to "give a respectable academic veneer to the results that powerful actors want.").

[10] *See, e.g.*, Weisbach & Sunstein, *supra* note 1, at 434 ("In this Essay, we explore the issue of discounting in the context of climate change.").

[11] *See id.*

[12] *See, e.g.*, Simon Dietz & Giles Atkinson, *The Equity-Efficiency Trade-Off in Environmental Policy: Evidence from Stated Preferences*, 86 LAND ECONOMICS 423 (2010).

[13] For a general discussion of IAMs, see Hope, *supra* note 9.

are interdisciplinary in nature.[14] They combine modules that model the climate impacts of greenhouse gas emissions with economic modules that model the intersection between climate and growth.[15] There are numerous different IAMs, which can vary considerably in their modeling assumptions.[16] The law review literature on discounting, however, has failed to take sufficient heed of the heterogeneity across models. Such discussions have considered a few of the prominent IAMs, but without any consideration of the ways in which the nature and structure of the model might affect choice of discount rate. My bottom line argument offered here is simple: the appropriate discount rate should depend on the type of IAM at issue. There are a number of useful surveys in the modeling literature, which seek to establish a taxonomy for various models.[17] There is no uniform approach to taxonomy here, reflecting in part the fact that models may be designed with a particular analytical framework in mind but then evolve to handle other sorts of calculations.[18] For present purposes, given my hope to map the disagreements in the legal literature onto the range of models, I follow a basic distinction drawn in the modeling literature between two broad classes of IAMs: so-called "policy evaluation IAMs" and "optimization IAMs."[19] These are very different creatures. Evaluation IAMs are models that provide an estimate of costs (both with respect to damages and abatement) under various emissions paths.[20] These *outputs* of the models work as *inputs* to some separate policy process (external to the model) which must then determine an appropriate path.[21] The models themselves do *not* determine such policy. By contrast, optimization IAMs are based on a model of the entire economy (either globally or subdivided into regions).[22] The output is a stream of consumption that results,

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[14] *Id.* at 78.
[15] *Id.* at 78–79.
[16] *See id.* at 82.
[17] *See* Hans-Martin Füssel, *Modeling Impacts and Adaptation in Global IAMs*, 1 WIREs CLIM. CHANGE 288 (2010); Elizabeth A. Stanton et al., *Inside the Integrated Assessment Models: Four Issues in Climate Economics*, 1 CLIM. & DEV. 166 (2009).
[18] *See* Füssel, *supra* note 17, at 288 (noting the application of certain models in alternate modes).
[19] *See id.* It is possible to make even more fine-grained distinctions. For example, Füssel also discusses the possibility of a "policy guidance" model. *Id.* at 289. That category, however, applies to only one of the models studied in the survey. *Id.* By and large, existing models can be classified as either the optimization type or the evaluation type.
[20] *See* Hope, *supra* note 9, at 80–81.
[21] *Id.* at 87.
[22] *Id.* at 86.

contingent on various climate inputs.[23] Such models are designed to select an optimal path based on an assumed social welfare function.[24] As developed below, many arguments about discounting apply with respect to one of these categories of IAMs but not the other. Thus, the first step in reducing some of the disagreement here is to delineate evaluation IAMs from optimization IAMs and clarify how arguments about discounting play out differently in each.

Regarding policy relevance, one must acknowledge the fact that all of the climate models are highly simplified abstractions involving many crucial assumptions. The numerical precision of the outputs are understandably appealing, but they are in equal measure dangerous for the way in which they can lull the policymaker into a false sense of complacency. The models are sufficiently problematic along this dimension that one encounters calls for essentially ignoring their outputs in the policy process. This issue ties closely back to the question of discounting precisely because the outputs of the models are so sensitive to discount rates. If one is already concerned that models make extreme simplifying assumptions that call their worth into serious question (such as arbitrary decisions about the damage function, for example), this concern will be greatly amplified by the fact that choice of discount rate can serve to exaggerate already questionable modeling assumptions.

Highlighting the import of model heterogeneity and policy relevance suggests that we might make some progress by reframing the debate about discount rates for "climate policy" in terms of the following four particular questions:

1. What does a particular model purport to discount?
2. Which type of model should one use?
3. How should one integrate the results of a model into the broader policy space? (And a necessarily included sub-question: should such models play *any* role in policymaking?)
4. How should one take account of design and implementation decisions when making determinations about discount rates?

I divide the discussion in this Paper into two parts, styled "Disagreement" and "Design." Broadly, the section entitled "Disagreement"

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[23] *Id.* at 87.
[24] *Id.* at 91.

is related to the first three questions above. The main focus will be on the first question, with respect to which I suggest that a substantial amount of current disagreement can be reduced if we are simply mindful of what a particular model is actually discounting. My premise here is simply that *within* a particular model, one should be true to the assumptions and framework of that particular model. Regarding the second and third questions, my basic suggestion is that a range of current disagreement in these debates, which is nominally about choice of discount rate, can better be understood as disagreement over model choice and integration of model outputs into a broader policy space. I do not undertake those particular substantive inquiries in this Paper, as these questions raise more general issues which cut across the debates regarding discounting.[25] My point is simply that a debate over the parameters and tradeoffs with respect to model choice and the policy relevance of models is likely to be more productive than an abstracted debate about discount rates for climate policy. In particular, such a debate will push towards a holistic policymaking process for which the relevant tradeoffs are explicit and in which there is space for competing views to urge consideration of a preferred model type or a preferred method of incorporating model outcomes with other policy inputs. These are less controversial issues for the simple reason that nobody maintains that any single model in existence comes anywhere remotely close to comprehensively capturing all relevant variables. Similarly, nobody really contends that climate policy should be wholly dictated by the outputs of mathematical models without consideration of broader political and distributional concerns.

Regarding "Design," I seek to focus attention on how questions of program design should be considered alongside questions of discounting. This hopefully will further narrow the range of appropriate discount rates. This sort of *simultaneous* consideration of discount rate and program design has not played a prominent role so far in discussions of climate policy and discount rate. Some might even consider such joint consideration as somehow inappropriate because it is conceptually backwards. But, I consider the serial consideration of discount rate and program design (i.e., treating the derivation of a discount rate as a conceptual exercise disembodied from actual program detail) to be an unfortunate and contingent artifact of the intellectual history surrounding debates on an even

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[25] For a discussion of the issues related to the incorporation of IAMs into the overall assessment of policy, see Edward A. Parson & Karen Fisher-Vanden, *Integrated Assessment Models of Global Climate Change*, 22 ANN. REV. ENERGY ENV. 589, 618–20 (1997).

broader set of foundational questions. Thus, most resources on the question of discount rate find their roots either in highly abstracted treatments in the economics literature on optimal growth theory and optimal provision of public goods or in highly abstracted treatments in philosophy dealing with moral questions of intergenerational obligation. Of late, these somewhat ancient debates have resurfaced as scholars attempt to calibrate a justified response to climate change. In carrying out that application, scholars have focused on a number of characteristic (though still highly abstract) features of the problem: it is large; it is international; it covers very long time spans.[26] With consideration of these factors, one is meant to be able to use cost-benefit analysis to get some sense of the scale of the problem, how much we should spend, and how fast.[27] That analysis, of course, is deeply reliant upon a chosen approach to discounting. Note crucially that under such an approach the analysis is independent of the details surrounding program implementation. My premise is that some of the important factors that drive disagreement among proponents of divergent discount rates are themselves related to questions of program design.

This is true particularly where climate policy involves implementation of market mechanisms such as a carbon tax or a permit trading scheme so as to fully internalize the social costs of greenhouse gas emissions. Here, I suggest that one should think about issues of finance and issues regarding the method of establishing a carbon price as one considers the cost-benefit analysis. As we shall see, such issues of program design are at issue through embedded assumptions in choice of discount rate. By clarifying the relevance of these assumptions, hopefully, one can again shrink the amount of disagreement over discount rates.

I. DISAGREEMENT

A. Two Margins of Disagreement

As mentioned in the introduction, the range of discount rates defended by economists who model climate change appears to fall in the range of approximately 1% to approximately 6%.[28] To understand what drives this diversity of opinion, and hopefully move towards a consensus view on a smaller range of acceptable discount rates, I begin by attempting

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[26] *See, e.g.*, Stern, *supra* note 5, at 2.
[27] *Id.*
[28] *Id.* at 13.

to clarify the nature of disagreement about different approaches to discounting. Prominent scholars have undertaken related exercises in a range of work over the years. One of the earliest such treatments specific to the climate change context appears in the work of Kenneth Arrow, where the author drew a basic distinction between "descriptive" versus "prescriptive" discounting.[29] Other similar exercises draw a range of various distinctions in an attempt to shed light on these debates: ethicists versus positivists, money versus utility, allocation versus distribution.[30] The disputes surrounding these issues have been described as having a "ships passing in the night" character.[31] The suggestion would seem to be that various commentators are using discount rates to accomplish different tasks and, if we are just a bit clearer about which question is on the table, there will be greater agreement about how to set the discount rate appropriate to the task at hand. I am not so sanguine, because I believe there to be underlying fundamental disagreements about which question *should* be on the table in the first place. Even so, as a first step it is very useful to have a basic taxonomy in hand of the different positions asserted by various parties. There is a lot of different terminology floating around in these debates. My initial suggestion is that we can make some progress in understanding the nature of the disagreement by taking account of the *functional* aspect of two distinct margins. We can then map various positions and distinctions onto this framework.

Functionally (that is, stripped of all the various terminological baggage), we have one question about *what* we are discounting with the discount rate, and we have a second question about *how* we determine the discount rate. Now, consider each of these axes in greater detail. On the question of *what*, observe first that all discount rates provide a way to compare future costs and benefits with current ones.[32] But which costs and benefits? Within the *private* sector, that question admits two straightforward answers. First, from the standpoint of consumption, the issue is the relative value of future versus present consumption. If a representative consumer is indifferent between $100 of current consumption and $110 of future consumption, this implies a discount rate (for consumption)

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[29] *See* Arrow et al., *supra* note 6, at 131–32.
[30] *See* Weisbach & Sunstein, *supra* note 1, at 435–36; Louis Kaplow, *Discounting Dollars, Discounting Lives: Intergenerational Distributive Justice and Efficiency*, 74 U. CHI. L. REV. 79, 99 (2007).
[31] Louis Kaplow et al., *The Social Evaluation of Intergenerational Policies and Its Application to Integrated Assessment Models of Climate Change*, 10 B.E. J. ECON. ANALYSIS & POL'Y 1, 27 (2010).
[32] *Id.* at 2.

of 10%. Thus, if the consumer happens to defer $x of current consumption for something less than future consumption of $1.10x, then the consumer will be worse off than with current consumption. Second, from the standpoint of production, the issue is one of opportunity costs or the return on competing uses of capital. If a representative producer's best investment on the margin entails a $100 capital investment for a return of $110 in the future, this implies a discount rate (for production) of 10%. If the producer happens to invest $x of capital in a marginal investment that returns less than $1.10x, then the producer is worse off than it could have been by choosing an alternate marginal investment.

But of course we are not operating in the private sector. The government faces a more complex problem, as it must decide not only among competing uses of funds, but also whether funds should be deployed through the public, rather than private, sector in the first place. Thus, we are in search of a discount rate the government should apply (that is, a *social discount rate*) when determining whether to raise funds (either through current taxes or current borrowing and future taxes) and spend such funds on a certain use. This raises the question whether we should think of the government functioning like a representative consumer or producer. If the government raises a marginal dollar (say through taxation) and that dollar would have been consumed if it had been left in the private sector, then it would seem appropriate for the government to take the stance of a representative consumer. Conversely, if that marginal dollar would have been invested in the private sector, then it would seem appropriate for the government to take the stance of a representative producer.

This brings us to the second axis—the question of *how*. I will follow Arrow's basic distinction between the prescriptive and the descriptive.[33] These are not perhaps the best terms. As we shall see, certain "descriptive" approaches may embed non-empirical value judgments and certain "prescriptive" approaches may have an empirical flavor. For now, though, we should have in mind the basic idea that "descriptive" approaches begin with an observation of market behavior (on either the producer or consumer side) and then contemplate possible adjustments to such baseline.[34] Conversely, "prescriptive" approaches reject that the appropriate starting point is the observation of market rates.[35]

We can now synthesize the above discussion of *what* is being discounted and *how* the discount rate is to be determined. Consider the family

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[33] *See* Arrow et al., *supra* note 6, at 131–32.
[34] *Id.* at 129.
[35] *Id.*

of descriptive approaches first. As applied to consumption, the consumer interest rate as observed in the market provides a measure of the price that savers demand to defer consumption. Such price may be demanded either because of some pure time preference or because of myopic considerations. Whatever the underlying causes, we can think of this as capturing market realities about the supply of capital from savers. As applied to production, the producer interest rate describes the parallel phenomenon on the production side and allows one to describe the demand for capital in the market.[36] As is well understood, in a perfectly competitive market with no distortions, supply and demand for capital would be in equilibrium at a single real interest rate.[37] Then the equilibrium consumer interest rate would equal the equilibrium producer interest rate, which should in turn equal the social discount rate.[38] Under real world conditions, especially due to taxes and externalities, there is a wedge between consumer and producer interest rates.[39] This means that, within the bounds of a descriptive approach, one must make some decision about how such divergent rates feed into the social discount rate.[40]

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[36] *Id.* at 138, 141, 308.
[37] *Id.* at 41, 415.
[38] *See* Stern, *supra* note 5, at 13.
[39] *See* Juzhong Zhuang et al., *Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: A Survey*, ERD WORKING PAPER SERIES NO. 94 3 (2007).
[40] This basic point is reflected in the various technical approaches discussed in the social discounting literature. There are four general contenders for approaches to setting the social discount rate: the social rate of time preference (SRTP), the marginal social opportunity cost of capital (SOC), the weighted average approach, and the shadow price of capital (SPC). *Id.* at 3, 4, 9, 10, 12. The SRTP is premised on the claim that government investment wholly displaces consumption and thus should be evaluated based on a discount rate appropriate to discounting consumption. The SRTP can be determined through a descriptive approach (typically by reference to yields on riskless government bonds). *Id.* at 4. The SOC is premised on the claim that government investment wholly displaces private investment and thus should be evaluated at a discount rate appropriate to production. *Id.* at 9. Under a descriptive approach, such rate might be determined by reference to the rate of return on corporate bonds. The weighted average approach is premised on the idea that government investment displaces both consumption and private investment and attempts to reflect the respective displacements in the social discount rate. *Id.* at 10. The rate determined under this approach would lie somewhere between the consumer and producer rates along the descriptive axis. Finally, the SPC approach again is premised on the idea that government investment displaces both consumption and investment, but accounts for the further complication that the proceeds of some government investment will in fact be reinvested rather than consumed in intermediate periods. *Id.* at 12–13. As with the weighted average approach the resultant rate would fall somewhere between the consumer and producer rates along the descriptive axis. For a further discussion of these distinctions, see Zhuang et al., *supra* note 39.

Prescriptive approaches do not begin with observation of market rates. Consider the prescriptive approach to consumption first. The task is not to observe the discount rate from *actual* savings behavior but rather to derive what the discount rate *should* be, premised on some ethical theory. Thus, such an approach would focus not on how much people do save, but on how much they should save. Because the derivation of the discount rate follows some ethical theory, there is no single correct approach. The approach, rather, depends on one's chosen theory. One leading approach follows Ramsey's optimal growth model.[41] Ramsey set out to analyze the optimal amount of savings (and, by implication, consumption) for a society.[42] He based his analysis not on actual savings rates, which would determine consumer interest rates under a descriptive approach, but rather on what aggregate savings should be to satisfy his specified welfare criterion.[43] Our final possibility—the prescriptive approach to the production question—is in some ways unique because there is no well-formed theory in existence that takes this approach and produces some bottom line *number* to use as a social discount rate. It is difficult to imagine what such a theory would even look like. By analogy to the optimal growth theory literature, such a theory would have to derive from *a priori* ethical reasoning a minimum return on government investment. We have no such theory. But the conceptual space for a "prescriptive production" approach remains important, as it functions as a negation of the descriptive-production approach. That is, there are important arguments in these debates which do not produce independent social discount rates from a production perspective but that nonetheless reject as legitimate those rates generated by observing producer interest rates in the market. A prominent example of such an approach is captured by arguments for a precautionary principle.[44] The precautionary principle functions as a burden-shifting argument, particularly with respect to non-renewable environmental resources which are taken not to have acceptable renewable market substitutes. It tells us that in the face of uncertainties regarding such resources, a social discount rate based on a descriptive approach (reference to market rates of return) may not alone

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[41] *See* Frank P. Ramsey, *A Mathematical Theory of Saving*, 38 ECON. J. 543 (1928).
[42] *Id.* at 543.
[43] *Id.* at 544–45.
[44] For a recent defense and description of the approach, see DOUGLAS A. KYSAR, REGULATING FROM NOWHERE 2, 11 (2010), *available at* http://isites.harvard.edu/fs/docs/icb.topic526279.files/Kysar%20Regulating%20from%20Nowhere%20Chapters.pdf.

warrant undertaking a certain course. We can summarize the various possibilities in the following chart:

	Consumption	**Production**
Descriptive	Market Consumer Interest Rate	Market Producer Interest Rate
Prescriptive	*e.g.*, Optimal Growth Model	*e.g.*, Precautionary Principle

I would emphasize three basic points at the outset, all to be elaborated in the pages to come. First, I take it as given that there is some type of *fundamental* disagreement along the descriptive-prescriptive axis both with respect to consumption and production.[45] The nature of the disagreements here run very deep, as they relate to the propriety of using the market to allocate and distribute across space and across time.[46] No amount of line-drawing, conceptual clarification, or argumentation is likely to break through this type of disagreement. Second, the nature of dispute along the consumption-production axis is much more pliable. It is one of the key claims of this Paper that one *must* make the determination about that axis with reference to the particular details of the IAM under consideration. Prior treatments in the literature that deal with discounting generally for climate change do not typically make this distinction.[47] Third, once one has identified the proper place along the consumption-production axis, the particular features that make climate policy distinctive (and fuel some of the fundamental disagreement along the descriptive/prescriptive

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[45] *See infra* note 47.

[46] *Id.*

[47] An important recent paper in the area is Richard L. Revesz & Matthew R. Shahabian, *Climate Change and Future Generations*, 84 S. CAL. L. REV. 1097 (2011). Revesz and Shahabian distinguish among four types of discounting, which are consistent with the taxonomy introduced in the text. *Id.* at 1101. Thus what the authors label "prescriptive pure time preference" discounting is tantamount to what I label as the prescriptive-consumption cell. Similarly, "growth" discounting is also subsumed within the prescriptive-consumption cell, as it relates to the general issue of how future growth relates to optimal consumption and savings. "Descriptive pure time preference" discounting is tantamount to what I label the descriptive-consumption cell. "Opportunity cost" discounting is tantamount to what I label the descriptive-production cell. The authors level a range of critiques of "opportunity cost" discounting. *Id.* at 1144–54. These critiques occupy the conceptual space of what I call the prescriptive-consumption cell. The Paper does not, however, draw distinctions regarding the way the different approaches to discounting relate to different IAMs or inform one about how to go about choosing a particular discount rate to use in any given model. *Id.*

axis) should inform the approach to discounting *within* one's preferred approach. Further, one can also make progress towards consensus with respect to this axis by focusing on issues of program design and implementation. That is, I hold out for the prospect of moving in the direction of some greater consensus *without* calling for various proponents of descriptive or prescriptive positions to jump ship to the other side, which would run counter to the basic supposition of fundamental disagreement across that divide. As a general matter, these points will put downward pressure on the discount rates generally defended by descriptivists and upward pressure on discount rates defended by prescriptivists.

We can use this basic framework to understand why the approach here can hopefully move us somewhat beyond the current state of affairs. A number of prominent scholars have attempted to cut through the seeming confusion and disagreement surrounding the choice of discount rate for climate policy.[48] These efforts have not, regrettably, brought the issue towards any type of resolution. Indeed, quite to the contrary. For these purposes, one can distinguish two broad types of approaches, under which proponents arrive at essentially opposite points on the spectrum of potential discount rates. One type of approach seeks to advance matters by bracketing contentious ethical issues about intergenerational distribution of resources. The other type of approach takes consideration of such ethical issues to be unavoidable.

An important example of the former type of approach appears in a recent paper by Cass Sunstein and David Weisbach.[49] Their analysis is based upon the delineation of two key camps in the discounting debates, whom they call "positivists" and the "ethicists."[50] Mapping this distinction onto Arrow's terminology, the positivists are essentially descriptivists and ethicists are essentially prescriptivists. Drawing this distinction was meant to bring greater clarity to our understanding of the disagreements taking place in these debates.[51] I take it that the key contribution in this paper is not the mere delineation of the positive and the ethical (or the descriptive from the prescriptive), which was a distinction that was already well understood in the literature.[52] Rather, the crux of the argument depends upon an explicit pairing of the "positivists" with questions of asset allocation

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[48] *See, e.g.*, *id.*
[49] Weisbach & Sunstein, *supra* note 1.
[50] *Id.* at 435–36.
[51] *See id.* at 436.
[52] Arrow had already drawn this distinction in his paper for the IPCC in 1995. *See* Arrow et al., *supra* note 6.

and the pairing of the "ethicists" with questions of intergenerational distribution.[53] As applied to climate policy, the basic claim, then, is something like the following: because climate policy involves a severable issue of asset allocation, one should apply market discount rates in setting policy. Thus, there is the claim of the authors that the "positivists are largely correct."[54] They are only "largely" correct, though, because the severable issue of distribution (the proper concern of the ethicists) can and should be dealt with elsewhere in the system.[55] The import of severability, of course, is that the distribution question is deeply difficult and contested.[56] Under this approach, though, we can treat the allocation question as analytically prior and address it through reliance on market discount rates without having already addressed the contentious distributional issues.[57]

A prime example of the diametrically opposed approach appears in the work of Douglas Kysar.[58] On Kysar's account, one *cannot* bracket the issue of intergenerational distribution, which is fundamentally ethical in nature and analytically prior to the question of allocation.[59] This means that one cannot resolve issues about intergenerational use of environmental resources (including those relevant to climate change) through resort to a discount rate. To be sure, whatever resolution we come to through ethical analysis will *imply* some discount rate. But that discount rate, in essence, would drop out of the picture after the fact and therefore is doing no independent analytical work.[60] This approach, though hostile to the idea that discount rates can be used to solve problems of intergenerational resource allocation, does preserve space for consideration of

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[53] *See* Weisbach & Sunstein, *supra* note 1, at 437 ("That is, the ethicists are concerned with distribution, and the positivists are concerned with efficiency.").
[54] *Id.* at 456.
[55] *See id.* at 436–38, 456–57.
[56] *See, e.g.*, *id.*
[57] This strategy of separating distributional questions from efficiency questions in the climate context is a particular manifestation of a general approach that has been applied to a range of questions in public economics. *See* LOUIS KAPLOW, THE THEORY OF TAXATION AND PUBLIC ECONOMICS 3–4 (2008) (describing a general research approach of analyzing policy instruments under an assumption of distribution neutrality and revenue neutrality in order to isolate efficiency effects).
[58] KYSAR, *supra* note 44.
[59] *Id.* at 166 ("We must therefore address the baseline distribution of resources across generations *first*, before inter-generational efficiency analysis can even begin to get off the ground. Our failure to perceive this need—our belief instead that the current market equilibrium somehow reflects a normatively privileged moment even with respect to the unborn—is indefensible.").
[60] *Id.* at 167.

opportunity costs, which themselves are generally captured through the use of discount rates. Again, though, discounting for opportunity costs can only play a role after one has already addressed the ethical question of intergenerational distribution.[61]

It is difficult to see where exactly one is to go from here, with so little common ground between these stated positions, one of which seeks to completely ignore the set of distributional issues that the counter position takes to be central to the entire analysis. That is, however, the basic challenge of this Paper. I begin by observing that each of the extreme views described above is problematic, though not necessarily in the way argued by the counter-position.

Consider first the bracketing approach, as embodied in the ethicist/positivist distinction. As noted above, the bracketing approach is premised on one type of approach to discounting (descriptive) being associated with questions of allocation, while another approach to discounting (prescriptive) is associated with questions of distribution.[62] Bracketing is supposed to make life (relatively) easy because choosing pareto superior allocations (or at least potentially pareto superior allocations assuming sufficient transfers) is not supposed to invite difficult ethical questions.[63] One basic problem with this, however, is that focusing on these "descriptive-allocation" and "prescriptive-distribution" dyads unduly truncates, or at least obscures, the full range of opinions voiced in the climate change and discounting debates. To begin, observe that allocation versus distribution here are just the same thing as the production versus consumption axis. The idea that one should focus on allocation is a claim about production efficiency. These allocations can be strictly preferred on the grounds that everybody can be made better off *with* compensating transfers (that is, with the assumption that nobody's consumption has gone down). Thus, in terms of the framework introduced above, the basic ethicist/positivist divide would seem to focus attention on the descriptive-production cell versus the prescriptive-consumption cell. This is unsatisfactory for the simple reason that it ignores, by definitional setup, important positions that need to be taken into account. As we have seen, one must at least acknowledge the conceptual space for the prescriptive-production position, which asserts that the market fails to give us adequate information about certain goods,

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[61] *Id.* at 171–72 ("[Opportunity costs, however, should not be compounded mechanically into a welfare-maximization exercise, at least not without first asking certain foundational questions regarding intergenerational environmental equity.").
[62] *See* Weisbach & Sunstein, *supra* note 1, at 436–37.
[63] *See* KYSAR, *supra* note 44, at 168.

particularly important non-renewable environmental goods that are not traded on the market.[64] The government thus requires other criteria besides market indicators to determine what level of resources to devote to their preservation. For proponents of such a view, it should be true *irrespective* of effects on aggregate savings and thus is conceptually distinct from the consumption axis. Likewise, one must take account of the descriptive-consumption pairing. Indeed, this is particularly important with respect to the question of whether we make any progress by bracketing ethical considerations, because I believe it is a sharply disputed question whether the "descriptive" approach here does allow for such bracketing. Methodologically, it *begins* with a market interest rate which requires no value judgment to determine.[65] But, the very use of such a rate with respect to questions of consumption implicates an ethical problem, at least in the view of some scholars, because the observed market rate regarding current consumption embeds a (necessarily ethical) choice about how much we are *not* consuming, that is, saving for future generations.[66]

The bottom line here is that a simple collapsing of opinion into the "descriptive-allocation" versus "prescriptive-distribution" taxonomy will inevitably be unsatisfactory because it fails to take account of important viewpoints and arguments. To move matters forward, it will be more advantageous to take account of the full range of opinion, and in particular to inquire how that range of opinion maps onto the range of IAMs under consideration.

The extreme view espoused by Kysar is also problematic. As noted above, his approach is generally hostile to the use of discount rates as an independent determinant of the content of climate policy.[67] Although opportunity costs are not to be ignored, Kysar asserts that they "should not be compounded mechanically into a welfare-maximization exercise, at least not without first asking certain foundational questions regarding intergenerational environmental equity."[68] Instead, one should view the problem as part of a pluralistic assessment, with opportunity costs playing only a part of the analysis.[69] But, this raises a fairly concrete conundrum: what should an adherent to this view do when asked to evaluate a welfare maximization model that incorporates a term for a discount rate? Broadly, there would seem to be two choices. One could simply refuse the

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[64] *See id.* at 165–66.
[65] *See id.* at 172.
[66] *See id.*
[67] *See id.*
[68] *See id.* at 171–172.
[69] *See* KYSAR, *supra* note 44, at 172.

question, rejecting that such models are a relevant or useful aspect of the policy space. Or, one could attempt to evaluate the model, keeping in mind that the implications of the model would have to be balanced with a broader range of policy inputs in an overall pluralistic assessment.

I believe one can state a good case that the better course here is to at least attempt to evaluate the model.[70] That argument comes by analogy to a powerful argument made by Richard Revesz and Michael Livermore regarding the application of cost benefit analysis in the domestic regulatory context.[71] Revesz and Livermore argue persuasively that when groups have refused to engage in cost benefit analysis on the grounds of perceived fundamental deficiencies in the approach, the unfortunate result has been lopsided policy, tending to favor industry interests over that of environmental preservation.[72] They advocate instead for an enlightened application of cost benefit analysis under which critics work *within* the framework, applying sound economic argument to address the perceived deficiencies.[73] One could well make the same case here. To be sure, the application of IAMs with reference to climate policy is importantly different from traditional domestic project-based CBA. In this context, we have no single agency that is charged with the power of implementing, or not, a comprehensive climate program which must pass a cost-benefit test. It is thus important not to lose sight of the broader context. There are numerous IAMs floating around, created by a range of academic and governmental bodies, making numerous different modeling decisions that produce very different results.[74] The way in which the results of these models ultimately feed into the policymaking process is amorphous and somewhat arbitrary.[75]

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[70] Note that prominent voices, such as Nicholas Stern, who make important use of IAMs to produce policy recommendations, have stated firmly that they should be mere supplement to other decision methods better suited to handle the risk characteristics of the problem. *See* Stern, *supra* note 5, at 12.

[71] RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY: HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH 12–13 (2008).

[72] *Id.* at 10–11.

[73] *Id.* at 18–19.

[74] *See, e.g.*, Nicola Cantore, *The Relevance of Climate Change Integrated Assessment Models in Policy Design*, OVERSEAS DEVELOPMENT INSTITUTE BACKGROUND NOTES 2 (2009), http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/5060.pdf.

[75] For example, current United States regulatory policy determines the social cost of carbon for regulations with marginal impact, in part, by simply averaging outputs of three prominent IAMs. *See* INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, TECHNICAL SUPPORT DOCUMENT—SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS—UNDER EXECUTIVE ORDER 12866 (2010). Clearly, there are many other ways one could take account of the range of outcomes in various different outcomes under IAMs. For a

Even so, I believe that there is much to learn from Revesz's and Livermore's analysis of CBA in the domestic context. Whatever their detriments, the reality of the matter is that it is to be expected that IAMs will play at least some role in the creation of climate policy in the years to come. Policymakers will continue to demand *some* quantitative tool to assist in decision-making and they will reasonably turn to IAMs, notwithstanding their defects, to help with the task. Autonomous researchers who have spent years (or decades) developing these models can be expected to continue fine tuning them and channeling the results to policymakers. But all of this will require some approach to choosing a particular discount rate appropriate to a given model. It is not at all clear, though, how a scholar such as Kysar would approach that problem. Surely his nod to acknowledging the role of opportunity costs cannot mean anything like incorporating market discount rates into a welfare maximization model, as that is the precise position that is under attack.[76] But, then, where to look?

Again, to move matters forward, I will attempt an answer to that question. The goal will be to consider how the views of "prescriptivists" should affect the setting of a social discount rate incorporated into a model, particularly when taking account of the different types of IAM that might be under consideration. This is not to say that the output of any IAM should solely determine policy. It is only to attempt to move in the direction of consensus about an acceptable discount rate, on the plausible assumption that economists will continue to run IAMs and policymakers will continue to pay at least some attention to the results.

B. Two Types of Models

IAMs form a coherent modeling category insofar as all IAMs share an interdisciplinary character, bringing together scientific and socioeconomic aspects of climate change within a single model.[77] Beyond the shared interdisciplinary character, though, the models do not constitute a homogenous phenomenon. Rather, they manifest a substantial degree of variation, representing a multitude of different decisions adopted by their creators.[78]

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general critique of this interagency document, see Jonathan S. Masur & Eric A. Posner, *Climate Regulation and the Limits of Cost-Benefit Analysis*, 99 CAL. L. REV. 1557 (2011).

[76] *See generally* REVESZ & LIVERMORE, *supra* note 71.

[77] *See* J. P. Weyant et al., *Integrated Assessment of Climate Change: An Overview and Comparison of Approaches and Results*, *in* CLIMATE CHANGE 1995: ECONOMIC AND SOCIAL DIMENSIONS OF CLIMATE CHANGE 367, 377 (James P. Bruce et al. eds., 1996).

[78] *Id.*

Such variation across the models has played almost no role in the existing discussions of discounting and climate policy.

As a first step, we can begin by drawing a basic distinction between so-called policy evaluation IAMs and optimization IAMs. The former type of model allows one to assess the merits of a single exogenously specified policy.[79] For example, that policy could take the form of a particular greenhouse gas emissions path.[80] The model would then predict climate effects based on such emissions, and ultimately the impact of such climate effects. There are many ways one can represent the impacts of climate change, and different models take different approaches with respect to regional subdivisions, sector, and underlying metrics.[81] For example, regarding regional analysis, models might focus on particular geographically contiguous regions, particular countries, or particular latitude bands. Regarding sector, models might focus on impacts regarding matters such as agriculture, water, forestry, or health. Finally, regarding metrics, policy models may resort to either monetary measures or measures in terms of direct biophysical impact. The output of such models can thus be quite varied. For a given emissions path, such a model might predict effects on increased flooding in India, on the predicted effects on crop yields within a given geographical area, or predicted monetary effects in Latin America.[82]

To sharpen the role of discounting in policy evaluation IAMs, it will be instructive to consider a particular example of such a model. Consider, then, the role of discounting in IMAGE, which has been developed at the National Institute for Public Health and the Environment and continued at the Netherlands Environmental Assessment Agency.[83] In a series of runs IMAGE has been used to predict abatement costs required to achieve stabilization of greenhouse gas concentrations at different levels.[84] Thus, one could begin with the policy goal of achieving stabilization at, say, 650 ppm (parts per million) CO_2-equivalent. With

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[79] *See, e.g.*, David L. Kelly & Charles D. Kolstad, *Integrated Assessment Models for Climate Change Control, in* INTERNATIONAL YEARBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 1999/2000: A SURVEY OF CURRENT ISSUES 4 (Henk Folmer & Tom Tietenberg eds., 1999) ("Policy evaluation IAMs . . . consider the effect of a single policy option . . . on the biosphere, climate, and sometimes economic systems.").

[80] *Id.* at 2.

[81] *Id.* at 6.

[82] *See, e.g.*, NETHERLANDS ENVIRONMENTAL ASSESSMENT AGENCY, INTEGRATED MODELING OF GLOBAL ENVIRONMENTAL CHANGE: AN OVERVIEW OF IMAGE 2.4 7–16 (A.F. Bouwman et al. eds., 2006) (describing regional breakdown in model and various parameter inputs and outputs).

[83] *Id.* at 5.

[84] *Id.* at 57.

that input, the model would generate a series of estimated abatement costs.[85] One could then run the model with an exogenously specified policy goal of stabilization at 450 ppm CO_2-equivalent, in which case the model generates a different series of predicted abatement costs.[86] A policymaker could use such outputs to conduct an exercise that looks much like standard project-based CBA. Thus, the policymaker could take the stream of abatement costs and discount these to present value.[87] Reducing the benefits from adoption of any such policy to a monetary amount that can be compared to the costs of abatement is no simple matter. Even so, one can see how the basic approach resembles traditional project-based CBA. IMAGE, for example, has been used to estimate the relative difference in risk of exceeding an exogenously specified two-degree (Celsius) global temperature increase under different stabilization scenarios.[88] Thus, the model has predicted that the probability of meeting a two-degree increase target increases from a 0–18% range to a 22%–73% range, as the stabilization goal decreases from 650 ppm to 450 ppm.[89] These are obviously wide ranges (indicative of the broader uncertainties in modeling here), but in principle one could establish an aggregate willingness to pay for such risk reduction and then compare such benefit to the predicted costs of abatement under a typical cost-benefit type of analysis. The use of policy evaluation IAMs also fits squarely within the frame of traditional CBA where the model outputs are stated in terms of direct biophysical impacts.[90] Thus, one could attempt to monetize the biophysical impact of taking some policy course (like atmospheric stabilization at a given level) as compared to doing nothing. Such monetized impacts could be discounted to present value to produce a monetary measure of the benefits of taking the particular action.

By way of contrast, consider now the concept of discounting at issue in the optimization IAMs. Such models do *not* begin with an exogenously specified policy goal, such as stabilization of atmospheric greenhouse gas concentrations.[91] Rather, they assess a range of possible emissions paths in the search for an optimal one.[92] Consider, for instance, the DICE model,

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[85] *Id.*
[86] *Id.*
[87] In the case of IMAGE, the NEAA has applied a 5% discount rate, though without explicit justification of that number. *Id.* at 58.
[88] *See* NETHERLANDS ENVIRONMENTAL ASSESSMENT AGENCY, *supra* note 82, at 58.
[89] *Id.*
[90] *See* Füssel, *supra* note 17, at 290.
[91] *See* Kelly & Kolstad, *supra* note 79, at 4.
[92] *Id.*

which has played prominently in the discounting debates.[93] The model is structured such that, in each period, global income can be used in one of three ways: current consumption, investments in abatement, or investments in other capital.[94] Depending on the breakdown of such use over time, one generates a wide array of different possible consumption streams over time.[95] The "optimal" path is the one that maximizes welfare under some specified social welfare function.[96] In order to evaluate the social welfare function, one must make *some* decision about how consumption arising in different times differentially affects welfare. That is, one must take some position on the appropriate discount rate (which could be zero) to apply to future consumption.

Although both policy evaluation IAMs and optimization IAMs face the problem of relative valuations across time—and invoke some notion of discounting to deal with the problem—the above discussion hopefully demonstrates that the two types of model use discounting in very different ways.[97] To call upon a basic distinction mentioned above, the *core* role of discounting within context of policy evaluation IAMs is to resolve questions of allocation—about whether the evaluated policy is a good use of resources or rather is an inferior use of resources compared to some alternative embodied in the discount rate.[98] Conversely, the *core* role of discounting within the context of optimization IAMs is to resolve questions of distribution—about how the distribution of aggregate consumption through time produces more or less total well-being.[99] Admittedly, the fact that these are the core concerns for these classes of models does not mean there are no broader implications. Indeed, it is the clouded relationship between what is going on at the core and such broader implications that explains much of the fundamental disagreement between descriptivists and prescriptivists in various cases. I turn to an extended discussion of precisely this issue in the next two parts. Before taking up that discussion, however, it will be instructive to highlight what is going on at the core through the presentation of a couple of simple numerical examples. These are highly stylized, but draw, nonetheless, the important differences between the models effectively.

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[93] *See* Hope, *supra* note 9, at 97.
[94] For a brief description of the model, see *id.*
[95] *See* Kelly & Kolstad, *supra* note 79, at 5.
[96] *See id.* at 4.
[97] Weisbach & Sunstein, *supra* note 1, at 434.
[98] *See id.* at 435–36.
[99] *See id.* at 436.

Consider a hypothetical policy evaluation IAM framework under which one might face a problem involving, say, a $100*x* abatement cost in period 1 yielding a $120*x* benefit in period 5. Is this a good policy? It depends on the assumed discount rate. The relevant valuations, assuming a range of discount rates from 0% to 6%, appear in Table 1 below (in *x* dollars, rounded to nearest dollar).[100]

TABLE 1

Net Present Value	Discount Rate
20	0
15	1%
11	2%
6	3%
2	4%
0	**~4.66%**
(1)	5%
(5)	6%

Under a standard cost-benefit approach the policy should be accepted with an assumed discount rate below approximately 4.66% and rejected with a discount rate above such level. Here, the meaning of the discount rate, of course, is that there are alternative investment opportunities in the economy at the specified rate. Suppose that the proposed policy was undertaken here on the basis of a 4% discount rate when the correct rate in fact would have been 5%. In that case, it would have been better to have allocated resources to the investment yielding 5%. Under the alternative investment, the "pie" would have been larger (by $*x*) and, assuming compensating transfers, everybody can be made better off. This is all obvious and has been noted a thousand times before. The point of the example, though, is to stand in contrast with the problem under consideration in optimization IAMs.

Consider, then, a hypothetical in which an optimization model produces two possible aggregate consumption streams.[101] Stream 1 is premised

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[100] The numbers in the table are calculated using the standard formula for the present value of a sum, *x*, received in future with *n* periods of compounding and discount rate of *i*: $x/(1+i)n$. *Id.* The net present value here is thus simply: $(120x/(1+i)5)-100x$.

[101] This is obviously for illustrative purposes only. In reality, an optimization model would consider many, many streams, rather than a small number of discontinuous streams. Even

on current sacrifice to reap some future benefit and takes the following values over five periods: \$50*x*, \$50*x*, \$50*x*, \$50*x*, \$150*x*. Stream 2 is premised on greater consumption at the outset, but at the cost of continued reduced consumption until the end of time.[102] It has the following values: \$99*x*, \$60*x*, \$60*x*, \$60*x*, \$60*x*. Which stream is better? If one were constructing an optimization model, how would one even structure the model to select the "right" answer? This is again a function of the assumed discount rate. Consider how the streams look in present value terms under different discount rate assumptions (in *x* dollars).[103]

TABLE 2

Present Value of Stream 1	**Present Value of Stream 2**	**Discount Rate**
350	339	0
338	330	1%
326	321	2%
315	313	3%
305	**305**	**4%**
295	297	5%
285	290	6%

so, this simple example will serve to draw the basic distinction between the way in which optimization and evaluation IAMs use discounting.

[102] I ignore here the complication of how to deal with the question of how to determine when or how consumption actually ends for good. Optimization models have made similar assumptions for computational convenience. With positive discount rates, periods far out into the future essentially take on such little value that they can be ignored. With a zero discount rate, the value of future consumption greatly outweighs current consumption in a long-lived world, giving rise to well known paradoxes in the discounting literature. *See* Tyler Cowen & Derek Parfit, *Against the Social Discount Rate*, *in* JUSTICE BETWEEN AGE GROUPS AND GENERATIONS 144, 148–49 (Peter Lasett & James S. Fishkin eds., 1992).

[103] There are difficult issues here lying (barely) below the surface regarding the relationship among dollar measures of consumption, individual utility, and social welfare. Within a welfarist framework, we would care here at bottom about welfare and not dollars. *See generally* J. Riley, *Generalized Social Welfare Functionals: Welfarism, Morality, and Liberty*, 3 SOC. CHOICE & WELFARE 233 (1986). I return below to a discussion of how some of these factors feed into various disagreements between market discounters and social discounters. *See infra*, note 128. For present purposes, we can put these issues to the side. The point is just to show a simple example of how the model is addressing distribution over time (whether measured in dollar consumption or the welfare effects of such consumption). The numbers in the table reflect the sum of present value of the amounts, *x*, in the stream, each calculated using the standard formula: $x/(1+i)n$. *See* Weisbach & Sunstein, *supra* note 1, at 436.

We should note a couple of things here. First, as above, the bottom line conclusion changes as the interest rate increases. Below a 4% discount rate, stream 1 looks preferable, but above a 4% discount rate, stream 2 appears to dominate. Recall that stream 1 is relatively future-regarding and stream 2 is relatively present-regarding. If we erroneously choose a course that yields stream 1 in a world where the discount rate should be 5%, the meaning of the error is plainly *not* that choosing stream 2 would have made the "pie" bigger and with compensating transfers to the future, everybody is better off. By definition, there is *no* conceptual space for compensating transfers, as we are already evaluating different streams of aggregate consumption.[104] Switching to stream 2 just is what it is—a choice to distribute the aggregate potential consumption stream in just that way specified by that stream. Thus, the meaning of erroneously applying a 5% discount rate in this case is not about misallocating resources. If there is error, the meaning is that we have given undue distributional weight to the future, yielding less total welfare (for an assumed social welfare function) than would have been achieved under the alternate path.

With these basics in place regarding the differential roles, at the core, of policy evaluation models versus optimization models, I turn now to a discussion of what I take to be fundamental versus non-fundamental disagreement in these two cases.

C. Towards a Consensus Range in Policy Evaluation Models

In Subsection 1 below, I first explain why the adoption of a policy evaluation model should channel one towards the production end of the consumption-production axis. Next, in Subsection 2, I explain why there is likely to be continued fundamental disagreement between descriptivists and prescriptivists, even within this curtailed decision space. This will tend to favor higher discount rates by descriptivists. In Subsections 3 and 4, however, I discuss a number of factors that should push discount rates acceptable to prescriptivists upwards. Crucially, these points do not require a bridging of the fundamental divide between descriptivists and prescriptivists. These are "concessions" that would be made *within* the preferred discounting framework. This is a central aspect of the consensus-building approach I seek here. In Part D below, I will undertake the parallel analysis

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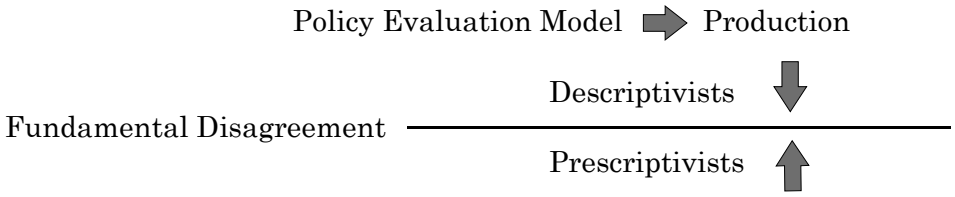
[104] *See* Douglas Kysar, *Discounting on Stilts*, 74 U. CHI. L. REV. 119, 123–24 (2007) [hereinafter *Discounting on Stilts*].

for the case of optimization IAMs. The basic dynamic is captured in the following diagram:



1. Disagreement About Production vs. Consumption: Choice of Model

The detailed discussion of policy evaluation models in Part I.B. was meant to show that these are instruments which, at the core, are about allocation of government resources across various policy alternatives. This fact should naturally push the focus, at least in the first instance, towards the production end of the consumption-production axis. The decision embodied in the discount rate is about whether to devote resources to climate investments or some other productive capacity, with the returns on the alternative captured by the discount rate.[105]

The basic critique of focusing on production here looks something like this: rates of return available on alternative productive uses of capital embed decisions about aggregate savings. That is, the aggregate rate of savings across all types of capital will affect marginal returns to capital. If one makes standard assumptions about declining marginal returns to capital then with greater savings and greater capital stocks, the marginal capital investment will produce a smaller return. On these assumptions, the rate of return on alternate investments is always higher than it would have been in the presence of greater savings. To discount future benefits

[105] This observation does not definitively resolve the question regarding *what* is actually being discounted in such a model. The proper approach to that question would have to consider whether actual enactment of the policy being evaluated would displace consumption, production, or some combination of the two. This issue, however, does not raise questions particular to climate policy. If a government policy which purports to allocate production resources in fact displaces consumption to some extent, then it would be appropriate to take this into account under standard approaches to the social discount rate, such as the weighted average approach. *See supra* note 40. This looks just like what governments do whenever they evaluate policy under discounted CBA. Thus, I put these considerations aside here and focus on what I take to be the factors that might render climate policy distinctive.

at prevailing rates of return on alternate investments is to invite the rejection of projects on the basis of current levels of savings. Further, because climate change is such a large problem, it raises the prospect that current levels of aggregate savings are too low. If that is right, then the desired governmental policy would be to force more savings. That is the same as saying that government policy should be to displace *consumption*—a result generally inconsistent with discounting based on displaced *production* possibilities.[106] For example, suppose observed market rates of return are 5% and that the belief is that they would be some lower rate, *x*%, if aggregate savings were increased by an appropriate amount.[107] The accompanying governmental policy goal would be to force additional savings up until such time as market returns dropped to *x*%. The governmental goal would in effect be to force current people to behave better towards future generations than they are naturally inclined to behave. Discounting at rates above x% would be said to be inconsistent with this.

The typical response to this is that the government should still consider the marginal impacts of its decisions at any given time. This argument has been put forward most forcefully by David Weisbach and Cass Sunstein.[108] Following the numbers above, the claim would be that as the government begins to adopt its forced savings policy it should still choose projects first based on the 5% discount rate. As savings increase and returns decrease, the government should always be choosing projects using the marginal rate. Thus, the core ethical claims are separable: it can be granted that government policy should be structured to drastically increase savings, and yet government investment projects should still be chosen on the margin.

I believe this dispute in some sense blurs disagreements about choice of discount rate for a particular type of model with a different sort

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[106] JOHN BROOME, COUNTING THE COSTS OF GLOBAL WARMING 37 (1992).

[107] We will have to defer for the moment discussion of how such "appropriate" amount might be determined. I return to this below. The reason to use a variable *x* here rather than some assumed arbitrary number is that there is an important debate in the literature about whether one should assume the rate to be zero or something greater than zero. *See, e.g.*, Tyler Cowen, *What Is the Correct Intergenerational Discount Rate?*, GEO. MASON U. CTR. FOR STUDY OF PUB. CHOICE 1, 6 (2001), https://www.gmu.edu/centers/publicchoice/faculty%20pages/Tyler/DISCOUNT.pdf. One might think that, in the absence of any pure time preference, we would observe savings until market rates drop to zero. This is the view of Derek Parfit and Tyler Cowen. *See* Cowen & Parfit, *supra* note 102, at 151. John Broome has argued that this line of analysis is incorrect and that we should treat the equilibrium rate as greater than zero. *See generally* BROOME, *supra* note 106.

[108] *See* Weisbach & Sunstein, *supra* note 1, at 453.

of disagreement about the type of model that one should be using to set policy. Policy evaluation models are marginal constructs.[109] They ask the policymaker to consider the costs and benefits of a particular environmental policy on the margin.[110] In this sense, they look like typical project-based cost benefit analyses and the argument of the descriptivist rehearsed above—make the highest value allocations on the margin first—would seem to run.

The problem, though, is that many have argued that climate change cannot be analyzed as a marginal problem in the vein of typical project-based CBA.[111] Nicholas Stern, for example, has stated in very clear terms that the non-marginal nature of climate change (and the risk involved) requires one to apply CBA using aggregate models and a social welfare function to compare results.[112] In other words, the claim of non-marginality leads to calls to do CBA with a tool like a policy optimization IAM rather than a policy evaluation IAM.

I think Stern has staked out the correct position here. For scholars who view climate change as a non-marginal problem, it will be tempting to reject discount rates based on alternate investments, arguing that such a rate is too high once one considers the embedded savings question. But, this looks like conceptual error. Within the bounds of what the model is asking, a market rate would seem appropriate, since the model purports to be operating on the margin. Further, as we will see below, the non-marginal issue can be dealt with to some extent through proper adjustments in an approach that *begins* with an observed market discount rate. The bottom line, then, is that if a critic really views the non-marginal aspect of climate change as fundamentally inconsistent with discounting at a market rate (with adjustments), this position should best be incorporated within the broader debates about the desirability of evaluation IAMs versus optimization IAMs. That is, these arguments should be considered alongside other considerations weighing in favor of one type of model versus another, such as the tradeoffs between computational complexity and additional fine-grained information at the regional and sectoral levels. If one believes that we are dealing with a non-marginal problem that cannot be dealt with through a model based on a marginal analysis, then the best approach is to call for a different model, rather than to reject reference to discount rates within the contours of a model based on marginal analysis.

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[109] *See* Weyant et al., *supra* note 77, at 371–72.
[110] *See* Stern, *supra* note 5, at 11.
[111] *See id.* at 12.
[112] *See id.*

2. Fundamental Disagreement About the Proper Scope of the Market

If one accepts that the question posed by policy evaluation models is centrally about allocation, then we can understand a fundamental disagreement as arising in cases where prescriptivists reject the use of a market discount rate to perform that allocation. As should be evident from the above discussion, using a descriptive approach to policy evaluation is tantamount to allocating resources based on market valuations of alternate resource use.[113] In order to perform a cost benefit analysis in which one discounts using such a rate, however, one must first accept that it is permissible to state the costs and benefits of the relevant climate policy in dollar terms—that it is permissible, in other words, to make a direct comparison between the environmental goods and services under consideration and other market traded goods.[114] Some scholars in the climate policy debates who reject descriptive approaches make such rejection, at least in part, on the grounds that one does not have such commensurability here.[115] The issue can be seen with particular clarity in the context of policy evaluation models where the model states impacts not in dollar terms in the first instance but rather in terms of direct biophysical impact. Where the impacts are directed to nonrenewable environmental goods, this will make the strongest case for incommensurability. One must acknowledge that these issues are certainly not novel to debates surrounding climate policy. They permeate cost benefit analysis generally and policymakers have had to grapple for many years with converting non-traded goods and services into dollar terms. For example, one common approach to solve this problem is to use survey evidence regarding willingness to pay for certain classes of risk reduction.[116] I have no interest in entering those debates here. I will note only that the incommensurability concerns that have surfaced elsewhere are to some extent supercharged in this context because of the long time spans at issue, the vast uncertainties, and the potential for great catastrophe in the tails of the probability distributions of possible outcomes. Given these characteristics,

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[113] *See* Arrow et al., *supra* note 6, at 132.
[114] *See* Stern, *supra* note 5, at 10.
[115] *See, e.g.*, *Discounting on Stilts*, *supra* note 104, at 134 (rejecting generally monetization of certain goods as precursor to discounting).
[116] For a general discussion of such a "contingent valuation" approach, see Paul R. Portney, *The Contingent Valuation Debate: Why Economists Should Care*, 8 J. ECON. PERSP. 3 (1994).

it seems probable that skeptics of market discounting on incommensurability grounds will remain. To such skeptics, claims that failure to discount at the market rate will leave a smaller pie and everybody worse off will necessarily ring hollow.

3. Adjustments Within the Descriptivist-Production Framework

a. Non-Marginal Aspects of Climate Change

As noted above, one of the key sources of disagreement here is the issue regarding the marginal or non-marginal nature of climate policy.[117] This may be redressed in part through model choice and in part through elements of program design.[118] But such disagreement can also be addressed to some extent through *adjustments* to the market discount rate that take place squarely within the descriptivist-production position. The most important point to observe here is that prominent defenses of the descriptive-production approach both acknowledge the importance of the non-marginal point *and* give the appropriate solution.[119] For example, in a general discussion of discounting (that is not focused on climate change), Kaplow discusses the complication that arises when the choice of government project under consideration will itself affect equilibrium rates of return.[120] If this is the case, then using the pre-adjustment marginal rates will give one the wrong results. In other words, one must assess the opportunity costs in the event that one actually undertakes the project. Accordingly, one should discount cashflows at the *resulting* equilibrium interest rate.[121]

This issue likely arises under some applications of policy evaluation IAMs. We have seen above that such models are marginal constructs in the sense that they do not model aggregate consumption flows for the whole economy.[122] They have conceptual space for compensating transfers and look, to this extent, like typical project-based CBA.[123] However, it is consistent with all of this that some of the actual policies subject to

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[117] Revesz & Shahabian, *supra* note 47, at 1152–53.
[118] Maryse Labriet, *Greenhouse Gas Abatement: Techno-Economic Modeling of Global Cooperative and Non-Cooperative Scenarios*, UNIVERSITÉ DU QUÉBEC À MONTRÉAL 1, 31 (2005), *available at* http://www.iea-etsap.org/web/Applications/THESE_LABRIET.pdf.
[119] Kaplow, *supra* note 30, at 112.
[120] *Id.*
[121] *Id.*
[122] Stern, *supra* note 5, at 17.
[123] *Id.* at 11–12.

evaluation are sufficiently large that they are non-marginal, in the sense that they are big enough to affect equilibrium rates of return. Determining such rates is no simple task and one can anticipate a lot of disagreement about what the equilibrium rate would be. Even so, one can observe that the effects will at least all move in the same direction, thus pushing the defended rate downward, closer to the range likely defended by prescriptivists.

Sunstein and Weisbach, in their recent treatment of these issues, seem to reject this basic point that one should adjust the discount rate downward to reflect resultant interest rates.[124] They do so for two reasons. First, while acknowledging that market rates of return are dependent upon the level of savings, they claim that even if we should be saving more, we should still undertake highest value projects first.[125] In their numerical example (conveniently tracking rates propounded by Nordhaus and Stern), if the current market rate of return is 5.5% and the social discounter thinks it should be 1.4% (based on ethical arguments about intergenerational distribution of resources), then we should still undertake the investment projects yielding 5.5% *first*.[126] But this is just to reject the claims of scholars such as Stern and Broome that climate change is sufficiently large to be non-marginal.[127] What that claim means is that when we are evaluating the climate change "project" we must consider resulting rates of return and discount at that rate, which is very likely to be somewhere between 5.5% and 1.4%. Just because the non-marginal project does not take the equilibrium point all the way down to 1.4%, it still follows from within the commitments of *market* discounters that we use the resulting market discount rate.[128]

b. Externalities

Next, one should consider the role of externalities in this context. Prescriptivists sometimes seem to reject the use of market interest rates because market interest rates fail to take account of the externalities involved in climate change.[129] To discount at market rates where we have

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[124] Weisbach & Sunstein, *supra* note 1, at 456.
[125] *Id.* at 452.
[126] *Id.* at 450.
[127] Stern, *supra* note 5, at 2.
[128] It remains true that *within* the scope of the climate change "project" it will make sense to choose the highest return investments first. But this is more an issue of program design than an issue about choice of governmental discount rate because, within the parameters of any particular program, it may well be possible to leverage the market to get efficient inter-temporal allocation. *See* Kaplow, *supra* note 30, at 112.
[129] *See* Stern, *supra* note 5, at 13.

such an externality in order to determine whether to fix the externality would be circular. To be sure, externalities present a problem, but the descriptivist might well reject the idea that their existence necessitates the complete abandonment of market discount rates. That is perhaps easiest to see in the case of externalities that are thought to be less severe than those involved in climate change. In the case of relatively small externalities, one might say that rather than throwing market discounting overboard, the proper approach would be to make one's best good faith assessment of the social return on marginal investments and then discount at that rate. Just because climate change involves large externalities does not mean it necessarily requires a different approach. It would be defensible rather to attempt an adjustment of market rates of return to take account of the externalities. Some would argue that it is impossible to do this without then assessing costs to future generations, which requires the ethical framework employed in social discounting.[130] Without resolving that debate here, one can observe that, even within the framework of the descriptivist, the effect of externalities is to push the ceiling on the appropriate market rate downward.

c. Uncertainty

The concept of uncertainty also plays a crucial role in the range of discount rates defended by prescriptivists.[131] This is uncertainty in the sense of Frank Knight—that is, a phenomenon that relates to the *unknown* probability distribution in future growth rates.[132] This is different from the riskiness of the displaced private investments, which is supposed to relate to known (or estimated) probability distributions of the returns on the displaced capital investments. The most prominent proponent of reflecting uncertainty in the chosen market discount rate is Martin Weitzman.[133] As Weitzman has shown, taking account of uncertainty can have profound effects on choice of appropriate discount rate in the climate change context.[134] The argument is driven essentially by two factors. First, climate change is a phenomenon that has very low probability and very high costs

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[130] *See, e.g.*, BROOME, *supra* note 106.
[131] Martin L. Weitzman, *Why the Far-Distant Future Should Be Discounted at the Lowest Possible Rate*, 36 J. ENVTL. ECON. & MGMT. 201, 202 (1998) [hereinafter *Lowest Possible Rate*].
[132] FRANK H. KNIGHT, RISK, UNCERTAINTY AND PROFIT 233 (Sentry Press 1964) (1921).
[133] *See Lowest Possible Rate*, *supra* note 131, at 202.
[134] *See id.* at 201.

in the tails of the distribution.[135] This makes the future growth rate of the economy uncertain in the sense just described. Second, Weitzman has argued persuasively that even with a known probability distribution for the discount rate, the force of compounding will cause possible lower discount rates to outweigh the contribution of possible higher discount rates.[136] In bringing these observations to bear on the choice of actual discount rate, Weitzman suggests that a rate of approximately 2%–4% may result.[137]

The derived discount rate under approaches taking countenance of uncertainty are lower than the rates derived under approaches that merely take account of riskiness.[138] A lower discount rate, of course, means that the government should be willing to pay more to undertake a certain project. It is helpful to conceptualize that "extra" amount as insurance. That is, uncertainty (like the issue of non-marginality) has been one feature that has pushed some scholars away from a cost-benefit framework altogether in this context.[139] Under such an approach, we could analyze the problem strictly in terms of current willingness to pay for insurance. But, to some extent, one can accommodate the same concern *within* the bounds of market discounting through a reduction in the discount rate. Indeed, as we have just seen, some descriptivists have advocated precisely this type of step.[140]

4. Adjustments Within the Prescriptivist-Production Framework

Establishing the types of reasonable concessions by prescriptivists is a more complex task than with respect to descriptivists. The reason has been hinted at above. Within the camp that rejects reference to market discount rates for allocation decisions (say on the grounds of incommensurability), this can be understood as a rejection of discounting altogether. That is, there is no well-formed theory that produces some alternate discount rate. Still, for the reasons discussed above, I think the better course is for the prescriptivist to offer up *some* discount rate here rather than none. In light of this, I note a few points.

The first point to observe here is that, within the bounds of a policy evaluation model, the role of the discount factor *must* be understood

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[135] *See id.*
[136] *See id.* at 205. For a straightforward example of this phenomenon, see Revesz & Shahabian, *supra* note 47, at 1115.
[137] *See* Weitzman, *supra* note 7, at 708.
[138] *Id.*
[139] *See* KNIGHT, *supra* note 132, at 233.
[140] *See Lowest Possible Rate*, *supra* note 131, at 201.

as relating to opportunity costs. Such models provide predictions of expected costs and benefits of a particular tested policy. The question before the policymaker is whether enacting such a policy is a good use of resources or not. This fits with the basic allocative function of such models at the core. The basic question, then, is whether an alternate use of resources would be better. That much is agreed. The dispute is about whether observed market rates give us the right information about opportunity costs. For the reasons discussed above, prescriptivists will reject that they are.[141]

The second point is that if the prescriptivist is going to offer some discount rate here, but is intent to reject descriptivist approaches, then the obvious place to start would be through the rate determined under the prescriptive approach specified for explicit consumption decisions—that is plausibly the Ramsey optimal growth model (to be discussed in the next section). The point to make here, though, is that application of such a rate in a policy evaluation model would clearly be an error. We can see this by considering the numerical example discussed above where a prescriptive-consumption approach yields a discount rate of 1.4% and a descriptive-production approach yields a rate of 5.5%.[142] The point made above was that, from the standpoint of the descriptivist, it should be acknowledged that if the policy under consideration is non-marginal (that is, large enough to affect marginal rates of return) then this must be reflected in the discount rate.[143] We can make the inverse point for the prescriptivist. If the discount rate is applied in a context that is non-marginal but falls short of implicating sufficient additional savings to bring one down to the desired rate on a prescriptive-consumption approach, then it would indeed seem to be error to apply such a rate (here 1.4%). That is, *some* acknowledgment should be made of higher yielding investments. This would tend to drive the defended social discount rate upwards, and towards that advocated by the descriptivist.

D. Towards Consensus in Policy Optimization Models

I undertake here a discussion of movements towards consensus regarding discount rates in policy optimization models, which is exactly symmetrical to the discussion above. As in the above treatment, I first explain how choice of model should influence location on the production-consumption axis; I then explain the likelihood of continued fundamental

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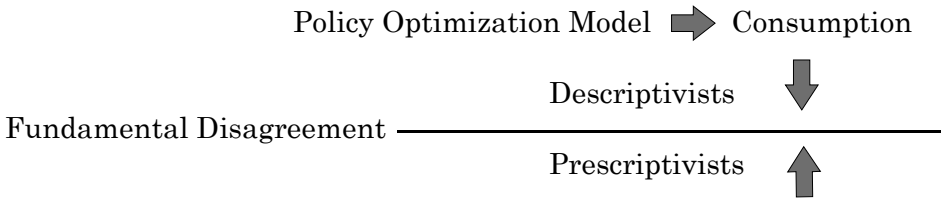
[141] Stern, *supra* note 5, at 12.
[142] Weisbach & Sunstein, *supra* note 1, at 440.
[143] Revesz & Shahabian, *supra* note 47, at 1152–53.

disagreement between descriptivists and prescriptivists; and finally I discuss factors likely to build consensus, even in the presence of a continued fundamental divide here. The basic dynamic is captured in the following diagram:



1. Disagreement About Production vs. Consumption: Choice of Model

In the discussion of policy evaluation models above, we saw that one source of disagreement is the insistence that although such models are at the core about allocation, one must still take account of distributional considerations.[144] The suggestion I made in response is that we should consider that charge as relevant to the choice of model but not as stating a valid rejection of the descriptivist approach. One encounters the exact parallel situation in the context of optimization models. That is, one sometimes sees the allocation/opportunity cost position raised as a rejection of *prescriptive* approaches. But, optimization models, as we saw above, produce as their output aggregate consumption streams.[145] Conceptually, then, these should be analyzed as a problem about discounting consumption, not production. Allocation and production are not irrelevant, of course, to the overall policy space. But, to the extent that one must take account of allocation/production, this is more properly seen as bearing on the choice of model than it is through rejection of prescriptive-consumption approaches generally.

Consider the basic position of Nordhaus, who states that we must calibrate the discount rate (within an optimization model that is clearly about discounting aggregate consumption) to reflect observed market returns.[146] If we do not do this, then the supposed harm is that we will be

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[144] Weisbach & Sunstein, *supra* note 1, at 438.
[145] Labriet, *supra* note 118, at 18.
[146] *See* WILLIAM NORDHAUS, A QUESTION OF BALANCE: WEIGHING THE OPTIONS ON GLOBAL WARMING POLICIES 9–10 (2008).

foregoing better investments in the economy.[147] I think this risk should be acknowledged, but we should have conceptual clarity about how this relates to the connection between choice of discount rate and choice of model. I believe that the real claim here goes not so much to the proper discount rate for the optimization model but to something rather different. We could recast the issue as follows: the basic problem is that we might determine policy regarding climate using an aggregate consumption model whereas *other* policies (regarding maybe health or education) are pursued within a marginal framework. If, however, we built a series of optimization models for these various subfields—all producing aggregate consumption flows—and we discounted under all of these models with a fairly low prescriptive rate, then what we would produce is a series of "optimal" investment patterns in environment, education, health etc., the aggregate cost of which we would *never* be willing to bear as a society. But what is the appropriate answer to this? I think it better to acknowledge that it is problematic to use optimization models like this in some policy areas but not others. However, this would not justify using a descriptively determined producer interest rate to solve the issue. Conceptually, the issue is about discounting consumption streams and we cannot get around that. If one is concerned about the policy implications of using an optimization model in one sub-area (even if it is a very important sub-area) then the better response in terms of model choice and design would be to switch to something like a policy evaluation model (within the climate context) or perhaps call for greater use of optimization models in other sub-fields.

2. Fundamental Disagreement About the Proper Scope of the Market

In the above discussion of policy evaluation models and allocation, I argued that one should accept there is likely to be an abiding fundamental disagreement between descriptivists and prescriptivists. This state of affairs arises because I take it that there are foundational differences about the precise range of goods and services for which it is appropriate to use a market mechanism to determine allocations. Because descriptivists rely on the market to determine allocation-determining discount rates, this leads to an unbridgeable gap. We encounter a parallel phenomenon with optimization models, though the issue now becomes not one of the proper scope of the market to allocate goods and services, but rather

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[147] *Id.* at 10.

the proper scope of the market to determine distribution of consumption across generations. Here we encounter an issue about the temporal, rather than spatial or sectoral, limits of the market.

Economists who employ descriptivist approaches to set discount rates base their determinations upon the observation of revealed preferences of market participants. This is supposed to be preferable to approaches that require ethical argumentation about distributional consequences, as such ethical argumentation is considered to be both indeterminate and beyond the proper purview of what economics can accomplish as a discipline.[148] Prescriptivists, however, take the view that a focus on revealed preferences cannot spare one from making contested value judgments.[149] The reason relates to the idea that the basic distributive question on the table is one as between generations. Thus, the fundamental problem is one of a missing or partial market. That is, future generations are not at the bargaining table, participating in the market, voicing an opinion about how to distribute resources across time. If one takes the current consumer discount rate to discount the consumption of future generations, this effectively substitutes current preferences for, as yet, unstated future ones. Privileging current preferences in this way, however, is supposed itself to be a decision of ethical import.[150] This is why prescriptivists consider the discounting of consumption by future generations based on rates reflecting the way the current generation would discount its own future consumption to be impermissible.[151]

The advocate of the descriptive approach who would like to focus on revealed preferences of current savers/consumers can give a couple of possible responses. I describe these in some detail immediately below. The basic contours of what I take to be a continuing fundamental disagreement, though, can be put rather simply. Prescriptivists here find it ethically illegitimate for preferences of the *current* generation to determine savings rates, and the accompanying distributional consequences for future generations.[152] Descriptivists counter that we must look to the preferences of the *current* generation, as it is the only evidentiary base available.[153] Let us consider then two possible ways in which descriptivists might seek to focus attention on current market behavior regarding savings and consumption.

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[148] *See, e.g.*, Weitzman, *supra* note 7, at 712.
[149] *See, e.g.*, Cowen & Parfit, *supra* note 102.
[150] *See* Weitzman, *supra* note 7, at 720.
[151] *See id.*
[152] *See* Weisbach & Sunstein, *supra* note 1, at 436.
[153] *See id.*

First, the descriptivist could say that what we confront here in terms of a missing market is no different from other cases of market failure. But, even with market failure, the argument would continue, we should begin with revealed preference and attempt to design some corrective mechanism to the extent possible. In this particular case, the option for corrective mechanisms may be limited given the nature of the problem. Future people do not exist, so there is no way to bring the non-existent into the market. Once they exist and we do not, there is no way to transfer resources back in time to the past. Accepting these problems, a plausible approach might be to hypothesize the preferences of future persons. Suppose we imagine that they have preferences a lot like us (in terms of how they will view the past and how they will view posterity). Then, one might try to estimate what the effect on market rates would be.[154] For example, one might hypothesize that if only future people could express an opinion they would bargain for more current savings, which would drive interest rates down. Thus, we could accommodate the market failure embedded in their absences by making a downward adjustment to current market rates when using them as a discount factor. But, such thought examples, with attendant adjusted interest rates, are themselves problematic and would have to embed certain assumptions. The central problem is the thought examples only make sense if we make some background assumptions about what the future persons have in terms of resources. If we start off with the assumption that, as imaginary constructs, the future persons have no resources, then they will have no bargaining power and, thus, could not affect equilibrium interest rates in the first place. This suggests that perhaps we should imagine that the future persons *do* possess resources. But how much? These resources, after all, will be inherited from the present. To determine the amount of future resources, we would have to make a determination about the amount that will be left for the future, which is the very question that is on the table.

Second, Louis Kaplow has developed an argument, based on the distinction between money and utility, which is meant to allow for the non-problematical discounting of future consumption (even by future generations).[155] Kaplow suggests that the appropriate way to deal with

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[154] A number of scholars have proposed such thought exercises, wherein one considers the effect on market rates if future persons had an actual voice in distribution of resources across generations. *See id.*; BROOME, *supra* note 106, at 93–94.

[155] Kaplow, *supra* note 30, at n.8.

utility of future persons is to state a dollar equivalent through the well-accepted concept of a statistical life.[156] With the value of a statistical life in hand, one can undertake a simple three-step approach to discounting. First, lives are converted to an equivalent dollar amount.[157] Second, dollars are discounted.[158] Third, the dollars are converted back to lives, on the basis again of the value of a statistical life.[159] I think it unlikely this argument will bridge the fundamental divide between descriptivists and prescriptivists, though. Observe, initially, that I do not think the argument is best read as an *indirect* way of discounting the utility of future persons. If the prescriptivist finds the idea of the *direct* discounting of such utility problematic, it is difficult to see how taking future utility and adjusting by some fixed conversion factor before discounting could possibly remedy the moral defect. But, I believe this is to misunderstand the offered approach. The best reading, rather, is as rejecting a direct consequentialist analysis of the future in favor of an analysis that focuses simply on the present. This move occurs through the particular role that the concept of a statistical life plays in the argument. The concept of a statistical life is not a measure that relates to actual or hypothetical future lives. It is not even a measure that relates to risk to future lives (though one could certainly create such a measure). Rather, the statistical life is simply an assessment of willingness of *current* individuals to bears costs to avoid mortality risk in the future. For the descriptivist, then, the import of the statistical life in the argument is that it allows us to get a measure of how *current* individuals would allocate capital to risk reduction as compared to how they would allocate capital to other uses. The statistical life concept is very useful because it allows such an evaluation in cases where willingness to pay is not readily determined by direct observation of the market. Without question, though, the focus is still on an indirect determination of willingness to pay of *current* individuals. Understood in this way, though, we come immediately back to the fundamental divide between descriptivists and prescriptivists, as it is precisely the focus on the preferences of current persons that the prescriptivist finds problematic, or at least necessarily laden with ethical complications.

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[156] *Id.* at 83. For an overview of the statistical life concept see generally REVESZ & LIVERMORE, *supra* note 71.
[157] Kaplow, *supra* note 30, at 83.
[158] *Id.*
[159] *Id.*

3. Adjustments Within the Descriptivist-Consumption Framework

I consider here what types of concessions might be made by descriptivists *within* the framework of the descriptive-consumption approach. There is one basic concession here which is fairly simple. Acknowledging that the optimization models produce as an output aggregate consumption streams, the appropriate market-based discount rate to refer to here should be the *consumer* interest rate and not the *producer* interest rate. Note two further points: first, the temptation to rely on a producer interest rate on the grounds of opportunity costs should be rejected. Such an approach is not consistent with the underlying form of the model, which requires discounting of aggregate consumption streams. Moreover, as I will discuss in the section on program design below, concerns about an appropriate climate ramp (i.e., an approach under which investments in climate capital not be made too quickly) can be dealt with to some extent with proper design. Second, it should not be forgotten that optimization models *do* contain a method of reflecting the returns to non-climate capital. This can be modeled in each period where one has to make assessments under the growth model whether non-consumed capital is used for mitigation or is invested elsewhere.[160]

4. Adjustments Within the Prescriptivist-Consumption Framework

We must now say more about how prescriptivists would determine an appropriate social discount rate where the question is indisputably about consumption streams over time. Many treatments in the literature begin this exercise with an application of the "Ramsey formula," which derives from Frank Ramsey's analysis of the problem of an optimal savings rate from within the utilitarian tradition: $d = \rho \times \theta g$.[161] Within the tradition that accepts the Ramsey formula as an appropriate means of determining the social discount rate, d, three parameters are thus determinative.[162] The variable ρ measures the pure rate of time preference.[163]

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[160] *See* Arrow et al., *supra* note 6, at 131.
[161] *See* Ramsey, *supra* note 41. One could, of course, take other philosophical stances regarding the determination of the social discount rate. The focus on the Ramsey formula is here legitimate, given the role it has played in prominent approaches to social discounting.
[162] *See id.*
[163] *See id.*

This captures the relative weighting placed on the utility of future consumption merely in virtue of the fact that it happens to take place in future.[164] It has an analog in the utility function of a single individual, where a positive rate of pure time preference captures the preference for current consumption borne out of impatience.[165] The variable *g* measures the predicted rate of growth in the economy.[166] The variable θ measures the degree of curvature in a social welfare function.[167] Together, the term θ*g* provides a measure of how much to value consumption in the future not simply because it happens in the future but rather to take account of changes in overall wealth.[168] With positive growth, future persons will be wealthier than current ones.[169] On the assumption of declining marginal utility, marginal consumption will thus be worth less.[170] The magnitude of the variable θ (which embodies the degree of egalitarianism in the social welfare function) tells us how much less.[171]

The identification of these variables is suggestive of the ways in which one is most likely to achieve incremental consensus about the discount rate. Proponents of using a social discount rate in this context typically defend substantially lower discount rates than proponents of a descriptive/revealed preference approach. As noted, Nicholas Stern defended, under this approach, a discount rate as low as 1.4%.[172] Depending on one's moral theory, the rate could go down to zero, or even be negative. The first point to note here is the one made above. Focus on the variable ρ, the pure rate of time preference, is not a very promising route for developing incremental consensus, for the simple reason that there is already a lot of consensus on this point.[173] Conversely, focus on the degree of egalitarianism built into the social welfare function is not very promising. There is fairly broad disagreement on such questions even within a given timeframe, where one finds vocal proponents of everything from straight utilitarianism to a Rawlsian maxi-min function. Layering an intergenerational component on these debates will only serve to aggravate matters.

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[164] *See id.*
[165] For a discussion of the relationship between the individual utility function and the social welfare function, see Kaplow et al., *supra* note 31, at 7–14.
[166] *See* Ramsey, *supra* note 41.
[167] *See id.*
[168] *See id.*
[169] *See id.*
[170] *See id.*
[171] *See id.*
[172] *See* Stern, *supra* note 5, at 13.
[173] *See id.* at 15.

The most important point I would like to emphasize here is the role that economic growth should play within the contours of an approach based on social discounting. Initially, observe that some scholars, who should properly be considered in the prescriptivist camp, are generally amenable to taking account of the effects of economic growth within the framework of an approach of social discounting. The Stern report is a good example of such an approach.[174] From a straightforward application of the Ramsey formula, the result is that even with a zero rate of pure time preference (or a relatively small rate of pure time preference to take account of the possibility of extinction), one should still discount the future by a factor representing predicted economic growth. This follows from the assumption that the future will be wealthier than the present and, with declining marginal utility of income, marginal dollars are worth less to future persons than to current persons.[175]

Total rejection of a growth discount factor from within this perspective seems perverse. Consider the numerical assumptions favored by Nordhaus and Stern to shed light on this problem. Thus, suppose we assess the current rate of return on real capital to be 5.4%, as in Nordhaus, and the social discount rate to be 1.4%, as in Stern.[176] The number derived by Stern, recall, is driven almost entirely by the assumed long term growth rate.[177] The way to understand the 1.4% number within the Ramsey framework is as a conditional statement of the optimum. *If* we were actually to behave in accordance with the zero pure time preference

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[174] *See generally id.*

[175] Although one might question the continuing relevance of the Ramsey framework as a theoretical approach to optimal savings and growth in light of the many advances in that field over the last century, it is important to be careful to distinguish the ways in which the Ramsey framework has been supplanted from the ways in which it still holds core elements of truth. On the former, the essential advances relate to the theoretical advances on the supposed relationship between the rate of savings and capital accumulation to the rate of growth. Ramsey hypothesized a zero rate of growth in the case where the savings rate is unaffected by pure time preference. Modern growth theory would reject this outcome. *See* Revesz & Shahabian, *supra* note 47, at 1104–05. But, this evolution is more about the relationship between savings and growth than it is about the appropriate framework for assessing the welfare consequences across generations. *See id.* at 1105–06. On that latter question, the Ramsey formula is still an accurate rendering of how that question ought to be approached. Namely, one should take account of weights (if any) for utilities of different persons, the fact that some people may be wealthier than others (i.e., growth), and the fact that we predict that marginal dollars are worth less to wealthier people. *See id.* at 1109.

[176] Weisbach & Sunstein, *supra* note 1, at 440.

[177] *See id.*

suggested by ethical argumentation then the market rate and the social discount rate should converge at 1.4%. To reject a growth factor in the discounting formula would be to accept projects, for example, with a rate of return of 1%. One *can* voice plausible defenses of such a policy. The fact that marginal market returns are so high means that we are saving much less in total than required by the underlying ethical theory in optimal circumstances. In light of this, one might maintain that *any* move in the direction of greater current savings is ethically warranted, perhaps even required. But, this seems to me to be not a particularly strong argument. We can recall here what gets us to the general prescriptivist position in the first place. Observable market rates are flawed in the sense that they do not adequately reflect preferences of all relevant parties. In light of this, we need some framework to take account of the missing market. The ethical basis for falling back upon a growth discount factor in circumstances where we are not at the optimum is simply to say that one can cure the moral defect presented by the missing markets problem by acting in accord with how we would act if one could supply the missing market. The ethical complications presented by the missing market, however, ought not to require the current generation to act *better* than it would have had to act under optimal circumstances.[178]

To the extent the prescriptivist accepts the basic case for a growth discount factor, the relevant debates then boil down to one about an assessment of the proper growth rate to use. This is not a simple question, and it will be contested. One must make assessments about which benchmarks to use and particularly the complications that arise when one is trying to determine whether to use a growth rate for the world as a whole. I do not mean to enter these debates here, but rather only to observe

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[178] A different type of critique of including a factor for growth in the discount rate relates to *existing* distribution of resources. For example, Revesz questions the use of growth discounting, especially in the climate change context, on the grounds that many who would benefit from emissions abatement will *not* be richer than the current relatively wealthy persons trying to decide whether to undertake the costs of such abatement. *See* Revesz & Shahabian, *supra* note 47, at 1154. The best way to understand this critique is that it embodies a critique of the implicit weights placed on individual utilities under current distributions of wealth in the world. One can correct that ethical failing to some extent by rejecting growth discounting. To follow the numbers in the text, acceptance of the policy with the 1% return might result in distributions that reverse to some extent questionable current distributions. But, as others have noted, this is not really an argument against growth discounting so much as it is an argument against the weights reflected in current distributions. If one were willing to use intergenerational policy to alleviate such undesirable distributions, then the question is why not use intragenerational policy instead.

that discounting to reflect economic growth is a legitimate exercise from within the Ramsey framework and that it will operate to push the floor for defensible discount rates upwards—and towards that defended by descriptivists.

Not all scholars who reject descriptivist approaches are amenable to growth discounting, however. I would like to distinguish two basic arguments here, each of which questions the Ramsey framework's urging of a growth discount factor. My suggestion is that in each of these cases there is likewise room for incremental consensus building through the means of a growth discount factor.

The first argument observes that growth discounting is flawed, particularly in the climate change context, because some goods actually reflect *increasing* marginal utility as we become wealthier.[179] This is really an empirical assertion about price determination, rather than a direct critique of growth discounting. That is, the growth discounting framework can accommodate this factor through the means of relative prices.[180] The proper approach here is to state the values of future costs and benefits in prices that are adjusted for the fact that some goods may be valued relatively more as we get richer. Once we have done so, then it would seem the appropriate way of dealing with cost benefit analysis would be to use a growth discount factor for the reasons discussed above. I do not mean to suggest that determination of relative prices is simple. The point is only that shifting relative prices does not undermine the basic reason to use a growth discounting factor. Thus, even from within the standpoint of this critique, the discount factor should be pushed upwards from zero.

The second argument observes that growth discounting, which is based on declining marginal utility of income, is problematic because the costs of climate change are expected to be borne disproportionately by poor regions of the world.[181] Even accounting for economic growth, such regions may be poorer in future than the relatively wealthy countries of today.[182] Thus, taking account of the fact that the world as a whole may be wealthier in future would seem to understate the costs of climate change.[183] I would like to suggest that this critique is best understood as questioning

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[179] *See id.* at 1103.

[180] For a general discussion of the issue of relative prices and discounting in climate policy, see Thomas Sterner & U. Martin Persson, *An Even Sterner Review: Introducing Relative Prices into the Discounting Debate*, 2 REV. ENVTL. ECON. & POL'Y 61 (2008).

[181] *See id.* at 66.

[182] *See id.*

[183] *See* Revesz & Shahabian, *supra* note 47, at 1156–59.

various elements of model choice and model design, rather than the acceptability of using a growth discount factor within the scope of the general type of model under discussion here. The models under consideration here are welfare optimization models.[184] Note, initially, that within such models tools exist to take account of the inter-regional distribution issue that would seem to call growth discounting into question under the above critique.[185] Specifically, one can divide welfare results into sub-regions, rather than stating them globally.[186] With that division in place, it is possible to put equity weights on the welfare of different regions to capture welfare-increasing inter-regional transfers. Observe that because optimization models sum welfare from the present time, employing welfare weights in this fashion can have the predicted result of preferring the transfer of substantial resources to poor regions of the world in the near term in order to capture welfare gains.[187] This result runs in large part not because of climate change factors, but rather simply because of existing wealth disparities in the world. This effect thus mixes together issues of inter-regional redistribution arising from climate and non-climate factors in ways that may obscure the narrower climate issues that modelers are trying to reflect in the first place.

To counter this effect, some modelers have used a technical device referred to as "Negishi" weights.[188] The effect of such weights is to remove *all* beneficial welfare effects from inter-regional redistribution. In effect, the device treats the different regions in the model as having like consumption levels.[189] Conversely, other modelers have used specific equity weights in optimization models that do reflect welfare gains from inter-regional transfers.[190] These modeling choices present complicated tradeoffs.

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[184] *See* Elizabeth A. Stanton, *Negishi Welfare Weights in Integrated Assessment Models: The Mathematics of Global Inequality*, 107 CLIMATIC CHANGE 417, 418 (2011).
[185] *See id.* at 421.
[186] *See id.* at 424.
[187] *See id.*
[188] *See generally id.*
[189] *See id.* at 421.
[190] *See, e.g.*, David Anthoff et al., *Equity Weighting and the Marginal Damage Costs of Climate Change*, 68 ECOLOGICAL ECON. 836, 840–41 (2009). I should emphasize the fact that Revesz and Shahabian, who develop the basic critique of growth discounting set out in the text, appear to take a favorable stance towards the type of equity weighting employed by Anthoff et al. Thus, they state, "[a]bsent the kind of explicit equity weighting Anthoff and his coauthors propose, growth discounting conflates the issues posed by distributive justice and efficiency." Revesz & Shahabian, *supra* note 47, at 1157. I read this to mean, at the least, that their particular critique of growth discounting does not apply in cases of optimization models that use equity weights (to be distinguished from Negishi weights). They do not explicitly state what the best course would be if one were forced to

Within a welfare maximizing framework, it seems odd to construct a model that, as under the Negishi weights approach, explicitly obscures the prospect of welfare improving transfers. On the other hand, it may seem clearly counterproductive to construct a model, as with substantial regional subdivision and equity weighting, that urges current inter-regional transfers that are completely out of step with current development commitments and institutional arrangements. My point, though, is that these choices ought not cloud the separable issue about use of a growth discount factor given a particular model specification. That is, if one is using an optimization model that sums utility (and given standard assumptions about declining marginal utility), there is no sound conceptual reason for ignoring growth (or any change for that matter) in consumption levels over the time periods covered in the model. If one finds objection with the inter-regional distributions that result under such an approach the conceptually sound approach is to urge either: (i) greater regional subdivision in the model, with accompanying equity weights; or (ii) greater reliance on models that do *not* optimize welfare, with overt consideration of redistributional inter-regional transfers taking place outside the model. As with the first objection to growth discounting, then, acceptance of this point would tend to move the discount rate in a positive direction from zero, improving the prospects of a smaller consensus range for discount rates.

II. DESIGN

In this second part of the Paper, I consider different ways in which program design in the climate change context should bear on the general discussions about choice of discount rate. Part I of the Paper was meant to work as a sort of arbitral template, which would increase the prospect of smaller consensus ranges of discount rates, particularly within the scope of a given model. In light of the fundamental disagreements, sketched above, though, one can expect that a divide will continue to exist between the discount rates defended by descriptivists and prescriptivists. The basic point of this part of the Paper is to show how this type of continuing disagreement, and its magnitude, should be sensitive to various questions of program design and implementation.

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choose a discount rate in an optimization model that just used a global aggregate of consumption or regional subdivision with Negishi weights. For the reasons stated in the text, I would favor reflecting a growth discount factor in such a context on the grounds of internal consistency with the model, with concerns about equity best understood as a broader critique of model choice and design.

As a general matter, descriptivists will continue to defend relatively higher discount rates than prescriptivists. In the first instance, the discount rates help us to determine how much money should be devoted to climate capital (the production question) and how much aggregate savings should increase in light of the overall problem (the consumption question). Prescriptivists will view the discount rates defended by descriptivists as leading to insufficient allocation to climate capital and insufficient upticks in current savings. Descriptivists will have the opposite view. Discount rates defended by prescriptivists will lead to excessive allocation to climate capital and excessive attempts to increase aggregate savings. These basic issues are sensitive to program design, however. If a prescriptivist believes that too high a discount rate is being used, thus leading to inadequate allocations to climate capital, it should nonetheless be relevant what the alternate allocations happen to be. This is an issue of program design and could make an otherwise unpalatable discount rate more acceptable. The same is true for descriptivists.

In this section, I describe two ways in which the details of program design can be relevant in this way. I mean the discussion here to be illustrative, rather than exhaustive. I take up first the position of the prescriptive-production standpoint and discuss how program design could make an otherwise excessive discount rate less problematic. I then take up the position of the descriptive-consumption standpoint and discuss how program design could make an otherwise insufficiently high discount rate more tolerable.

A. Compensating Transfers—Addressing the Prescriptivists' Concern About Incommensurability

Consider the discussion from Part I regarding the fundamental divide between proponents of a descriptive-production approach and a prescriptive-production approach. The basic disagreement arises here because of different views about the proper scope of the market as a means of allocating certain resources. Prescriptivists may, among other reasons, find discounting at market rates unacceptable because alternate investments in the highest return producing market assets are not seen as acceptable substitutes for certain goods or services, here particularly environmental goods or services. Climate effects are considered to be in this category. The standard descriptivist response would run along the following lines. The producer discount rate gives us information about returns to alternate uses of capital. One should discount at that rate. If the consequence is, for example, some degree of essentially irreversible climate

change with associated damages, then one does better to use the returns from the better investment to finance adaptation in future.

I would like to emphasize two points here, each linked to the issue of how program design and implementation is relevant to these basic disagreements about discounting. The first point is that even for a prescriptivist who rejects market discount rates from an incommensurability standpoint, it must be acknowledged that not all alternate uses of capital are equal. This is especially true over long time spans, where the issue is not merely one of alternate uses of capital but also the subsequent use of returns from such alternate uses. Thus, for example, if one of the claims supporting use of a market discount rate is that funds would be better spent on adaptation, then it will be important to the prescriptivist that a meaningful commitment is in fact made to finance such adaptation. This is clearly no simple matter, particularly given the times spans at issue. At bottom, though, these are questions of the broader policy landscape in which discounting arises. This echoes the discussion above regarding the distinctions between the use of discounting in climate IAMs as compared to the use of discounting in domestic project-based CBA. The use of discount rates in IAMs should not be understood as simply an up or down calculation, under which some specified "project" will either proceed or not. Accordingly, the use of a discount rate based on a theory of alternate allocations of capital ought not to be understood as leading to simple rejection of a given climate "project" with no further specification of approaches to the problem. The use of such models, rather, should be understood as one (perhaps small) input into a much broader and complicated global response to the problem. As part of that response one should, for example, consider substantial institutional arrangements to finance matters such as adaptation. This is obviously not the place to explore such institutional arrangements. The point is simply that the prescriptivist should find solace in the use of discount rates that are perceived to be too high in policy evaluation models, to the extent that the use of such models takes place within a broader context of program design that takes account of how alternate uses to capital relate to adaptation.

The second point is related to embedded distributional consequences in an analysis that is largely supposed to be about allocation and production. The prescriptivist's concern about incommensurability will be aggravated to the extent that there are adverse distributional consequences. It is not simply a matter that using market discount rates tilts the balance in favor of alternate market investments that are viewed as poor substitutes for investments in the environment. The deeper concern,

rather, is that the beneficiaries of such alternate investments are likely not the same parties who stand to lose the most from the decision not to invest in climate capital. The response of the descriptivist here is likely to be the standard one: one should separate concerns of distribution and allocation, focusing here on allocations with the highest returns. Those returns can be used to finance compensating transfers such that nobody is worse off. This again is an issue of program design. Such compensating transfers may be difficult but they remain possible, at least to some extent. As with the issue of adaptation, we should consider the use of discount rates in this context as part of a much broader policymaking process. It is not a simple up or down decision on some "project" with discussion of distributional consequences unspecified. Distributional consequences and compensating transfers are best considered as part of the same overall discussion. This factor too should assuage, to some extent, the prescriptivist who finds market based discount rates unjustifiably high.

B. Pre-Commitment—Addressing the Descriptivists' Concern About the Climate Ramp

I consider now an example of how program design should be relevant to somebody in the descriptive-consumption camp, that is, a proponent of using market discount rates in a policy optimization model.[191] One of the chief concerns underlying that stance is that the use of the relatively low discount rates favored by prescriptivists will tend to direct investment towards climate capital too quickly.[192] Scholars holding such a concern have described the more desirable policy in terms of an optimal climate "ramp."[193] The basic idea is that it is better to defer expenditures on climate capital as we wait for certain existing capital investments to exhaust themselves and for rival technologies to have time to develop before we undertake major capital infrastructure projects.[194] The assumption is that if the government discounts at a rate lower than currently available market returns, we are essentially steering resources away from projects with higher yields and increasing the cost of mitigation/adaptation to climate change.[195]

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[191] *See, e.g.*, NORDHAUS, *supra* note 146, at 31–32.
[192] *See id.* at 165.
[193] *See, e.g.*, *id.* at 166.
[194] *See id.* at 165.
[195] *See id.*

We can begin the argument regarding the relationship between this position and program design with a puzzle. In adopting *market* mechanisms to address climate change, we care about spatial and temporal efficiencies. Why is it, then, that in the contentious debates about how much to spend on climate change (and how fast), scholars typically do not take strong stances on sectoral or geographic dispersion of emissions abatement, much preferring to leave matters to market mechanisms such as permit trading or carbon taxes, but they do enter high-pitched disputes about the intertemporal dispersion of abatement?[196] Nordhaus, for example, uses results from his policy optimization model to defend a particular climate ramp, under which it is supposed to be optimal to defer expenditures on climate capital.[197] This basic argument, moreover, underlies at least a portion of the stated rationale for the unwillingness of the United States to ratify the Kyoto protocol.[198] Stern, by contrast, questions the delays embodied in such a ramp, urging much more rapid expenditures on climate capital.[199] As these debates have played out, they are supposed largely to turn on choice of discount rate.[200] Nordhaus, working from a descriptivist stance, derives the ramp he does based on considerations of opportunity cost of capital.[201] There are higher yielding non-climate investments to be made currently; thus we should defer such climate investments.[202] Note, though, that this basic approach appears at odds with the underlying structure of the model, which on its face purports to discount aggregate *consumption* streams. Moreover, the argument I would like to develop here is that the low rates defended by the prescriptivist need not be rejected because of concerns about a policy ramp, because such underlying concerns can be addressed, at least in part, through program design.

The descriptivist's concern here is best understood as relating to efficient allocation of capital on the margin.[203] Once we take account of modeling decisions (plus discount rate) along with issues of program design, one can observe both marginal and non-marginal aspects. The aggregate consumption streams that are the subject of optimization models

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[196] *See id.* at 179–81.
[197] *See* NORDHAUS, *supra* note 146, at 179–81.
[198] *See id.* at 31–32.
[199] *See id.* at 181–82.
[200] *See id.* at 65.
[201] *See id.* at 179–81.
[202] *See, e.g.*, Frank Ackerman et al., *Limitations of Integrated Assessment Models of Climate Change*, 95 CLIMATIC CHANGE 297, 311 (2009).
[203] *Id.*

are clearly not marginal.[204] Moreover, as enacted, any substantial regulatory approach to climate change may also be non-marginal, in the sense that it would be sufficiently large to affect equilibrium rates of return. But, at least in the case where the government intends to use a market-based mechanism in order to set a carbon price (either a price mechanism such as a tax or a quantity mechanism such as a permit trading program), individual decisions of market actors are marginal as such actors decide how to allocate efficient abatement across sectors, geography, and time. The marginal and non-marginal aspects of the regulatory program will interact in complex ways that ultimately circle back to details of program design. If one is going to use a market-based program, then market actors will be acting on the margin and should make abatement decisions based on marginal opportunity costs of capital. In this way, one can still use market forces to get cost-effective disbursement of abatement over time. For example, for any given program window, if market participants anticipate that it will be cheaper to defer expenditures in climate capital (typically meaning greater returns to non-climate capital are available), then they can be expected to do so.

But, this reliance on market actors to achieve efficient intertemporal dispersion of abatement will only work if the government regulator can resist pressures to modify the program mid-stream. Clearly, if market actors defer expenditures on climate capital not only because there are higher returns available elsewhere but also because there is a widespread belief that the governmental regulator will later soften regulatory requirements, then this will not yield an efficient outcome. Additionally, the very fact that the program in the aggregate is non-marginal means that one can expect continuing pressure to carve back on earlier regulatory commitments. The very fact, that is, that the government is attempting to undertake a program with a forced savings component (in the sense of greater savings than what would otherwise follow from existing pure time preference of the current generation), suggests that, even if the political will can be summoned to overcome this, there will be continuing risk that the program will be modified over time. The mere risk or expectation of this should be priced into the decisions of regulated actors regarding how aggressively they will invest in climate capital at any given time. If this is the case, then this means that a key element of program design involves the ability for the government to commit to a set of regulatory goals in such a way that regulated actors take the commitment to be a credible one.

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[204] *Id.*

This factor, in turn, contributes an important new consideration in the long-running debate over the relative superiority of quantity versus price mechanisms in regulating climate change. The standard account of this controversy observes that, with complete certainty, price and quantity mechanisms amount to the same thing, but in real world conditions the choice is between taking a certain price (the tax) and an uncertain quantity (total abatement in light of chosen tax) or a certain quantity (the cap) and an uncertain price (equilibrium permit price in light of the cap).[205] Regarding the efficiency consequences of this choice, the stock nature of greenhouse gases suggest that errors in quantity on the margin are less harmful than errors in price.[206] But, for the reasons just mentioned, from an efficiency standpoint, it is also important to consider the incentives of market actors to allocate abatement efficiently over time, which in turn is a function of the government's ability to commit to a stable program over time.

As a conceptual matter, with sufficient assumptions about idealized circumstances, one can always make quantity and price mechanisms look the same.[207] To the extent abatement decisions are marginal and market actors are trading off investments in climate capital and other capital at the margin, the carbon price should rise over time.[208] A rising carbon price, of course is consistent either with a quantity mechanism (permits spread across time in way such that equilibrium permit price rises over time) or with a price mechanism (carbon tax rises over time).[209] But, of course, once we engage real world non-ideal circumstances, this simple conceptual equivalence drops away. This can be seen in the following observation, which favors quantity mechanisms over price mechanisms.

Ongoing political pressures and the nature of the pre-commitment problem look very different in a price mechanism versus a quantity mechanism. As we have just seen, if there is any substantive merit to the idea of ramping up climate expenditures (and there is reason to believe this is true to at least *some* extent), then we essentially want market actors

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[205] *See, e.g.*, Harrison Fell et al., *Prices Versus Quantities Versus Bankable Quantities*, RESOURCES FOR THE FUTURE (2008), *available at* http://www.rff.org/RFF/Documents/RFF-DP-08-32-REV.pdf.

[206] *See* Richard G. Newell & William A. Pizer, *Regulating Stock Externalities Under Uncertainty*, 45 J. ENV. ECON. & MGMT. 416, 423–27 (2003).

[207] *Id.*

[208] *See* T.H. TIETENBERG, EMISSIONS TRADING: PRINCIPLES AND PRACTICE 111 (2d ed. 2006).

[209] *Id.* at 116.

to be using relatively more permits in the early years of a program (thus deferring investments in climate capital) or, alternatively, paying relatively more tax in early years of the program.[210] This represents an efficient path, but firms are unlikely, or at least less likely, to take that path if it is believed that government will later soften the program. In the context of a quantity measure, softening the program would mean issuing more permits in later years even though there had been an initial commitment to issue only a fixed number of permits. In the context of a tax, softening the program would mean lowering the tax burden in later years. The relative political pressures in the two types of program are drastically different, however. In a quantity-based regulatory program with tradable permits, there will be a widespread constituency that holds the permits issued at the beginning of the program. Issuing more permits will devalue the price of existing permits and it can be expected that current permit holders will constitute a powerful lobby fighting against just such an outcome. In the case of a price mechanism, by contrast, there is no such lobby. Indeed, the price mechanism being set directly by the government, the only obligation runs from regulated party to the governmental revenue collector. We could predict in this type of circumstance that there would be intensified lobbying to soften the program over time.

These factors, taken together, suggest that there is room to accommodate the concerns regarding climate ramps and a prescriptive approach to discounting under a policy optimization model. As above, with close attention to program design, a range of discount rates which at first seems unacceptable, may well become less so.

CONCLUSION

There is no correct single discount rate, or approach to discounting, appropriate to climate policy. Nor is there a single appropriate approach for *how* to determine the discount rate. Debates about discounting and climate policy will likely thus continue for a long time, in large part because one confronts here fundamental disagreement about where the market appropriately ends as a social construct to deal with questions of

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[210] Note that this deferral of abatement to later in the program is consistent with a rising permit price or rising tax over time. Under a tax, parties would be paying relatively more in absolute amounts, but the effective price per unit would still be rising over time. This is possible, of course, because the total amount of emissions is going down. The same is true of a quantity-based mechanism.

allocation and distribution. This presents a very large problem given the ability of discount rates to affect policy recommendations in very substantial ways. I have tried to paint a less bleak picture in this Paper. One should acknowledge the nature of the fundamental disagreement, but, if we are also clear about the type of model at issue (and the central discounting task which is implicated), the relevance of program design, and the reasonable concessions that descriptivists and prescriptivists alike should make *within* the bounds of their preferred methodology, then one can hold out the hope for reasonable consensus ranges of discount rates appropriate to the model under consideration.