

Description, Prescription and the Choice of Discount Rates

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## Abstract

The choice of discount rates is a key issue in the analysis of long-term societal issues, in particular environmental issues such as climate change. Approaches to choosing discount rates are generally placed into two categories: the descriptive approach and the prescriptive approach. The descriptive approach is often justified on grounds that it uses a description of how society discounts instead of having analysts impose their own discounting views on society. This paper analyzes the common forms of the descriptive and prescriptive approaches and finds that, in contrast with customary thinking, both forms are equally descriptive and prescriptive. The prescriptions concern who has standing (i.e. who is included) in society, how the views of these individuals are measured, and how the measurements are aggregated. Such prescriptions are necessary to choose from among the many possible descriptions of how society discounts. The descriptions are the measurements made given a choice of measurement technique. Thus, the labels “descriptive approach” and “prescriptive approach” are deeply misleading, as analysts cannot avoid imposing their own views on society.

**Keywords:** Discounting; cost-benefit analysis; ethics; social choice; democracy; climate change

**JEL Codes:** D60, D71, D91, Q54

## 1. Introduction

The choice of discount rates to use in a cost-benefit analysis (CBA) is a key issue in the analysis of long-term societal issues, in particular environmental issues such as climate change. The core question at stake is how much weight to place on future costs and benefits relative to present costs and benefits. Opinions vary sharply on how to answer this question, leading to a major debate over discounting. The policy implications of this debate are substantial. For example, Nordhaus (2007) estimates that differing views on discounting lead to recommended tax rates on greenhouse gas emissions that differ by a factor of ten.

Throughout this paper, I will refer to discount *rates* in the plural form because more than one discount rate will be considered. In particular, we will consider the discount rate on money and the discount rate on utility. Other discount rates for other phenomena are also possible. For example, Caney (2008) discusses the discounting of future human rights. The discussion presented here could readily be extended to the discounting of these other phenomena.

Approaches to choosing discount rates are generally placed into two categories, as defined in Arrow et al. (1996). The *descriptive approach* to discounting matches discount rates to

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monetary interest rates observed in financial markets. Some descriptive approach supporters, who I will refer to as *descriptivists*, include Bauer (1957), Nordhaus (2007), and Anthoff et al. (2008). The *prescriptive approach* to discounting derives discount rates from fundamental ethical views, even if the resulting rates do not match market rates. Some prescriptive approach supporters, who I will refer to as *prescriptivists*, include Ramsey (1928), Stern (2007), and Dasgupta (2008).<sup>2</sup> A variety of arguments have been made for and against both discounting approaches.

One line of argument used to both criticize and defend the descriptive approach involves a literal interpretation of the “descriptive approach” label. Descriptivists using this line of argument claim that they are using the correct discount rate because their rate correctly describes how society discounts. Prescriptivists and other critics counter – correctly, as it were – that any stance on what discount rates *should* be used necessarily involves a value judgment and cannot be defended on description alone: “any descriptive approach must ultimately be defended in prescriptive terms” (Sunstein and Rowell 2007, p.178; see also Caney 2008; Nelson 2008). Descriptivists might accept this point and counter that their discount rate choices can be justified on the ethical claim that we should choose discount rates according to descriptions of how society discounts. Justifications to this effect follow the idea that analysts should discount according to descriptions of how society thinks we should discount instead of the analysts imposing their own discounting views on society. Several examples of such justifications are presented below. I call this type of justification the *descriptivism justification*.

This paper analyzes the descriptivism justification in relation to the descriptive and prescriptive approaches to discounting as they are commonly implemented. The core finding is that the common descriptive and prescriptive approaches are both equally descriptive and prescriptive. The common descriptive approach depends crucially on a series of prescriptions for assessing how society discounts. These prescriptions concern who has standing (i.e. who is included) in society, how the views of these individuals are measured, and how the measurements are aggregated. These prescriptions cannot be defended on descriptive grounds. Meanwhile, the common prescriptive approach can also be defended using the descriptivism justification, i.e. the approach can claim to be choosing discount rates according to a description of how society discounts. Just like with the common descriptive approach, the descriptions of the common prescriptive approach depend crucially on a series of prescriptions that cannot be defended on descriptive grounds. In light of this finding, it is clear that the labels “descriptive” and “prescriptive” approaches are deeply misleading. Moreover, analysts cannot avoid imposing their own prescriptions on society; the descriptivism justification alone is inadequate for defending market interest rate-based discounting.

This paper’s results weaken but do not eliminate the set of justifications for using market interest rates to select discount rates. The descriptivism justification for using market rates is found to depend on specific prescriptions for how to describe how society discounts. Such prescriptions can be made, though, as discussed throughout this paper, they are also readily contestable.

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<sup>2</sup> The prescriptive approach is commonly associated with the views of Stern (2007), which are criticized by Dasgupta (2008). Thus one might be surprised to see Stern and Dasgupta placed in the same category. What Stern and Dasgupta share is the view that the choice of discount rate is fundamentally an ethical choice which should be derived from fundamental ethical views. For this reason I place both in the prescriptive approach category. Where Stern and Dasgupta disagree is on which ethics to derive the discount rate from.

Meanwhile, market rates may be justifiable via other means, such as grounds of efficiency. Consideration of these other means is beyond the scope of this paper. In my own view, using market rates may sometimes be appropriate but should not be strictly insisted upon. Instead I agree with the prescriptive approach philosophy of deriving discount rates from ethical judgments. This leaves open the enormous question of which judgments to use, a question I will not pursue here.

Though focused on the discounting debate, this paper's insights extend more broadly to issues of description and prescription in general. These issues appear in a variety of other contexts. For example, valuations of human life are often based on descriptions of how humans value their own lives (c.f. Viscusi 1993, p.1913). Another example is in catastrophic risk policy (discussed below; see also Nordhaus 2009, p.6). Because of this broader relevance, throughout the paper I highlight the “general problem”, i.e. the general issue of description and prescription beyond the more narrow case of discounting.

The analysis presented in this paper follows two core ecological economics research traditions. First is the tradition of bringing transdisciplinary research perspectives to bear on important issues of environmental economics and policy (Norgaard 1989). In this paper I draw on concepts and discussions from ethics, political science, law, and psychology as well as both environmental and ecological economics. Such breadth is crucial to this paper's analysis; neoclassical techniques alone would be insufficient.

The second ecological economics research tradition followed here is that of careful ethical analysis sensitive to long-term environmental concerns. Proops (1989, p.62) identifies “a framework for the ethical analysis of intertemporal and interspecies choice” as being a foundational problem for ecological economics. Proops argues for the centrality of questions of the rights of future humans and non-humans. This paper focuses not on rights but on preferences (in particular, preferences about how we should discount), but the questions explored here are otherwise the same as those Proops raises. While I make no claims of having definitive answers to these questions, I nonetheless argue that it is important to recognize and consider them, for their answers have major implications for how we make discounting and other decisions.

Section 2 provides further background on the discounting debate and the descriptivism justification. Sections 3, 4, and 5 explain why there exist multiple ways of describing how society discounts and present which descriptions are used by the common descriptive and prescriptive approaches. Section 3 focuses on the multiple ways of defining who has standing in society. The common descriptive approach gives standing only to contemporary humans who participate in financial markets; the common prescriptive approach gives standing to contemporary and future humans. Section 4 focuses on the multiple ways of measuring how individuals discount. The common descriptive approach makes these measurements by inferring discount rates through certain market behaviors; the common prescriptive approach makes these measurements through the structure of the Ramsey model. Section 5 focuses on the multiple ways of aggregating individual discounting descriptions into aggregate societal discounting descriptions. The common descriptive approach uses a “one dollar equals one vote” aggregation approach; the common prescriptive approach uses a “one unit of utility equals one vote” aggregation approach. Section 6 concludes.

## 2. Background

Two sets of background information will be helpful for the present analysis. The first concerns the Ramsey optimal growth model (named after Ramsey 1928). The model structures the discounting debate as it appears in the climate change literature. The second concerns the descriptivism justification, including its motivation and its parallels to the domains of social choice and democracy.

### 2.1 The Ramsey model

The Ramsey model is designed to assess tradeoffs between present and future consumption. Present wealth can either be spent on present consumption or invested so as to increase future consumption. In the climate change literature, efforts to reduce greenhouse gas emissions are interpreted as investments in future consumption (c.f. Arrow et al., 1996; Stern, 2007; Nordhaus, 2007; Dasgupta, 2008).

In the Ramsey model, there are several discount rate variables, which are related to each other according to the *Ramsey equation*:

$$r = \rho + \eta * g \quad (1)$$

Here,  $r$  is the monetary or consumption discount rate.  $r$  is the variable which descriptivists match to descriptions of financial market interest rates.  $\rho$  is the utility discount rate, which describes how the value of utility is deemed to change over time.<sup>3</sup>  $\eta$  is the elasticity parameter,<sup>4</sup> which defines the relationship between utility  $u$  and consumption  $c$ :

$$u(c) = \frac{c^{1-\eta}}{1-\eta} \quad (2)$$

$\eta$  can be interpreted as how much more a dollar is worth to the poor than to the rich. Finally,  $g$  is the growth rate of consumption.  $g$  is generally assumed (by descriptivists and prescriptivists alike) to be set based on empirical observations of actual consumption growth; a value of around 2% per year is typical. The other three variables are set based on either empirical observations or on value judgments.

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<sup>3</sup>  $\rho$  is often labeled the “pure rate of social time preference”. Nordhaus (2007) refers to  $\rho$  as the “time discount rate”. I favor the term “utility discount rate” because this term makes it clear that  $\rho$  discounts utility, in contrast with  $r$ , which discounts money. Some of the confusion that exists between  $\rho$  and  $r$  may be due to the confusing terminology.

<sup>4</sup>  $\eta$  is sometimes also referred to as the “rate of relative risk aversion”.

The key difference between the prescriptive and descriptive approaches is in how they go about choosing  $r$ ,  $\rho$ , and  $\eta$ . The prescriptive approach sets  $\rho$  and  $\eta$  based on ethical views and then calculates  $r$ . Here  $\rho$  is commonly set to 0 based on the view that utility should hold equal value, regardless of when it occurs.<sup>5</sup>  $\eta$  is commonly set to a positive value; opinions vary on how high of a value to set it to.<sup>6</sup> Meanwhile, the descriptive approach sets  $r$  based on descriptions of financial market interest rates and then calculates  $\rho$  and  $\eta$ . Descriptivists are often flexible on the specific values of  $\rho$  and  $\eta$ , as long as they combine to yield the desired value for  $r$ .

It should be noted that the Ramsey equation is not the only means of defining and relating discount rate variables. However, the equation does receive wide use, in particular in the climate change literature.

## 2.2 The descriptivism justification

The descriptivism justification argues that we should choose the discounting parameters in Equation 1 (or the discount rates as found in other models) to match descriptions of how society discounts. This justification is spelled out in Arrow et al. (1996, p.132), who write that the descriptive approach argues that:

“The appropriate social welfare function to use for intertemporal choices is revealed by society's actual choices (hence the name, descriptive approach). Believing no justification exists for choosing an SWF different from what decision makers actually use, advocates of the descriptive approach generally call for inferring the social discount rate from current rates of return and growth rates.”

Descriptivists argue on the pro-populist, anti-elitist grounds that analysts should use society's discount rate instead of imposing their preferred discount rate on society. This view is apparent in the following defenses of the descriptive approach:

“I attach significance, meaning, and value to individual acts of choice and valuation, including the individual time preference between the present and the future; and my position is much influenced by my dislike of policies or measures which are likely to increase man's power over man, that is to increase the control of groups or individuals over their fellow men” (Bauer, 1957, pp.113–114).

“Instead of imposing our own normative values on the selection of a single SCC estimate, we look at the behaviours of democratically elected governments to infer distributions of the rates of risk aversion and pure time preference that are actually used in practice”<sup>7</sup> (Anthoff et al., 2008, p.2).

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<sup>5</sup> The prescriptive approach sometimes (e.g. Stern 2007) sets  $\rho$  to slightly higher than 0 as a means of handling uncertainty about whether society will continue to exist in the future. This variation in how to set  $\rho$  does not affect the basic arguments of this paper. Detailed discussion of uncertainty in the prescriptive and descriptive approaches is beyond the scope of this paper.

<sup>6</sup> How high to set  $\eta$  to is the value judgment which Stern (2007) and Dasgupta (2008) disagree on. Stern favors a lower value ( $\eta=1$ ), whereas Dasgupta favors higher values.

<sup>7</sup> SCC refers to the social cost of carbon, an estimate for the cost to society of one tonne of carbon gas emitted into the atmosphere. The cost is due to the impacts of the climate change caused by the gas emission.

Meanwhile, the descriptivism justification can also be observed in criticisms of the prescriptive approach. These criticisms charge prescriptive approach supporters of elitism, claiming that the supporters impose their discounting views on society, even if society does not agree with these views. This line of criticism can be found, for example, in recent criticisms of the prescriptive approach-based *Stern Review* (Stern 2007):

“The *Review* takes the lofty vantage point of the world social planner, perhaps stoking the dying embers of the British Empire, in determining the way the world should combat the dangers of global warming. The world, according to Government House utilitarianism, should use the combination of time discounting and consumption elasticity that the *Review*’s authors find persuasive from their ethical vantage point.” (Nordhaus 2007, p.691)

The term “Government House utilitarianism” is in turn from Sen and Williams (1982, p.16), referring to a situation in which utilitarianism is imposed by a select few even if society overall does not support utilitarianism. The *Stern Review* bases its discount rate prescriptions on its preferred form of utilitarianism. The clear imagery here is of a government being unresponsive to the views of its citizens, or, in a word, “undemocratic”. (Another word used, by Marglin (1963), is “authoritarian”.) In contrast, the descriptive approach is taken to be “democratic”. For example, Dasgupta (2008, p.158) describes the descriptive approach as “an interesting, democratic move, in that the idea is to infer  $\delta$  and  $\eta$  [ $\rho$  and  $\eta$  in Equation 1] from data generated by people’s behaviour as they go about their daily lives”. The idea that the descriptive approach can be justified on democratic grounds is a powerful one and worth examining in some detail.

It should be noted that there are multiple conceptions of democracy, some of which do not fit descriptivism. Sunstein (1991) distinguishes between classical and modern views of democracy. In the classical view, democracies are interested in promoting the virtues of their citizens, striving for some conception of the good. In contrast, democracies in the modern view are interested in promoting whatever conception of the good that its citizens hold. Here, “people are taken as they are, not as they might be” (Sunstein 1991, p.4). Democratic decision making in the modern view thus involves identifying what citizens think should be done and then acting accordingly. The modern view of democracy is essentially a process of preference aggregation. Preference aggregation is also the basic structure of the discipline of social choice analysis, as pioneered by Condorcet (1785), Arrow (1963), and others. Some basic insights of the social choice literature are discussed in Section 5 on aggregation.

The descriptive approach accords with the modern “preference aggregation” view of democracy when justified with the descriptivism justification. (Other justifications might not be in any way democratic.) The descriptivism justification makes no attempt to assess whether people are choosing the correct discount rate. Descriptivists might disagree with how society discounts, but they would use society’s discount rates in their analysis anyways. Descriptivists might use similar logic for a wide range of choices besides the choices of discount rates. For example, Nordhaus (2009, p.6) criticizes an approach to assessing catastrophic risk policy as being “unrealistic”. Thus, *descriptivism* can be interpreted broadly to refer to the view that decisions should be made according to descriptions of how society would make the decisions.

On the surface, the descriptivism justification appears to hold a certain admirable modesty not found in the prescriptive approach. Analysts often could use their own preferred discount rates just as easily as they could use society's and could do so without repercussion to themselves. Thus, for analysts to follow descriptivism looks somewhat like an omnipotent dictator who voluntarily follows results of popular referendums- except of course for the fact that descriptive approach analysts are typically not omnipotent. In contrast, analysts who follow *prescriptivism* resemble authoritarian, undemocratic dictators. These dictators may well be quite benevolent, but they are, one might think, dictators nonetheless.

Upon closer inspection, the distinction between the common descriptive and prescriptive approaches breaks down. A descriptivist is forced to make a series of prescriptions that cannot be justified on descriptive grounds. First, one must choose who has standing in society, i.e. who it is that will be described. Second, one must choose how to go about describing (measuring) the preferences of whoever it is that has standing. Third, one must aggregate these measurements into a description of society's aggregate preference for discount rates or whatever else it is that is being described. All three prescriptions are necessary to form an aggregate description of society's preference. Furthermore, the particular prescriptions made in the common descriptive approach are readily contestable, further weakening any claims made by the approach to using the correct or most appropriate description. I now take a closer look at how these three prescriptions are implemented in the common descriptive and prescriptive approaches.

### **3. Standing**

To have standing *in this context* is to count in an analysis, i.e. to have one's views described. This usage of the term "standing" is adopted from Whittington and MacRae (1986) and has recently been used in Baum (2009). The present usage should not be confused with the more common legal usage of the term, in which to have standing is to be able to initiate a lawsuit. In the present context, individuals (for example, non-humans) may have standing but lack capacity to initiate a lawsuit. The tension between these two usages of "standing" is unfortunate, but there may be no superior term. The terms "suffrage", "representation", "franchise" and "target population" were also considered in the development of this paper, but none of these accurately convey the underlying idea. Like standing, the terms suffrage, representation, and franchise refer to processes (lawsuit initiation, voting) in which the included individuals participate through active processes, whereas to be described (the present context) is a passive process. Meanwhile, "target population" is vague. Thus, based on the minimal precedent of Whittington and MacRae (1986) and Baum (2009), I use "standing", although I somewhat hope that a more appropriate term may develop to supplant this.

In the context of the descriptive approach to discounting, to have standing is to be described. In other words, if the descriptive approach to discounting uses a description of society's aggregate discount rate, then the question of standing is the question of who belongs to the society being described. This section shows that there are multiple answers to the question of who has standing. The choice of who has standing requires a strong value judgment. The common descriptive approach makes such a value judgment: it grants standing to contemporary humans who participate in financial markets. This value judgment is readily contestable. Meanwhile,

the common prescriptive approach can be interpreted as granting standing to a set of individuals: all present and future humans. One could argue that the common prescriptive approach's choice of standing makes for a more defensible description.

### 3.1 The general problem

As motivation, consider the following example, hereafter called the *Farm Example*. Imagine that you are out on a farm, away from grocery stores and other modern culinary conveniences. At the farm, you are faced with a choice between going hungry, slaughtering a cow for food, or harvesting some grain for food. Also suppose that the cow is owned by your neighbor, who is an upstanding citizen, and the grain is owned by a criminal currently serving time in prison.

Now, suppose that I am tasked with recommending whether you should slaughter the cow. Suppose further that I am to make my recommendation using descriptivism. What recommendation am I to make? Clearly, I am stifled, because I cannot determine *via descriptivism* who has standing in my definition of society. Presumably your neighbor and you have standing. But what about the criminal? Criminals are often disenfranchised in civil society. What about the cow? The cow is, we can be highly confident, also a sentient being with preferences of its own. Finally, what about the grain? The grain is presumably non-sentient and thus without preferences, but it may still have interests in a morally relevant sense. The question of whether to give standing to the grain- or to any of the other individuals in this situation- must be answered before a recommendation can be made. However, this question cannot be answered based on descriptions of society's aggregate ethics. As the analyst, I must make some value judgment regarding who to give standing. It is impossible for me to make a recommendation without resorting to some justification other than descriptivism.

The question of standing is often overlooked in economic analyses. Most analyses assume that the membership of society is given and focus on how to aggregate the views of the members. Whittington and MacRae (1986) is a noteworthy exception. More contributions can be found outside of economics. This literature highlights several areas where who should have standing is ambiguous or controversial, including future humans, non-humans, non-citizens, and criminals. A general discussion is found in O'Neill (2001). Hannon (1998) explores the possibility of granting ecosystems standing; Stone (1972) is a classic paper in that realm. Sunstein (2000) discusses standing for non-human animals. Ekeli (2005) and Wolfe (2008) among others discuss standing for future individuals. In each case, whether to grant standing is a matter of dispute and thus subject to the value judgments of the analyst.

We should not underestimate the challenge of describing the discount rates of those with whom we cannot communicate (future humans, non-humans, and certain isolated humans). Baum (2007, p.20) argued that this difficulty "may be sufficiently difficult to scuttle the entire descriptivist project". However, descriptivism may be able to function in these difficult cases by operating in a probabilistic mode, i.e. by allowing the analyst the opportunity to make estimates of what preferences these individuals are likely to hold. Such estimation is necessary in even the least difficult cases, as one generally cannot know with perfect precision what someone's preferences are.

### **3.2 The common descriptive approach**

In the common descriptive approach to discounting, the only individuals to have standing are current humans who participate in financial markets. Here future humans (and also non-humans) are “disenfranchised” (Broome 1994, p.151). This follows from the fact that the description in the approach is of financial market interest rates. The participation requisite for standing here can be any participation that in any way affects interest rates. However, the relevant participation is generally assumed to be in the form of deciding whether to consume present wealth or invest it in future consumption. Thus markets describe how people discount future consumption relative to present consumption.

It should be noted that market interest rates are determined by more than just decisions of consuming now or later. Broome (1994) emphasizes the role of technology. Labor markets also contribute, since it is through labor (and technology) that there can be greater future consumption.<sup>8</sup> To the extent that these other factors influence market interest rates, it follows that the market descriptions are at least somewhat inaccurate. But regardless of how accurate the descriptions are, it remains the case that the descriptions are of only those current humans participating in financial markets.

First, consider the claim that only humans have standing in the common descriptive approach. Clearly, only humans participate in financial markets. This fact is sufficient to conclude that only humans have standing in the common descriptive approach. The restriction to humans cannot be because only humans discount. Indeed, other research readily makes descriptions of how non-humans discount. For example, Richards et al. (1997) describe discounting among rats; Stephens et al. (2002) describe discounting among blue jays. By excluding non-humans from their descriptions, supporters of the descriptive approach have imposed their values on “society”. This imposition is particularly important in analysis of climate change, given the strong impacts that climate change has on non-humans (Schneider and Root, 2001).

The point that only humans have standing should not be confused with the point that non-humans may be valued in the resulting analysis. Non-humans might be (and indeed, generally are) valued in descriptive approach analysis because they are valued by humans. This value includes, for example, the value humans place on ecosystem services. Valuing ecosystem services does not imply granting ecosystem services standing. Some have argued that our analyses are inevitably “anthropocentric” in the sense that they are inevitably performed by humans. However, just as one human analyst can, at least approximately, factor in the interests of other humans, so too can the analyst factor in the interests of non-humans (Hayward, 1997). The challenge of granting non-humans standing is different in magnitude from the challenge of granting other humans standing, but it is not different in kind.

Second, consider the claim that the only humans who have standing in the common descriptive approach are humans who participate in financial markets. Since the approach bases its

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<sup>8</sup> It can be argued that those participating in labor markets also have at least some standing in the common descriptive approach. This is because market interest rates are influenced by workers’ decisions to, for example, forgo present leisure in exchange for future consumption. In this sense there is symmetry between investment and labor, in that they both involve present sacrifice for future consumption. I am grateful to an anonymous reviewer for suggesting the importance of labor in this context.

description on market observations, those humans who do not participate in markets go undescribed. As with non-humans, it is challenging but possible to describe how these humans discount, at least in approximate terms.

Third, consider the claim that the only humans who have standing in the common descriptive approach are current humans. Some descriptivists are explicit about this. One such descriptivist is Marglin (1963, p.97), who writes “I consider it axiomatic that a democratic government reflects only the preferences of the individuals who are presently members of the body politic”. Other descriptivists might contest this claim, arguing that the discount rates of present *and* future society are revealed through market behavior. However, these descriptivists’ argument could not be the case: future humans have no say in the market behavior of present humans. This is in contrast with typical market transactions, in which buyer and seller negotiate a price. In investment decisions, the future is not there to negotiate, so the present sets the terms in what could be called a “dictatorship of the present”.

The point that only current humans have standing should not be confused with the point that future humans may be valued in the resulting analysis. As with non-humans, future humans may be (and generally are) valued because current humans value them. In fact, market discount rates can be interpreted as descriptions of how much present humans value future humans. But while future humans may be valued by present humans, they will not have standing in the choice of discount rates.

Also, the claim that future humans do not have standing in the common descriptive approach to discounting should not be mistaken for a claim that future humans do not have standing in the broader CBA. Indeed, the opposite is the case, because costs and benefits to future humans are included in the CBA. However, even if future humans have standing in the CBA, they do not have standing in the choice of discount rate.

As somewhat of an aside, note that the text here has not distinguished between future generations and the future selves of people alive today. This in deference to the view that our present selves and our future selves are not the same: you are not the same person now as the person you will be in the future. This view rests on the extensive empirical evidence on discounting (in particular “hyperbolic discounting”, on which see e.g., Ainslie 1975; 2001) which finds that people (and members of other species) exhibit *dynamic inconsistency*, meaning that our choices at one time are inconsistent with our choices at another time. Thus, our future selves might disagree with the market investment decisions (or other decisions) of our present selves.

However we define future humans, their exclusion is readily contestable. The decisions in question- those of discounting- are precisely those decisions which affect future humans. Sunstein and Rowell (2007, p.178) ask, “Why should the interests of future generations be determined by consulting the preferences of the present generation? Those preferences might well be self-interested. Even if there is a degree of altruism, there is no reason to think that the (bounded) altruism of the present should settle the moral entitlements of the future.” (See also Sen 1961, p.482, 486, and Cowen and Parfit 1992, p.146.) To exclude future humans is thus to violate the basic principle that those who are effected by a decision should have input in the

decision-making process. Thus, by excluding future humans, supporters of the common descriptive approach are making a very dubious value judgment.

### **3.3 The common prescriptive approach**

Who has standing in the common prescriptive approach? If we are to believe prescriptive approach critics, then the only people who have standing here are analysts themselves and the governments who support them, because these people choose the discount rate without any input from anyone else. This choice of standing would make for a very small society! Under this interpretation of the prescriptive approach, the critics have strong grounds for accusing the prescriptive approach of being elitist and anti-democratic. However, this “elitist interpretation” is not the only possible interpretation of the prescriptive approach.

The prescriptive approach also has a “populist interpretation” which gives standing to all contemporary and future humans. This range is apparent from how the prescriptive approach chooses the utility discount rate and the elasticity parameter ( $\rho$  and  $\eta$  in Equation 1). The prescriptive approach sets  $\rho=0$  on grounds that all utility should count equally, regardless of when it occurs, and sets  $\eta$  based on some reasonable estimation of the relationship between consumption and utility, i.e. an estimate within the range of values found by empirical or philosophical inquiries (c.f. Quiggin 2008, p.197–198; Stern 2008, p.15–17). As discussed below, “utility” can be interpreted to mean “preference”. The choice of  $\eta$  thus corresponds with a particular way of measuring preference strength, and setting  $\rho=0$  corresponds with a way of aggregating preference strength, as also discussed below. To count an individual’s preference is to grant that individual standing, so the prescriptive approach to discounting can be interpreted as granting standing to present and future humans in how it selects its discount rates.

The same line of reasoning cannot be used to argue that the descriptive approach grants standing to future humans. It is true that the descriptive approach also counts future utility. By setting  $\rho>0$ , the descriptive approach counts future utility less, but it does count future utility nonetheless. The key difference between the prescriptive and descriptive approaches is the method used to determine the discount rates. Whereas the prescriptive approach chooses these rates by appealing to the utility/preferences of present and future humans, the descriptive approach chooses these rates by appealing to the market behaviors of present humans. So while, as noted above, future humans have standing in the broader descriptive approach to CBA, they do not have standing in the choice of discount rate.

## **4. Measurement**

Given a selection of which individuals have standing in a description of discounting, the next step is to select how to measure the individuals’ discount rates. In this section, I will show that there are multiple answers to the question of how to make such measurements, and that these different answers lead to significantly different discount rates. The choice of which measurement to use requires another strong value judgment. The common descriptive approach makes such a value judgment, measuring discount rates through specific market activities. This measurement is readily contestable. Meanwhile, the common prescriptive approach can be

interpreted as employing a measurement technique as well, via its approach to choosing the elasticity parameter.

#### 4.1 The general problem

As motivation, consider the following example, hereafter called the *Finger Example*. First, hold up one finger. Then, say out loud, “I should hold up two fingers.” Then, repeat this while thinking in your mind “I should hold up three fingers.” Finally, imagine meanwhile being a devout member of the Church of I Should Hold Up Four Fingers and a citizen of a land where it is illegal to hold up anything other than five fingers.

Now, suppose that I am tasked with recommending how many fingers you should be holding up. Suppose further that I am to make my recommendation using descriptivism. What recommendation am I to make? Clearly, I am stifled, because I cannot determine *via descriptivism* which measurement to use. Perhaps I can rule out every number of fingers other than one, two, three, four, and five. But how do I choose from among these? Each of them represents a different measurement. In the absence of any other information (and there may well be no other information), I cannot make a recommendation without choosing which measurement to use. However, in choosing a measurement, I am making a value judgment. Therefore, in this very simple example, it is impossible for me to follow descriptivism without imposing my values on the analysis.

Some of the measurement challenge can be attributed to *dynamic inconsistency*, which is the phenomenon of an individual’s preferences at one time being inconsistent with the individual’s preferences at another time (c.f. Strotz 1955; Ainslie 1975; 2001; Hansen 2006). For example, perhaps you thought you should hold up four fingers when you joined the Church of I Should Hold Up Four Fingers, but you have since changed your mind. If we take the view that an individual at different points in time is not strictly the same individual, then the measurement challenge posed by dynamic inconsistency can be resolved by granting standing to individuals at each point in time and conducting a separate measurement for each.

Dynamic inconsistency cannot, however, explain the entire measurement challenge. The other part of the challenge comes from the possibility that an individual can hold multiple preferences *at the same time*. Marglin (1963) calls this “schizophrenia”. For example, you can readily hold up one finger at the same time as you say that you should hold up two fingers. This mismatch between revealed and stated preference is important, but the challenge runs much deeper. Research on moral cognition indicates that different parts of the brain simultaneously conduct different forms of moral reasoning. For example, Greene et al. (2001) present evidence from functional magnetic resonance imaging (fMRI) studies that appear to show that utilitarian thinking and deontological (Kantian) thinking occur in different parts of the human brain. Assuming this result (or at least something along the lines of this result) to be accurate, then choosing how to describe an individual’s ethics amounts to choosing which portion of that person’s brain to privilege on questions of morality.<sup>9</sup>

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<sup>9</sup> Some of these issues are further examined in Elster (1987).

It is true that economists often privilege behavior (i.e. revealed preference) over stated preference or other techniques. This privileging has a long and complicated history, deeply intertwined with positivist philosophy, behavioralist psychology, and assumptions of human rationality and market perfection (c.f. Easterlin, 2004; Kahneman and Sugden, 2005). There might (or might not) be excellent reasons to favor behavior for measurement purposes. However, these reasons cannot be value neutral, for they concern the question of how measurement *should* be conducted, a question which cannot be answered on descriptivist grounds.

## 4.2 The common descriptive approach

In the descriptive approach to discounting, as it is commonly implemented, the measurement is conducted through observation of specific market behavior. Here, preference strength is measured in monetary units: when less money is invested, interest rates increase so as to entice investors with higher returns. This “voting with dollars” is similar to that of CBA in general, in which money is used as a “measuring rod” for preference strength (c.f. Baumol, 1946-1947, p.46). The difference here is that in the common descriptive approach to discounting, the voting is for how high of an interest rate to accept.

Multiple market behavior measurements are possible, as follows from the range of available market interest rates, such as equities and bonds. The descriptive approach generally favors the higher rates found in equities. The challenge of reconciling these different rates is known as the “equity premium puzzle” (Mehra and Prescott, 1985). Quiggin (2008) and Brekke and Johansson-Stenman (2008) offer commentary on the significance of the equity premium puzzle to the climate change discounting debate. If a lower market rate is chosen, such as that of bonds, then the discount rates chosen by the common descriptive and prescriptive approaches become quite similar. This similarity suggests that the divergent philosophies of the two approaches can in some circumstances reach consensus on the choice of discount rates.<sup>10</sup> However, the existence of multiple market rates implies that analysts cannot consider any single market rate to describe how society discounts. In choosing one of these rates (whichever they choose), descriptivists impose their values upon society.

There are other approaches to measuring how people discount besides observations of market rates. One approach is stated preference surveys, in which people state how they make tradeoffs over time. In such surveys, people display an extremely wide range of discount rates, from negative to infinite (Frederick et al., 2002). Another approach is brain imaging. Some early brain imaging evidence suggests that different parts of the brain are active in different discounting decisions (McClure et al., 2004). A third approach is analyzing discount rates in public policy. Public discount rates have the advantage of avoiding collective action problems that may exist in market behaviors. For example, when individual saving is viewed as having positive externalities, then without public coordination, individuals may save at rates viewed as sub-optimally low (Sen, 1961, 1967; see also Sagoff, 1986 for a general discussion of the difference between public and private behavior and the normative significance of this

<sup>10</sup> I am grateful to an anonymous reviewer for emphasizing the importance of this point. It should also be noted that some forms of the prescriptive approach, such as that favored by Dasgupta (2008), lead to discount rates similar to the higher rates found in equities. This is another circumstance in which the descriptive and prescriptive approaches can yield similar discount rates.

difference). There have also been a wide range of institutionalized discount rates throughout history (Houkes, 2004), some of which persist today. Discount rates for United States federal regulations are set in OMB Circular A-4 (OMB, 1992; see Graham, 2007, for discussion). Cruz Rambaud and Muñoz Torrecillas (2005, p.344, Table 1) present a range of other government discount rates.

How one chooses from among these discount rates cannot be resolved from description of an individual's or a society's ethics, since these are all descriptions themselves. Analysts could choose any of these rates and make no less of a claim to being descriptive as those who choose the rates found in equities markets. One could make the argument that the market rates are inappropriate because they represent private decisions, whereas CBAs of climate change and other policies are public decisions (c.f. Stern, 2008). In private decisions such as market investment, the costs and benefits of the decision go only to the subset of society who is making the decision. In contrast, in public decisions such as climate change policies, the costs and benefits of the decision go to the public at large. Thus, the value judgment imposed on society in measuring discounting with market rates is readily contestable.

### **4.3 The common prescriptive approach**

Measurement in the common prescriptive approach depends on which interpretation of the prescriptive approach is chosen. First, consider the “elitist” interpretation, in which only the analysts and their sponsors have standing. Under this interpretation, the measurement is a measurement of what these elites claim they favor. The elites might be hypocritical in that they might not act as though they discount according to the rates they prescribe. In this case there would be a mismatch between their stated preference and revealed preference. Either way, they are making a value judgment in their choice of discount rate. While the prescriptivists are quite explicit in their value judgments, under this interpretation, they can again be accused of elitism.

Second, consider the “populist” interpretation, in which present and future humans have standing. Under this interpretation, the measurement is found in Equation 2. The choice of  $\eta$  is essentially a choice of measurement: it defines how preference strength is to be measured in terms of monetary consumption. Here, “utility” is equated with “preference” instead of with an experienced phenomenon such as happiness. (On the various definitions of “utility”, see Broome, 1991; Kahneman and Sugden, 2005.) Once  $\eta$  is chosen, the monetary discount rate  $r$  follows accordingly, given values for  $g$  and  $\rho$ . In this interpretation of the prescriptive approach, the choice of utility discount rate  $\rho$  is essentially a choice of aggregation and is discussed below.

## **5. Aggregation**

Given choices of which individuals have standing in society and how the preferences or discount rates of these individuals are to be measured, the final step is to aggregate these individual measurements into a societal measurement. This societal measurement is the description that the descriptive approach seeks to make. As with standing and measurement, there are many ways of implementing aggregation. Here lies the final space where descriptive approach analysts must inject their value judgments. The common descriptive approach uses a “one dollar equals one

vote” aggregation scheme. Meanwhile, the prescriptive approach uses a “one unit of utility equals one vote” aggregation scheme.

## 5.1 The general problem

As motivation, consider the following example, hereafter called the *Contract Killer Example*. Consider a society with three people: Alice, Bob, and Carlos. Suppose that Alice is a contract killer, and that Bob would like to hire her to kill Carlos. Carlos learns of the plot, and attempts to bribe Alice not to kill him. However, Carlos is poor and cannot offer as much money as Bob.

Now, suppose that I am tasked with recommending whether Carlos should be killed. Suppose further that I am to make my recommendation using the descriptivism. What recommendation am I to make? Clearly, I am stifled, because I cannot determine *via descriptivism* how to aggregate the preferences of Alice, Bob, and Carlos. If we aggregate based on a “one person, one vote” scheme, then Carlos should be killed, because Bob would vote for his death, as would Alice, because this would bring her more money. The same conclusion is reached under a “one dollar, one vote” scheme. However, Carlos presumably has a very strong preference not to die. If this preference is stronger than the combined preference strength of Alice and Bob, then aggregating based on preference strength would suggest that Carlos should not be killed. I cannot make a recommendation without choosing which aggregation scheme to use. However, in choosing how the preferences should be aggregated, I am making a value judgment. It is again impossible for me to follow descriptivism without imposing my values on society.

The problem of how to conduct aggregation has a long and distinguished history in the field of social choice analysis. The voting paradox of Condorcet (1785) and the impossibility theorem of Arrow (1963) are both statements of the challenge of aggregation. Sen (1999) describes how the impossibility can be overcome, though not without the analyst’s value judgment entering the process.

Economists have long performed aggregation by counting all dollars equally. This approach is viewed as consistent with Pareto efficiency with potential (Kaldor-Hicks) compensation. (See Adler and Posner 2006 for further discussion.) However, this aggregation scheme is not a value-neutral one (c.f. Baumol 1946–1947, p.46). In particular, this scheme counts the preferences of the rich more than the preferences of the poor. Dowlatabadi (2007, p.655) notes this in the context of climate change impacts: “When a monetary metric is used to aggregate costs and benefits across different communities, the aggregate outcome will be biased towards the consequences of climate change and policy in the richest subgroup.” The “one dollar, one vote” aggregation scheme is thus highly controversial, and understandably so.

## 5.2 The common descriptive approach

As with so much economic analysis, the common descriptive approach to discounting aggregates using a “one dollar, one vote” scheme. This again follows from the approach’s use of market interest rates: interest rates respond to dollars invested, regardless of how these dollars are distributed among investors. And as with the common descriptive approach’s choices for standing and measurement, its “one dollar, one vote” aggregation scheme is readily contestable.

The “one dollar, one vote” scheme is not the only possible scheme, even given the decision to measure discounting preferences with dollars. This point is noted, for example, by Sen (1961, p.487), who writes that “the distribution of votes in a political decision need not conform to the distribution of the capacity to save in the market mechanism. Thus, the over-all discount emerging from the market mechanism may not have much in common with the decision that will emerge from political voting”. In particular, aggregate rates would differ if individual rates varied as a function of wealth. If such variation does not exist, then everyone (that is, everyone who has standing) agrees on which discount rates to use and thus there will be no aggregation issue.

### **5.3 The common prescriptive approach**

As with measurement, aggregation in the common prescriptive approach depends on which interpretation of the prescriptive approach is chosen. Under the “elitist” interpretation, aggregation is conducted through whatever decision-making process the elites use in choosing the discount rates. This interpretation is again vulnerable to charges of elitism.

Under the “populist” interpretation, the aggregation scheme is found in Equation 1. The basic principle is “one unit of utility equals one vote”, where utility/preference is measured by  $\eta$ , as discussed in Section 4.3. This principle follows from the decision to set  $p=0$ . Here, the utility discount rate is treated as an aggregation scheme. Meanwhile, the monetary discount rate is a property of the societal description as set via  $\rho$  and  $\eta$ . Thus, in the common prescriptive approach, the choice of discount rates can be interpreted as a description of the preferences of all present and future humans.

## **6. Conclusion**

It is not possible for an analyst to make a description of how society discounts without the analyst injecting her values into the analysis. Value judgments must be made when making decisions on standing (who is in society), measurement (how the views of individuals in society are assessed), and aggregation (how individual views are combined to form a societal view). The common descriptive approach to discounting makes value judgments at each of these three junctures. These value judgments are all readily contestable. Thus, while the descriptive approach to discounting can claim to discount according to a description of how society discounts, the approach cannot claim to have avoided injecting its values into the analysis. Furthermore, the common prescriptive approach can also claim to discount according to a description of how society discounts. For these reasons, the label “descriptive approach to discounting” is a misnomer.

More significant than the semantics of discounting approach labels is the result that analysts cannot avoid imposing their own prescriptions on society. Thus, discount rates based on market interest rates cannot be justified exclusively with the descriptivism justification, i.e. exclusively on the grounds that market interest rates describe how society discounts. Other justification is necessary. This result weakens the grounds for using market interest rates to select discount

rates. However, such rates can still be justified, whether via ethical judgments of how descriptions should be made or by other arguments entirely, such as arguments about efficiency. These justifications must be defended on their own terms without appeals to being descriptive.

The techniques and insights of this paper extend well beyond discounting. The relevance is to any argument involving the descriptivism justification, i.e. the claim that prescriptions should be based on descriptions of what society thinks should be done. Any societal description necessarily involves judgments of standing, measurement, and aggregation. Analysis such as that presented in this paper is necessary to identify what judgments are being made and in turn assess whether these judgments are desirable. Otherwise, we may be making the wrong societal descriptions and in turn the wrong prescriptions. Given the high stakes involved in so many of the corresponding decisions – whether about discounting in climate change, catastrophic risk, or other issues – getting the prescriptions wrong can be disastrous.

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## References

- Adler, M.D., Posner, E.A., 2006. New Foundations of Cost-Benefit Analysis. Harvard University Press, Cambridge, MA.
- Ainslie, G., 1975. Specious reward: a behavioral theory of impulsiveness and impulse control. *Psychological Bulletin*, 82 (4), 463–496.
- Ainslie, G., 2001. Breakdown of Will. Cambridge University Press, Cambridge, UK.
- Anthoff, D., Tol, R.S.J., Yohe, G.W., 2008. Risk Aversion, Time Preference, and the Social Cost of Carbon. ESRI Working Paper No. 252, Economic and Social Research Institute, Dublin.
- Arrow, K.J., 1963. Social Choice and Individual Values, Second Edition. Wiley, New York.
- Arrow, K.J., Cline, W., Maler, K.G., Munasinghe, M., Squitieri, R., Stiglitz, J., 1996. Intertemporal equity, discounting and economic efficiency. In: Bruce, J., Lee, H., Haites, E. (Editors), *Climate Change 1995: Economic and Social Dimensions of Climate Change*. Cambridge University Press, Cambridge, UK, pp. 125–144.
- Bauer, P.T., 1957. Economic Analysis and Policy in Underdeveloped Countries. Duke University Press, Durham, NC.
- Baum, S., 2007. Beyond the Ramsey model for climate change assessments. *Ethics in Science and Environmental Politics*, 2007, 15–21.
- Baum, S.D., 2009. Cost-benefit analysis of space exploration: some ethical considerations. *Space Policy*, 25 (2), 75–80.
- Baumol, W.J., 1946–1947. Community indifference. *Review of Economic Studies*, 14 (1), 44–48.

- Brekke, K.A., Johansson-Stenman, O., 2008. The behavioral economics of climate change. *Oxford Review of Economic Policy*, 24 (2), 280–297.
- Broome, J., 1991. "Utility". *Economics and Philosophy*, 7, 1–12.
- Broome, J., 1994. Discounting the future. *Philosophy and Public Affairs*, 23 (2), 128–156.
- Caney, S., 2008. Human rights, climate change, and discounting. *Environmental Politics*, 17 (4), 536–555.
- Condorcet, J.-A.-N. de C., 1785. *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix*. L'Imprimerie Royale, Paris.
- Cowen, T., Parfit, D., 1992. Against the social discount rate. In: Laslett, P., Fishkin, J.S. (Editors), *Justice Between Age Groups and Generations*. Yale University Press, New Haven, pp. 144–161.
- Cruz Rambaud, S., Muñoz Torrecillas, M.J., 2005. Some considerations on the social discount rate. *Environmental Science and Policy*, 8, 343–355.
- Dasgupta, P., 2008. Discounting climate change. *Journal of Risk and Uncertainty*, 37, 141–169.
- Dowlatabadi, H., 2007. On integration of policies for climate and global change. *Mitigation and Adaptation Strategies for Global Change*, 2, 651–663.
- Easterlin, R.A., 2004. *The Reluctant Economist: Perspectives on Economics, Economic History, and Demography*. Cambridge University Press, Cambridge, UK.
- Ekeli, K.S., 2005. Giving a voice to posterity: deliberative democracy and representation of future people. *Journal of Agricultural and Environmental Ethics*, 18, 429–450.
- Elster, J. (Editor), 1987. *The Multiple Self*. Cambridge University Press, Cambridge, UK.
- Frederick, S., Loewenstein, G., O'Donoghue, T., 2002. Time discounting and time preference: a critical review. *Journal of Economic Literature*, 40 (2), 351–401.
- Graham, J.D., 2007. Valuing the future: OMB's refined position. *University of Chicago Law Review*, 74 (1), 51–57.
- Greene, J.D., Sommerville, R.B., Nystrom, L.E., Darley, J.M., Cohen, J.D., 2001. An fMRI investigation of emotional engagement in moral judgment. *Science*, 293, 2105–2108.
- Hannon, B., 1998. How might nature value man? *Ecological Economics*, 25, 265–279.
- Hansen, A.C., 2006. Do declining discount rates lead to time inconsistent economic advice?. *Ecological Economics*, 60 (1), 138–144.
- Hayward, T., 1997. Anthropocentrism: a misunderstood problem. *Environmental Values*, 6, 49–63.
- Houkes, J.M., 2004. *An Annotated Bibliography on the History of Usury and Interest from the Earliest Times Through the Eighteenth Century*. Edwin Mellen Press, Lewiston, NY.
- Kahneman, D., Sugden, R., 2005. Experienced utility as a standard of policy evaluation. *Environmental and Resource Economics*, 32, 161–181.
- Marglin, S.A., 1963. The social rate of discount and the optimal rate of investment. *Quarterly Journal of Economics*, 77 (1), 95–111.
- McClure, S.M., Laibson, D.I., Loewenstein, G., Cohen, J.D., 2004. Separate neural systems value immediate and delayed monetary rewards. *Science*, 306, 503–507.
- Mehra, R., Prescott, E.C., 1985. The equity premium: a puzzle. *Journal of Monetary Economics*, 15 (2), 145–161.
- Nelson, J.A., 2008. Economists, value judgments, and climate change: a view from feminist economics. *Ecological Economics*, 65 (3), 441–447.
- Nordhaus, W., 2007. The Stern Review on the economics of climate change. *Journal of Economic Literature*, 45 (3), 686–702.

- Nordhaus, W.D., 2009. An Analysis of the Dismal Theorem. Cowles Foundation Discussion Paper No. 1686, Cowles Foundation, New Haven, CT.
- Norgaard, R.B., 1989. The case for methodological pluralism. *Ecological Economics*, 1 (1), 37–57.
- OMB, 1992. Circular No. A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. Office of Management and Budget, October 29.  
<http://www.whitehouse.gov/omb/circulars/a094/a094.html> (accessed 5 October 2008)
- O'Neill, J., 2001. Representing people, representing nature, representing the world. *Environment and Planning C: Government and Policy*, 19 (4), 483–500.
- Proops, J.L.R., 1989. Ecological economics: rationale and problem areas. *Ecological Economics*, 1 (1), 59–76.
- Quiggin, J., 2008. Stern and his critics on discounting and climate change: an editorial essay. *Climatic Change*, 89, 195–205.
- Ramsey, F., 1928. A mathematical theory of saving. *Economic Journal*, 38 (152), 543–559.
- Richards, J.B., Mitchell, S.H., de Wit, H., Seiden, L.S., 1997. Determination of discount functions in rats with an adjusting-amount procedure. *Journal of the Experimental Analysis of Behavior*, 67, 353–366.
- Sagoff, M., 1986. *The Economy of the Earth*. Cambridge University Press, Cambridge, UK.
- Schneider, S.H., Root, T.L. (Editors), 2001. *Wildlife Responses to Climate Change: North American Case Studies*. Island Press, Washington, DC.
- Sen, A.K., 1961. On optimising the rate of saving. *Economic Journal*, 71, 479–496.
- Sen, A.K., 1967. Isolation, assurance and the social rate of discount. *Quarterly Journal of Economics*, 81 (1), 112–124.
- Sen, A., 1999. The possibility of social choice. *American Economic Review*, 89 (3) 349–378.
- Sen, A., Williams, B. (Editors), 1982. *Utilitarianism and Beyond*. Cambridge University Press, Cambridge, UK.
- Stephens, D.W., McLinn, C.M., Stevens, J.R., 2002. Discounting and reciprocity in an iterated prisoner's dilemma. *Science*, 298, 2216–2218.
- Stern, N., 2007. *The Economics of Climate Change: the Stern Review*. Cambridge University Press, Cambridge, UK.
- Stern, N., 2008. The Economics of Climate Change. *American Economic Review*, 98 (2), 1–37.
- Stone, C., 1972. Should trees have standing? Toward legal rights for natural objects. *Southern California Law Review*, 45, 450–501.
- Strotz, R.H., 1955. Myopia and inconsistency. *Review of Economic Studies*, 23, 165–180.
- Sunstein, C.R., 1991. Preferences and politics. *Philosophy and Public Affairs*, 20 (1), 3–34.
- Sunstein, C.R., 2000. Standing for animals. *UCLA Law Review*, 47 (5), 1333–1368.
- Sunstein, C.R., Rowell, A., 2007. On discounting regulatory benefits: risk, money, and intergenerational equity. *University of Chicago Law Review*, 74 (1), 171–208.
- Viscusi, W.K., 1993. The value of risks to life and health. *Journal of Economic Literature*, 31, 1912–1946.
- Whittington, D., MacRae, Jr., D., 1986. The issue of standing in cost-benefit analysis. *Journal of Policy Analysis and Management*, 5 (4), 665–682.
- Wolfe, M.W., 2008. The shadows of future generations. *Duke Law Journal*, 57, 1897–1932.