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Philosophers and economists agree on climate policy paths but disagree on why

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Abstract

The estimated value to society from climate change mitigation is highly sensitive to the long-term social discount rate (SDR). While it is not clear that they possess any special expertise on intergenerational ethics, governmental discounting guidance has almost exclusively been influenced by economists. By contrast, we report the views of philosophers, who are most trained in ethical matters. We show that, as a group, these experts offer strong support for a real SDR of 2%; a value that is also predominantly backed by economists. We find multidisciplinary support for climate policy paths in line with the UN climate targets when views on discounting determinants are applied within a recent update of the DICE Integrated Assessment Model. However, this apparent agreement hides important differences in views on how the ethics of intergenerational welfare can be better incorporated into climate policy evaluation.

Main

The appraisals of climate mitigation policies and projects are notoriously sensitive to the weight placed on future costs and benefits [1, 2]. In Cost-Benefit Analysis using Integrated Assessment Models (IAMs), this weight is determined through the social discount rate (SDR) and its determinants, with small changes to the SDR having significant policy implications. The Trump administration's recalculation of the Social Cost of Carbon (SCC) showed that increasing the real SDR from 3% to 7% reduces the SCC by a factor of seven within its chosen model [3]. By contrast, New York State has raised its SCC from \$40 to \$125 per ton of CO_2 based on a real SDR of 2% rather than 3% [4], while recent interim estimates by the US Environmental Protection Agency (EPA) [5] calculate a central SCC of \$190 based on a real SDR that declines from an initial value of 2%. Recent judgements on the SCC and its underlying SDR in the US (Louisiana et al. vs. Biden et al.; Case 2:21-CV-01074) have underscored the importance of this issue.

Despite enormous sensitivities of policy appraisals to discounting choices and their ethical content, recommendations on the SDR have been dominated by economists [6] who do not have any special expertise in providing ethical advice [7]. Rather, economics has been described as being 'value-free' [8] due to a reliance on revealed preference and economic fundamentals to identify what is socially desirable [9, 10]. This has not gone unnoticed, with the Biden Administration being recommended to *"seek broad input"*, including from philosophers [4, p549] who do have specific competencies in such complex ethical matters. While a number of philosophers have engaged with social discounting [e.g., 11–19], a systematic account of the views of these disciplinary experts has previously been missing. We therefore undertake a comprehensive survey of

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philosophers with expertise on social discounting, focused on the appropriate intergenerational SDR, and compare the results to those from a previous identical survey of expert economists [20]. We find that philosophers and economists exhibit strong agreement on a long-run real SDR of 2%.

Our survey also allows us to apply philosophers' views on discounting to determine an optimal climate policy path within a recent update [21] of a prominent IAM, DICE [22]. This model is underpinned by the Simple Ramsey Rule (SRR) within the Discounted Utilitarian framework that is commonly understood by experts from both disciplines and found in government guidelines across the world [23–25]. The SRR equates the return to capital through real interest rates (r) on the *production* side of the economy, with the social rate of time preference ($\delta + \eta g$) on the *consumption* side: $r = SDR = \delta + \eta g$, which can be calibrated in different ways (see Methods). Here, δ reflects societal impatience as measured by the discount rate on utility, while ηg is the wealth effect that places a lower weight on future consumption if marginal utility of consumption is diminishing ($\eta > 0$) and when future societies are predicted to be wealthier than today ($g > 0$).

The evidence we present is directly relevant to EPA as it looks to update its SCC. As emphasised by [26, pp.648-9], many US statutes require agencies to use the highest quality data to allow them to best take into account the welfare of future generations, including "intergenerational equity". Additionally, Circular A-4 states that "special ethical considerations arise when comparing benefits and costs across generations." This paper explicitly addresses such ethical questions, providing data that are of direct relevance to EPA and other policy-makers.

Coupled with a direct elicitation of the SDR in its general formulation, we asked for values of each of the components of the SRR: r, δ, η and g. Our results show that experts broadly support the parameter values currently applied by EPA in its latest SCC estimates, although based on very different intellectual arguments. We then apply the philosophers' median recommended values of δ and η as inputs to an updated version of the DICE model [21]. This results in an optimal climate policy path that is almost indistinguishable from that recommended by the median view of economists as previously reported in [21]. Both are highly supportive of the UN Paris climate targets. The median views from both disciplines translate into climate policy paths that limit global temperature change to under 1.5°C by 2100, with estimates for the SCC of around \$220 per ton of CO_2 in 2020.

However, while there is agreement between the two disciplines on these and other matters, both quantitative and qualitative responses reveal that each has systematically different recommendations for how intergenerational welfare can be better incorporated into climate policy analysis. Philosophers are much more reluctant to reduce the complex matter at hand to simple parameter values within the SRR, reflecting their discomfort with the Discounted Utilitarianism approach. Economists, by contrast, often recommend technical extensions to the SRR to account for uncertainty, distribution and limited substitutability of non-market goods.

In addition, philosophers give systematically lower responses for δ than economists, reflecting their stronger preference for an impartial perspective of social justice. This impartiality perspective is also reflected in a greater median value for inequality aversion, η, although its sample frequency distribution does not differ significantly between the two disciplines. Yet, with positive expected growth, g, a higher median η leads to a *higher* SDR and less weight placed on future well-being. These two effects 'cancel out' on average within the SRR, and the implied climate policy paths are therefore similar to those recommended by economists.

Finally, philosophers place greater weight on normative considerations and less on the potential inefficiencies that arise from ignoring production-side opportunity costs (r) compared to economists. Therefore, while providing multidisciplinary support for the UN climate targets, philosophers and economists provide different practical and ethical insights into future methodological improvements for undertaking the appraisal of climate change mitigation policies.

Expert recommendations for the SDR

The survey, outlined in the Methods, asked respondents for their preferred value of the real, long-term (>100 years) SDR, and the values for each of the components, r, δ, η and g, of one specific formulation of the SDR: the SRR. Additionally, we asked each expert the extent to which the SDR should be based on normative issues, involving justice towards future generations, compared to descriptive issues, such as observed or forecast market rates of return. 'Acceptable ranges', within which each expert thought the SDR could reasonably lie, were also elicited, and an opportunity was given for open-ended qualitative comments.

We identified many fewer philosophers with expertise in social discounting ($n = 46$), selected on the basis of relevant publications, than expert economists ($n = 627$) [20]. However, we received a higher response rate from philosophers (63%, $N = 29$) than in [20] (31%, $N = 197$), thus capturing a more complete account of the relevant expert population. Yet, philosophers were much less willing to provide responses to the quantitative questions. Only 52% ($\nu = 15$) provided quantitative responses, with some questions receiving as few as 10 answers (see Table SI1). This is comparable to other recent expert surveys on key intergenerational matters [e.g., 27, 28].

We first illustrate the distributions of philosophers' quantitative responses and contrast these with those by economists (Figure 1); see Table SI1 and Figure SI1 for further details. A key finding, depicted in panel (a), is that philosophers and economists have very similar views on the appropriate value for the long-term SDR. Using a non-parametric Wilcoxon rank-sum test, we are unable to reject the null hypothesis that the two sets of responses come from the same distribution ($p = 0.818$). While economists have a slightly lower median response (2.0% versus 2.4%), the mean responses are almost identical at 2.27%. The multidisciplinary agreement on the SDR is further strengthened by examining 'acceptable ranges' for the SDR (Figure 1(b)). A real SDR of 2% is most often contained within this range for experts in both disciplines; for all but one philosopher and 77% of economists. Expert support falls quickly for higher values of the SDR. There are also no significant differences between the two disciplines on the descriptive components of the SRR; real growth, g, and the real risk-free interest rates, r, shown in panels (c) and (d) (rank-sum, p=0.681 and p=0.617).

There are, though, important areas of disagreement. Philosophers are much less persuaded by opportunity cost of capital arguments for setting the SDR than economists (see panel (e)). The mean (median) recommended weight put on normative considerations are 78.5% (80%) for philosophers and 61.5% (70%) for economists and the distributions are statistically significantly different (rank-sum, p=0.040). Panel (f) shows that, for the *"two central normative parameters"* [29, p33] of the SRR, philosophers recommend statistically significantly lower values (rank-sum, p=0.043) for pure time preference, δ, than economists despite a few outlier high responses. While it might be expected that this preference for intertemporal equity would lead philosophers to provide higher values for the elasticity of marginal utility, η, panel (g) shows that this view is not supported by the data, as the rank-sum test fails to reject the null that the two distributions of responses are identical (p=0.539). The median response of philosophers is notably higher than that of economists, though, and this has an important part to play in the next section.

Optimal climate policy paths

To consider implications for optimal climate policy paths, we apply an updated version of the IAM, DICE [21, 22], outlined in Methods. Key changes include an update of the climate module and more recent climate damage estimates. Discounting within DICE requires two input variables from the SRR framework: δ and η. For the two summary measures, we use the *median view* from

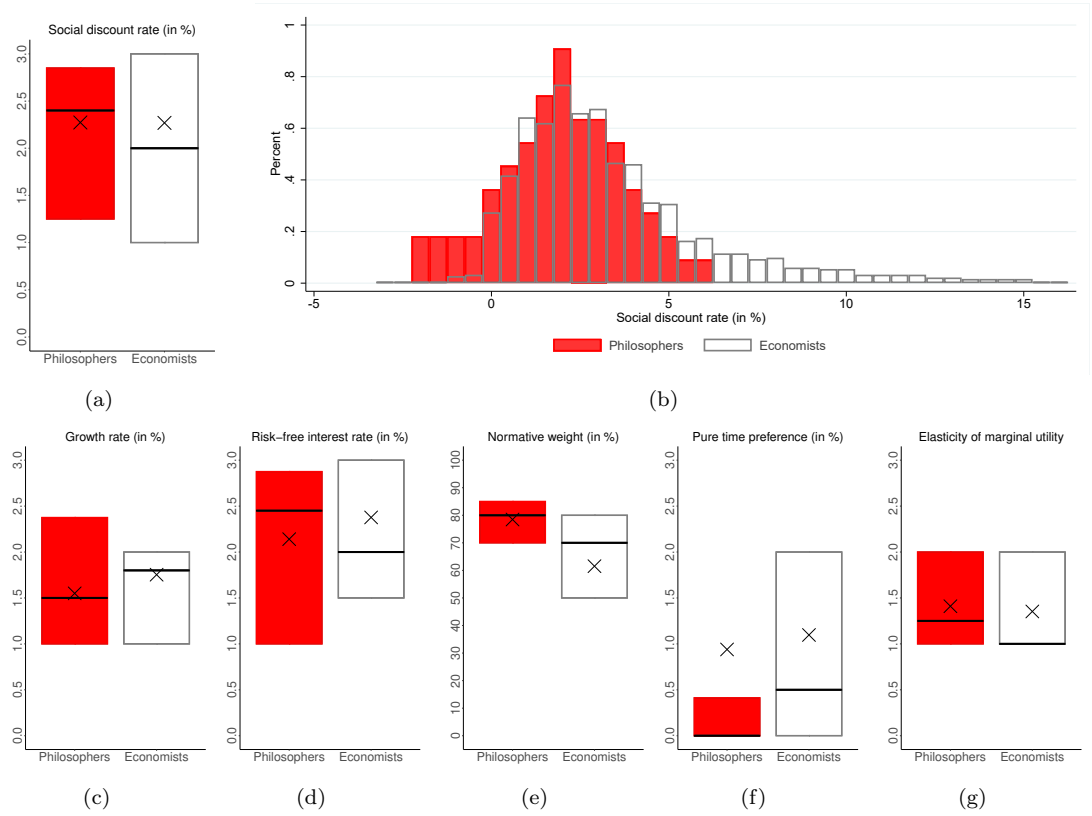

Figure 1: **Comparison of philosopher and economist recommendations on intergenerational discounting and key determinants.** (a) Real social discount rate, SDR; (b) percentage of experts whose SDR range they are comfortable with recommending includes the SDR-value given on the $x-$axis; (c) real growth rate, g; (d) real risk-free interest rate, r; (e) normative weight; (f) pure time preference, δ; and (g) elasticity of marginal utility, η. Number of observations for philosophers (economists) from top left to bottom right: n = 11(181), n = 11(182), n = 10(181), n = 10(176), n = 13(182), n = 14(180), n = 10(173). Boxes in panels (a) and (c) to (g) represent interquartile ranges (25 to 75 percentiles). The thick horizontal black lines depict medians and the crosses mean values.

philosophers for these two parameters and the *median run* of resulting climate policy paths. For each parameter pair, the optimal climate policy is computed. The growth path is non-constant and endogenised, not a constant long-term rate from experts' forecasts.

We illustrate climate policy paths for each of the ten philosophers that provided complete pairs of pure time preference and the elasticity of marginal utility (Figure 2). The *median view* represents this summary measure on both parameters individually (Figure 2(a)), while the specific combination ($\delta = 0.075$, $\eta = 1.25$) is not held by any particular philosopher. The *median run* of philosophers' policy paths, in contrast, is supported by three philosophers with identical views ($\delta = 0$, $\eta = 2$). We observe that 60% of the runs result in temperature changes below 2°C by the end of the century (Figure 2(d)).

Next we compare policy paths under median philosophers' views with an identical analysis by [21] that uses the median economists' views as reported in [20]. We also calibrate the DICE

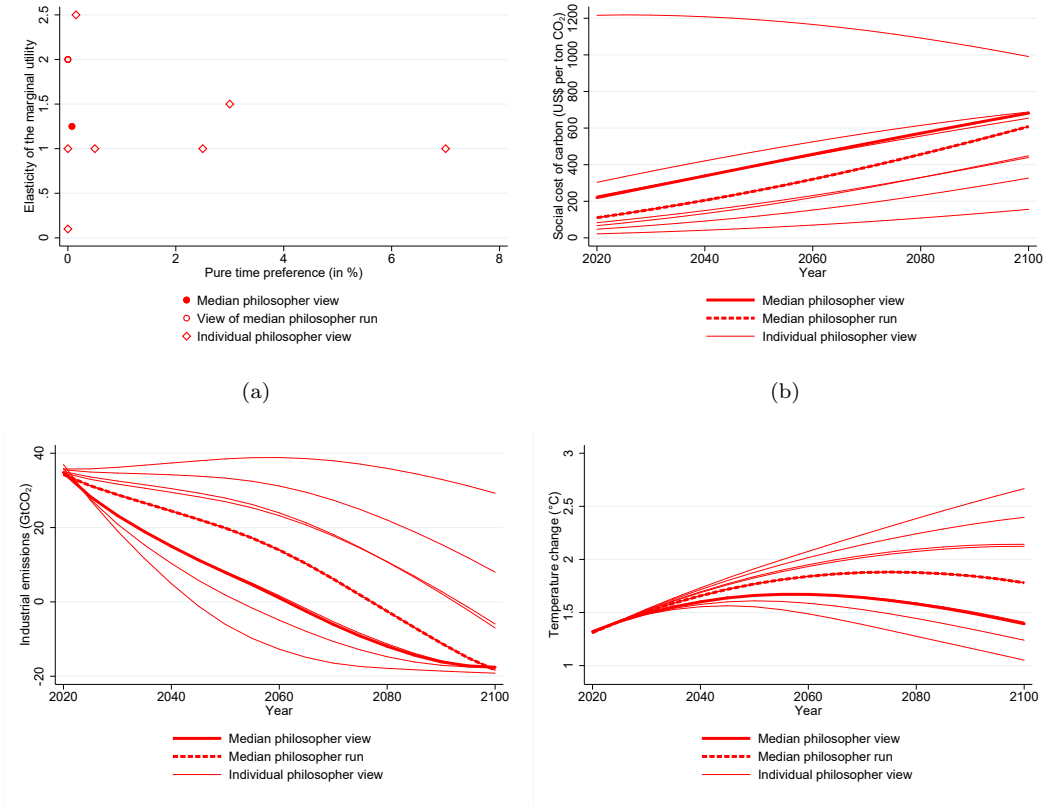

Figure 2: **Philosophers' views on climate policy paths.** Optimal climate policy paths in an updated DICE-IAM for each philosopher's view on the two normative policy parameters, pure time preference and elasticity of marginal utility, and the parameters of the *median view* and *median run*: (a) Views on the normative policy parameters; (b) Social cost of carbon (SCC) per ton of CO_2 in 2020 US dollars; (c) industrial emissions in $GtCO_2$; and (d) global mean temperature change in °C compared to 1850–1900 levels.

model using well-known parameter choices by Nordhaus [22] and Stern [30] for comparison. The median philosophers' and median economists' views translate into almost indistinguishable climate policy paths in terms of emission reductions and SCC estimates of around \$220 (\$219 and \$227, respectively) in the year 2020 (Figure 3(b)). These values are similar to estimates in a recent comprehensive analysis of the SCC [28]. We also observe almost identical temperature changes of around 1.4°C by the end of the century (Figure 3(d)). The median philosopher view exhibits a lower value of pure time preference than the median economist (0.075% versus 0.5%) but a higher elasticity of marginal utility (1.25 versus 1). Both effectively attach more weight to distributional issues, but with counteracting effects on the SRR. Within DICE, these 'cancel out' and result in very similar optimal climate policy paths. Furthermore, the median runs of philosopher and economist policy paths are also virtually indistinguishable (Figure 3), with SCCs in 2020 of around \$120 (\$112 and \$130, respectively) and temperature trajectories that stay below 2°C and reach 1.8°C by the end of the century.

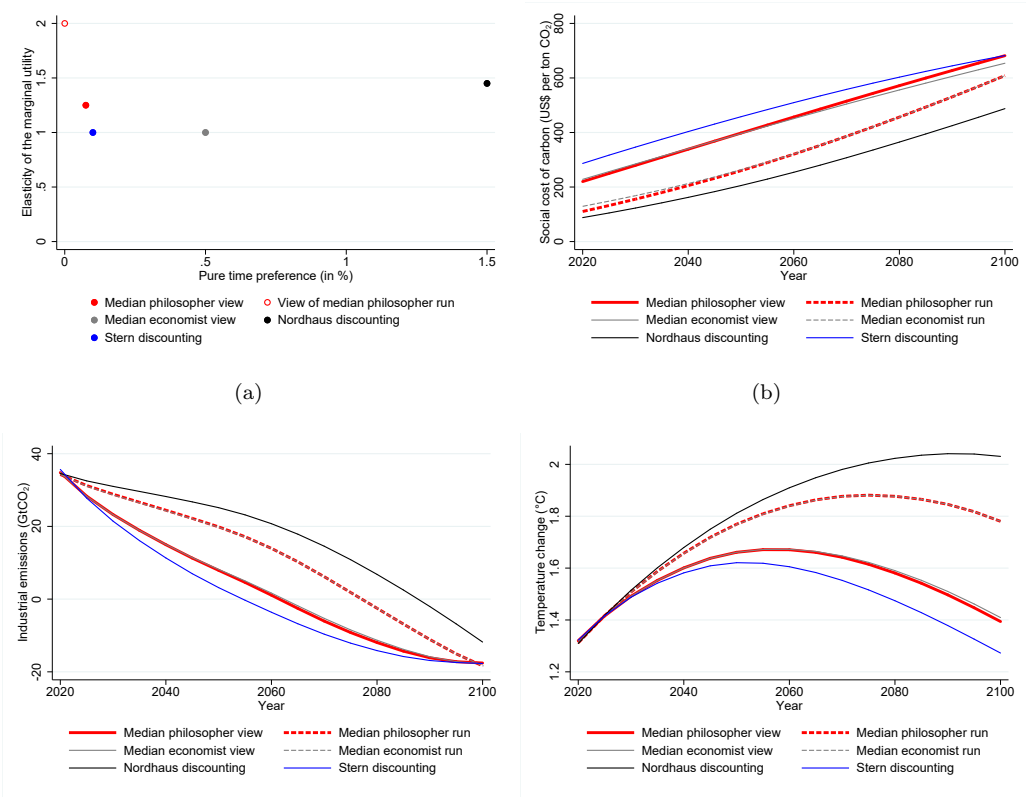

Figure 3: **Philosopher and economist agreement on climate policy paths.** Optimal climate policy paths for different views on the two normative policy parameters in an updated DICE-IAM. (a) Views on the normative policy parameters, pure time preference and elasticity of marginal utility, including the median economist and median philosopher views, parameter choices in line with the median policy run (only applicable for philosophers; see Methods), as well as of views by Nordhaus [22] and Stern [30]; (b) Social cost of carbon (SCC) per ton of CO_2 in 2020 US dollars; (c) industrial emissions in $GtCO_2$; and (d) global mean temperature change in °C compared to 1850–1900 levels.

Expert recommendations for intergenerational discounting

Philosophers' qualitative comments were particularly rich. These are compared to those of economists [20], which have not previously undergone detailed analysis. Comments from both philosophers (denoted by P#) and economists (E#) largely fall into the three broad categories that form the basis for the subsections below. We highlight selected comments that showcase areas of agreement and differences in each category (Tables 1 and 2) and provide a complete list of anonymised qualitative remarks, including a more complete analysis of comments (see SI).

Discounted Utilitarianism and the SRR

Discounted Utilitarianism underpins most discounting guidance [25] and often manifests as the SRR, a specific formulation of the SDR, e.g. [23]. A number of economists and philosophers

Table 1: Selected qualitative responses on the Simple Ramsey Rule, its components, and normative versus positive weightings

Philosophers	Category	Economists
The Ramsey formula requires some empirical input, specifically the rate of economic growth. (P13)	Ramsey Rule ($N_E = 17$, $N_P = 3$)	My discount rate is less than implied by the Ramsey rule because I use the extended rule, incorporating uncertainty. (E24) To employ the Ramsey rule [positively] [...] we need some serious research into the empirics of the Ramsey rule. [... yet] there is no empirical support for the Ramsey rule as a positive description. (E8)
I think it's morally acceptable—and in many contexts even required—for us to give greater weight to the concerns of those nearer and dearer to us than to those further away. (P5) I do not believe in pure time discounting at all. The idea is that time itself has no moral significance in itself. (P6) I mostly buy the Parfitt-Cowen response [...] but shoehorning existential risk into the discount rate [is reasonable]. (P5)	Pure time preference ($N_E = 10$, $N_P = 7$)	I see no reason to treat generations not equally. (E5) Pure time preference should probably reflect some catastrophic risk: 0.2% or so. (E4) I [...] favor a preference-based view of well-being, [...] some deference to individuals' own preference parameters. (E17)
0 in the case of wrongful harm to future generations (e.g. climate change) [...] 1.5 for all other effects. (P2)	Elasticity of marginal utility ($N_E = 12$, $N_P = 1$)	[η ...] being based on representative agent or [CRRA] formulations [...] is largely a distributional/equity consideration [...] (E13)
As climate change accelerates, and if the projections are at the medium to high end, this threatens to turn negative. I'd guess somewhere in the range of +2% to −2%. (P1)	Growth rate ($N_E = 14$, $N_P = 3$)	I foresee a very bright economic future with a continued 2 percent growth rate for the coming century. (E8) I have never understood why economists always assume that consumption will rise at a constant rate. (E1)
[T]he normative question of what social discount rate is required by justice to future generations can only be answered once the descriptive issues have been answered. Therefore it is not possible to assign proportions to these two. (P10)	Normative weight ($N_E = 16$, $N_P = 10$)	I don't think normative issues outside of an objective should have much of a role. [...] Indeed, under a different social welfare function there is a different positive description of the appropriate discount rate. (E23) The components of the SDR are overwhelmingly normative. (E13)

Note: N_E and N_P refer to the number of qualitative remarks from economists and philosophers, respectively.

expressed discomfort with using these frameworks as the basis for evaluating intergenerational decisions, but for different reasons. A critique from several philosophers concerned the difficulties of embodying all concepts of fairness consistently in such a limited ethical framework, resulting in discarding morally relevant information (P15, P3). This includes the intratemporal distribution of income, and the pathways of physical and economic outcomes over time that are lost in intertemporal aggregation (also E77). While sustainability rules may offer one way to introduce rights or duties into the Utilitarian framework, some philosophers propose stepping back completely and reassessing the essential moral issues at stake. One example is 'moral modelling' [31], which argues that decision theory can embody many ethical approaches despite having largely consequentialist foundations (P5; see Table 2). Rank-Ordered Utilitarianism, emphasising a generation's well-being rank [32], was suggested from both disciplines as an alternative to a zero or non-zero pure time preference (P3, E76). Some economists also proposed alternative criteria, such as sustainability rules and 'tolerable windows' approaches to rule out certain adverse outcomes for future generations (E28, E52).

By contrast, rather than mainly proposing alternatives to Discounted Utilitarianism itself, economists predominantly recommended technical extensions to the SRR. Examples include substitutability and environmental scarcity (E5, E51, E48) [33, 34], distributional issues (E20) [35, 36], uncertainty (E8) [37] and, relatedly, declining discount rates (E42) [1, 38]. Resolving the perceived inadequacies of the SRR via mathematical extensions within the Discounted Utilitarian

Table 2: Selected qualitative responses on extensions and alternatives to discounting

Philosophers	Category	Economists
Because the discount rate is dependent on assumptions about future scarcity,[...] etc. there should be no single discount rate across the board. Natural assets, monetary investments, infrastructure project etc. should be discounted at different rates. (P16) If there are real sustainability issues and we fail to take the path towards a sustainable development, then the growth rate of real per-capita consumption will be negative. (P2)	Limited substitut-ability ($N_E = 20$, $N_P = 4$)	If future costs/benefits accrue, e.g., to environmental amenities, I would argue for a very low discount rate, based on an expectation of increasing relative prices for these goods. (E48)
[I]f we're concerned about risk, then we should just model risk explicitly, but given the complexity of climate policy evaluation, I think shoehorning existential risk into the discount rate is a reasonable thing to do. (P5)	Uncertainty ($N_E = 20, N_P = 4$)	We need to admit that the current state of the world is full of uncertainties. [Yet] most uncertainties are neglected, and sometimes few remain when these are considered most important, [...] or easiest to accommodate. (E8) Discounting rates are useful but do not provide (accurate) market values of risky assets... but what does? (E56)
[A]n intergenerational sort of "differentiated love," to use the Confucian term, justifies a strictly positive rate of pure time preference that declines to zero over the course of a few generations. (P5) A discount is certainly justified [because] marginal utility of income will decrease with increasing material well-being, especially in countries counting at present as developing countries. But this consideration does not justify a discount merely for temporal distance. (P8)	Declining discount rates (N_E=20, N_P=3)	I am more comfortable with declining discount rates [...] due both to declining time preference rates and to uncertainty about future consumption growth. (E42)
In the case of a project that potentially harms people living abroad in health and property, these harms should be given equal weight in project appraisal. (P2)	Heterogeneity, distribution, aggregation ($N_E = 19, N_P = 1$)	The normative approach is based on weighing WTP for different generation, with less weight on the richer ones. It makes no sense to use this in combination with valuation studies where each individuals WTP are not weighted similarly by income. (E20)
As you know, the correct way to handle the 'opportunity cost of capital' is not by adjusting the social discount rate. (P13)	Opportunity cost of funds ($N_E = 8$, $N_P = 2$)	SDRs should reflect the social opportunity cost of funds. (E61) An opportunity cost of investment funds should be the instrument of capital rationing. (E15)
Instead of "cost-benefit," or "discount rates," long-term future assessments should be made according to a "sustainability index," which gives primary consideration, not to "market preferences," but rather to sustaining environmental conditions and resource availability. (P15) I think of [...] policy evaluation as something closer to Katie Steele's "moral modeling" than to some kind of Benthamite calculus (P5)	Alternatives to discounting ($N_E = 15$, $N_P = 9$)	Instead of imposing a [SWF] and calculate the corresponding optimum, it is "better" to depict a set of feasible paths of consumption, production, temperature, income distribution, etc., and let the policymaker make a choice. (E12)

Note: N_E and N_P refer to the number of qualitative remarks from economists and philosophers, respectively.

framework, rather than departing from it altogether, appeared popular amongst economists. This may help explain Figure SI2, which plots the frequency distribution of SDR $-(\delta + \eta g)$ across experts in each discipline. This distribution has a mean of -1.21% (two-sided t-test: p <0.000) for economists but is insignificantly different from zero for philosophers (p=0.517).

Normative versus positive weight

The Stern-Nordhaus debate was ostensibly polarised between positive and normative approaches and this framing continues to this day. Within the SRR approach, the SDR can be calibrated from the opportunity cost of capital, r, as recommended in, for example, Circulars A-4 and A-94

of the Office of Management and Budget in the US. However, these Circulars also acknowledge the virtue of alternative approaches such as using a shadow price of capital to value displaced investment. Alternatively, the SDR can be estimated from the consumption side as also recommended by the use of observed savings rates in Circular A-4, or calibrated to the SRR as in the HM Treasury's Green Book in the UK. The latter is seen as a predominantly normative approach, although g is a descriptive variable [25]. Yet, rather than experts being polarised, the quantitative and qualitative responses show that a large majority of both economists and philosophers find normative *and* positive issues relevant (P10, P2, P14, E26, E17).

As revealed by their quantitative responses, philosophers place stronger emphasis on normative issues, and this is also reflected in their comments. Within Discounted Utilitarianism, a number of philosophers take a fully normative approach to determining the SDR, believing that "uncertainty and justice should be key determinants" (P12). This position is also reflected in the comments of some economists. By contrast, some economists, but no philosophers, are 100% 'pure' positivists, believing that interest rates should be used to calibrate the SDR (E32). Some philosophers do, though, report that normative questions can only be answered when the positive facts are known (P10; see Table 1). The responses from both disciplines give little support for the purely positive position being taken to discounting that underpins the latest estimates of the SCC published by EPA [5], where δ and η on the consumption side of the SRR are calibrated on a purely descriptive basis; e.g., [39], [40].

Calibrating the components of the SRR

Philosophers and economists alike provided comments on calibrating the components of the SRR and the difficulties involved. One broad critique from economists was that there is no empirical support for the SRR as a descriptive model (E8; see Table 1). While modal responses on pure time preference in both disciplines suggest that remoteness in time itself has no moral significance [19, p357], this view is contested within both groups. Among those arguing for a non-zero δ, existential hazard risk is the most frequent motivation (P5, E4), and both groups also recognize tyranny arguments between generations that can arise from an inappropriate choice of δ (P5, E5). Positive rates of time preference result in weights approaching zero on the utility of very far-future generations, which may be morally unacceptable. In contrast, $\delta = 0$ can lead to 'hair shirt' outcomes for the current generation, who would be required to save 'damaging' amounts for the benefit of their distant descendants (P5).

Yet philosophers rely less on positivist considerations, preferring a variety of alternatives to classical Utilitarian consequentialism, including agent-relative ethics, suggesting that it is morally acceptable to place greater weight on those nearer and dearer to inform our preferred utility discount rate (P5). Economists more often used positive arguments for $\delta > 0$, and a deference to individual preferences (E17). Although one philosopher proposed that "people's actual behaviour in discounting reflects their genuine normative concerns" (P4), they were ultimately introspective on the validity of that assumption. While both groups engaged with the consequentialist approach, philosophers tended to invoke rights and duties (P15). Finally, only one philosopher commented on the elasticity of marginal utility, recommending a different value of η for "wrongful harm to future generations" than other effects, again leaning on the idea of rights and duties to future generations (P2). For economists, the qualitative comments reveal that η has different meanings with others also questioning whether it is appropriate to use a single value for this parameter in all contexts (E18, E5).

Discussion

Expert advice plays a key role in complex areas of public policy including discounting and its application to climate policy appraisal [1, 41–43]. Yet academic guidance in this area has been sought predominantly from one discipline, economics, where experts do not have any special insights into the underlying ethical issues at stake. Our survey of philosophers meets the need for broader multidisciplinary input into this policy field [4].

We find considerable agreement between the two disciplines for a long-term real SDR of 2%; a value that has underpinned recent estimates of the SCC [28]. Furthermore, median discounting values and median policy runs from each discipline result in almost identical optimal climate policy paths that support the UN Paris climate targets. Yet each discipline brings distinct expertise to bear. While economists provide guidance on technical extensions to discounting rules [25], philosophers point to broader extensions to Discounted Utilitarianism: the limitations of consequentialism, the rights of future generations, and the duties of the present generation.

When estimating the welfare cost of future climate damages, the SDR is critical. Embedding this within an intergenerational welfare setting requires many competencies, so deliberative and multidisciplinary perspectives are vital [4]. The different motives held by philosophers are complementary to those of economists and recommend alternative approaches to current climate policy analysis. Philosophical perspectives offer ethical checks and balances within IAMs to narrow the set of acceptable consequentialist climate policies, or offer altogether different procedural lenses through which to evaluate climate policy. Examples here include Rank-Ordered Utilitarianism, sustainability rules and 'tolerable windows' approaches. That economists and philosophers can agree on policy outcomes builds academic expert consensus, a key input to any legal challenge as recently seen in the US. These insights will be overlooked if economists continue to dominate the debate. Yet, how to structure such interaction within "larger-scale, participatory and deliberative, integrated scientific assessment processes", as remarked by one philosopher (P17), is an avenue for consideration in future research and policy.

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Author Contributions Statement

F.N., M.D., M.F. and B.G. designed research, F.N., M.D. and B.G. analyzed data, F.N., M.D., M.F. and B.G. wrote the paper.

Authors declare no competing interests.

All data and code is available in the Supplementary information.

Competing Interests Statement

F.N., M.D., M.F. and B.G. declare no competing interests.

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Methods

Sampling, respondents, survey text and response bias

We sampled economists based on keyword searches for various forms of the term "(social) discounting" in 100 leading economics journals to determine pertinent publications. This process yielded 627 potential expert authors, 197 of whom participated in the survey that was administered between May and November 2014. Further details are provided in [20].

For philosophers, we took a broader approach to search for articles on "discounting", "discount rate" and "social discount*" in the abstract or main text of philosophy papers stored at PhilPapers, PhilIndex and Scopus. This was accompanied by a purposive search of philosophers who work in the area based on our readings and recommendations from well-known academics in the field. We then checked, on a case-by-case basis, whether there was any evidence within their publications for expertise on "(social) discounting". We identified 46 potentially relevant experts, 29 of whom participated in the survey that was administered between October 2016 and April 2017. While the number of philosophers engaging with social discounting is lower than for economists, our survey design identifies a more complete account of the population of philosophers who can be deemed as 'expert' for our purposes. We updated the PhilPapers-PhilIndex-Scopus search in 2019, additionally picking up 10 potentially relevant experts in an attempt to expand the sample size, but none of them chose to participate.

The invitation e-mail and survey text is provided in SI. We pretested the survey to ensure that it was understandable to both expert groups. For the philosophers, we provided additional clarification to some of the economic terminology.

Overall, many more economists ($n = 627$) were identified in [20] as potential experts on social discounting than philosophers were for this survey ($n = 46$). However, we received a higher response rate from philosophers (63%, $N = 29$) than in [20] (31%, $N = 197$). Thus, while the absolute number of responses is lower for philosophers, we capture a more complete account of the expert population on social discounting in the field of philosophy than in economics.

A core difference between the two expert groups is the relative types of responses they were willing to provide. Only 52% ($\nu = 15$) of philosophers provided any quantitative responses, with some questions receiving as few as 10 answers; see Table SI1 in the SI. A much higher proportion of economists, 94% ($\nu = 185$), were prepared to give numerical values, with each question receiving at least 173 answers. By contrast, all philosophers, bar one, provided open-ended qualitative comments, against only 51% of economists ($\nu = 100$). Thus, even though the number of quantitative responses by philosophers is comparable to some recent expert surveys on key intergenerational aspects [e.g., 27, 28], here we place greater weight on analysing the textual responses of both philosophers and economists, alongside the quantitative results.

We did not find evidence for potential non-response and strategic response biases in the economists sample [20]. The SI reports these standard tests also for the philosophers sample [44–46], with a specific focus on characterizing the larger share of philosophers that provided qualitative responses.

For the illustration of economically optimal climate policy paths, we rely on an updated version of the IAM DICE [22] by [21], who showed implications of the views of economic experts only. The model was updated to account for recent scientific evidence on the carbon cycle, energy balance model and climate damage estimates. It also included non-CO_2 forcing in line with lower temperature scenarios, and technical requirements on the availability of negative emissions technologies and the speed of decarbonization. In addition for the present paper, we consider the views among the ten philosophers, who provided complete pairs on the two key normative policy parameters: pure time preference and the elasticity of marginal utility. We additionally,

consider the median view among these respondents, and also illustrate the median model run. Note that in the comparison to the economists views in Figure 3(a), we do not represent the view of the median economist run as a pair of parameters because they are time-varying (see [21]).

Calibration of the Simple Ramsey Rule

The Simple Ramsey Rule can be calibrated in different ways. The approach taken recently by EPA [5] in its latest interim estimates of the SCC, based on [40] and [28], is to work from the production side of the economy, r. Such an approach is supported by [47, pp207-8], who "recommend continuing to rely on existing asset markets to guide the discount rate choice", as well as Recommendation 6-2 of the National Academy of Sciences [39] report which stated that parameter values should reflect the consumption rate of interest. An alternative, which we take here following [20], is to directly apply expert recommendations concerning the appropriate parameter values. These will reflect both normative considerations of what these parameters ought to be from an ethical perspective, as well as perceived production-side opportunity costs.

Data Availability Statement

The replication files are available at https://doi.org/10.5281/zenodo.7852217.

Methods-only references

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Online supplementary information to

Philosophers and economists agree on climate policy paths but disagree on why

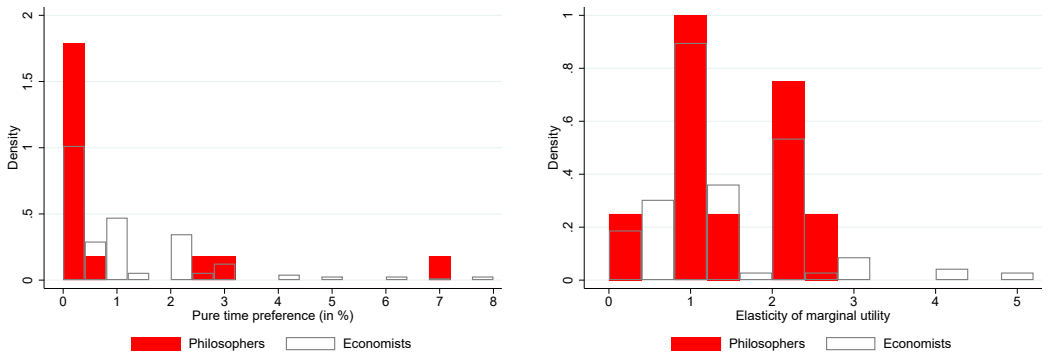
Quantitative materials

Table SI1 provides summary statistics on survey responses of economists and philosophers, while Figures SI1 and SI2 show histograms that compares responses by economists and philosophers along recommendations on discounting determinants and on the SDR itself as well as the imputed SRR.

Table SI1: Summary statistics on survey responses of economists and philosophers

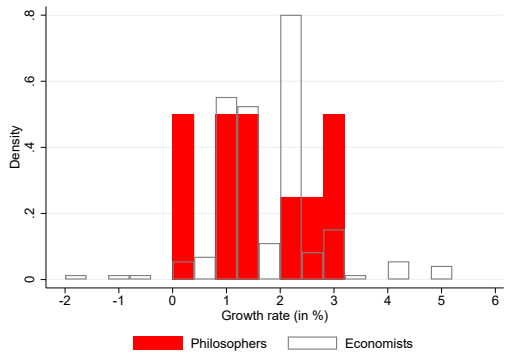
	g	δ	η	r	Norm	SDR	SDRmin	SDRmax
Economists								
Mean	1.7	1.1	1.4	2.4	61.5	2.3	1.1	4.1
Median	1.6	0.5	1.0	2.0	70.0	2.0	1.0	3.5
N_economists	181	180	173	176	182	181	182	183
N_quantitative	185							
N_qualitative	100							
N_economists_total	197							
Philosophers								
Mean	1.6	0.9	1.4	2.1	78.5	2.3	0.6	3.4
Median	1.5	0.0	1.3	2.5	80	2.4	1.0	3.5
N_philosophers	10	14	10	10	13	11	11	11
N_quantitative	15							
N_qualitative	28							
N_philosophers_total	29							
N_total	224							

Notes: g refers to the growth rate of real per-capita consumption, δ to the rate of societal pure time preference (or utility discount rate), η to the elasticity of the marginal utility of consumption, r to the real risk-free interest rate, normative weight to the relative weight placed on normative rationales for determining the real social discount rate (as compared to positive rationales), SDR to the real social discount, and SDRmin and SDRmax to minimum and maximum real social discount rate. N refers to the number of responses to each question, N_quantitative to the number of quantitative responses, N_qualitative to the number of qualitative responses, and N_total to the total number of responses.



(a)

(b)



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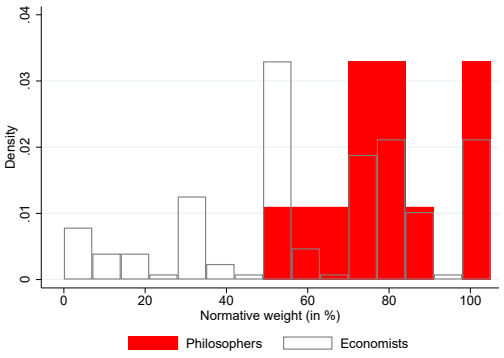

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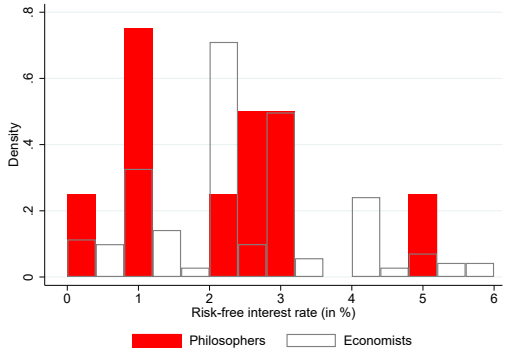

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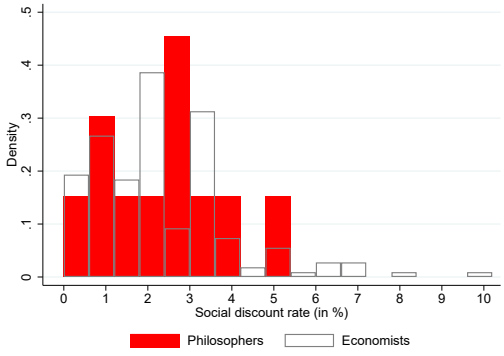

(f)

Figure SI1: **Comparison of economist and philosopher recommendations on intergenerational discounting and key determinants.** (a) Pure time preference; (d) elasticity of marginal utility; (c) growth rate; (d) normative weight; (e) risk-free interest rate; and (f) social discount rate.

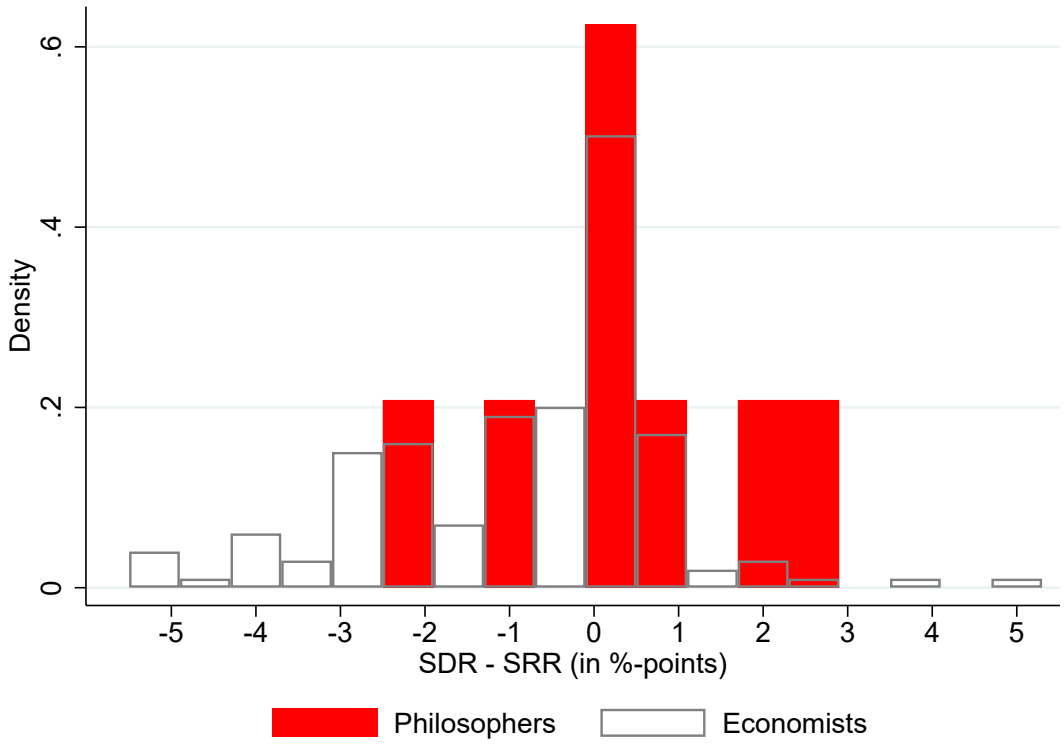

Figure SI2: **Comparison of economist and philosopher recommendations on intergenerational discounting and key determinants.** Deviations of SDR recommendations from the imputed SRR: SDR $-(\delta + \eta g)$.

Qualitative remarks

This section provides a more complete discussion of the broad categories i) the SRR and its components, ii) normative versus positive weightings, and iii) extensions and alternatives to discounting with references to and explicit mention of qualitative remarks by economist and philosophers. It further provides a complete overview of the categorized qualitative remarks by economist and philosophers. We group these individual comments in four main categories that address i) individual survey questions, ii) technical issues, iii) methodological issues, and iv) concerns about limited expertise. Individual economists and philosophers are given numerical identities (E1-E90, P1-P27).

Broad categories

The Simple Ramsey Rule and its components

Economists and philosophers alike provided comments on the components of the SRR that were central to the Stern-Nordhaus debate [7, 30] [49, 50], with a focus on the choice of δ. Economists commented on the difficulties of calibrating the components of the SRR, and offered explanations

for why their imputed SRR value did not equal the SDR, even though the SRR was not mentioned in the survey. They also provided a number of criticisms of the model itself; alongside proposed extensions (discussed below) one broad critique was that "there is no empirical support" (E8) for the Ramsey Rule as a descriptive model of human behaviour. Where philosophers commented at all on its deployment, they also highlighted empirical difficulties in relation to calibration (P13).

On pure time preference, $\delta = 0$ is the modal response for both philosophers and economists (64% and 25% of the samples respectively), lending support to the view that remoteness in time has no moral significance in itself [19, p357] for societal intertemporal decisions. However, this opinion is contested within both groups. Among those arguing for a non-zero δ, existential hazard risk is the most frequent motivation among both economists and philosophers (P5, E4). The risk that society in the future may not exist in a recognizable form to benefit from today's investments increases the appropriate discount rate. Economists and philosophers also recognize 'tyranny arguments'. Positive rates of time preference result in weights approaching zero on the utility of very far-future generations, which may be morally unacceptable (P5, E5). By contrast, $\delta = 0$ can lead to 'hair shirt' outcomes for the current generation, who would be required to save 'damaging' amounts for the benefit of their distant descendants (P5).

Yet some key differences exist in the rationales provided for zero or positive pure time preference. Philosophers rely less on positivist considerations, preferring a variety of alternatives to the classical Utilitarian consequentialism to inform their utility discount rate. Confucian principles are raised as a motivation for positive (albeit declining) pure time preference (P5). Agent-relative ethical considerations suggest that it is "morally acceptable" to place greater weight on our "nearer and dearer" making them less morally distant (P5). While such arguments are not alien to economists [see e.g. 51], the economists remained silent on agent-relative perspectives. Economists more often used positive arguments for $\delta > 0$, and a "deference to individual preferences" (E17). Although one philosopher proposed that "people's actual behaviour in discounting reflects their genuine normative concerns" (P4), they were ultimately introspective on the validity of that assumption. Finally, both groups engaged with the consequentialist approach, philosophers tended to invoke rights and duties, in one case using the concept of "wrongful harm" to motivate a 0% pure time preference (P2), and in another suggesting that discounting is not justified for "assessing benefits to those worse off than 'we' are" (P3). These *deontological* considerations were also reflected in the concern of many philosophers with sustainability (P2).

Philosophers had little to say on the elasticity of marginal utility of consumption, as we received only one comment (P2) that recommended a different value of η for "wrongful harm to future generations" than other effects, again leaning on the idea of rights and duties to future generations. For economists, the qualitative comments reveal that η holds a variety of different meanings (E13) with others also questioning whether it is appropriate to use a single value for this parameter in all contexts (E18, E5). In relation to real economic growth g, philosopher comments include that it "threatens to turn negative" following environmental pressures (P1), or instead caveat their answers with sustainably considerations (P3). Economists generally "foresee a bright economic future" (E8), while a small minority questions this assumption (E1).

Normative versus positive weight

The Stern-Nordhaus debate was ostensibly polarized between positive and normative approaches to discounting and this framing approach continues to this day, including in a recent report by the US National Academy of Sciences [39]. This issue has historically been one of the most contentious in social discounting and, reflecting this, we received comments on it from ten philosophers; more than for any other subject. However, rather than our experts being polarized, as a reading of previous literature might have predicted, a large majority of both economists and

philosophers find normative *and* positive issues relevant for determining the long-term SDR. Indeed, many respondents think of the normative and positive issues as being interdependent (E26; see also E17, P10, P2, P14), or as separable but still linked (E28, E4, E29).

There are several theoretical arguments that support these positions. While Discounted Utilitarianism is a normative framework, the parameters of the SRR can in some circumstances be calibrated using individually or socially revealed preferences (E4) [9, 10] [49]. Expected growth is arguably an unavoidably positive quantity even when applied within an otherwise normative calibration of the SRR, as recognized by respondents in both samples. Some philosophers believe that the normative question of what is fair to future generations must be informed by positive information about preferences and behaviour (P10). Nevertheless, the normative-positive framing remains a focal point for economists and philosophers alike.

As revealed by the quantitative results, philosophers place stronger emphasis on normative issues, and this is reflected in their qualitative comments. Within Utilitarianism, a number of philosophers take a fully normative approach to determining the SDR, believing that "uncertainty and justice should be key determinants" (P12). This position is also reflected in the comments of some economists (E13). By contrast, other economists are 100% 'pure' positivists, believing that the production-side of the Ramsey Rule alone, i.e. interest rates, should be used to calibrate the SDR (E32). Not one philosopher advocates a purely positivist approach. Despite some philosophers assuming that "many philosophers have a radically different conception of the normative role that discount rates play in intertemporal optimization exercises" (P9), what is remarkable is the frequency with which both economists and philosophers actually see both sides of the debate important to calibrate, e.g., the pure rate of time preference.

Extensions and alternatives to discounting

Economists and philosophers alike expressed discomfort with using Discounted Utilitarianism and the SRR as the basis for evaluating intergenerational decisions. These reservations can be divided into two broad categories. First, there are those who highlight the failure of the SRR to reflect the essential physical and economic aspects of the intergenerational investment appraisal, including limited substitutability and environmental scarcity (E48, P16) or uncertainty (E8, P5). Second, there are more existential concerns about the limitation of consequentialism to properly reflect the ethical aspects of the problem at hand. Rights, duties and procedures in general are potentially more relevant than outcomes when making decisions with long-term consequences around issues such as sustainability (E12, P15). Economists and philosophers both diagnosed these shortcomings although they tended to propose remedies to different extents.

Rather than mainly proposing alternatives to Discounted Utilitarianism per se, economists predominantly recommended myriad technical extensions that lie squarely within the consequentialist Utilitarian framework. Examples include modelling substitutability and environmental scarcity (E48) [33, 34], distributional issues (E20) [35, 36], uncertainty (E8) [37] and, relatedly, declining discount rates [1, 38]. Beyond these technical extensions to the Utilitarian model, some economists proposed alternative decision-making criteria to overcome more structural or ethical deficiencies of the standard model, such as the precautionary principle (E47), rules on sustainability rooted in non-declining well-being (E28), or a 'tolerable windows' approach to rule out certain adverse outcomes for future generations (E52). Related to the idea that time is not morally relevant, Rank-Ordered Utilitarianism [32] is an augmentation to the standard model that was suggested from both expert groups (P3, E76). Such approaches emphasise potentially more morally relevant characteristics such as a generation's rank in terms of well-being.

Rather than extending the standard Utilitarian model, many philosophers and some economists instead offered specific alternatives (P15, E8). A common critique concerns the difficulties of

embodying all concepts of fairness consistently in such a limited ethical framework, resulting in discarding important morally relevant information, such as the distribution of income at any given point in time, or pathways of physical and economic outcomes over time that are lost in intertemporal aggregation (E77). While sustainability rules and tolerable windows reflect one way to introduce rights or duties into the Utilitarian framework, some philosophers propose stepping back completely and reassessing the essential moral issues at stake. The 'moral modelling' approach in question makes the point that decision theory can embody many moral and ethical approaches, despite having largely consequentialist foundations, but whether this is true depends on the context and the nature of the problem (P5) [31]. One economist provides what could be described as an informational solution to the absence of moral content: present information on multiple outcomes across time and let policy makers choose the appropriate path (E12).

Single components

Growth rate ($N_E = 14, N_P = 3$)

E1: I have never understood why economists always assume that consumption will rise at a constant rate. Everything you have sent me (sans those on risk) presumes that it does. That way the Ramsey formula yields a constant (consumption) discount rate, which is presumably the attraction of the assumption, but there is no justification. Take for example the Ramsey model in its pristine form (single good; constant population; and so forth). If the production function is strictly concave, then consumption growth along the optimum will be a declining function of time, implying that the consumption discount rate will also be declining function of time. So you have "hyperbolic discounting" in even that model.

E2: For the purposes of the questions, I have taken a 100 year horizon and averaged the growth rates over that horizon.

E3: Growth rates and social discount rates are constant rate equivalents of declining rates.

E4: It would be useful to have the variance predictions for growth and risk free rate. My 1.5 for growth is really reflecting my minor pessimism about technological change but more the likelihood of environmental and resource constraints.

E5: This is not a number to choose but to observe?!? I have not made any forecasts myself, so I just pulled a number out of the back of my head that resembles historic average western GDP growth... (lazy, I know)

E6: I see the distribution of consumption growth as having pretty high variance and possibly even being bipolar. Over 100 years, humanity could be in a total mess (average growth rate zero or negative), and here's hoping we don't get the nukes out, or remarkably positive - a new wave of smart, clean innovation leads to delighted humanoids enjoying Keynesian levels of leisure or more. Who knows? 2% is merely some kind of unimaginative number that lies within the bounds and sounds plausible.

E7: Global averages can be misleading. Different countries will grow at different rates, and consumption of different goods will also grow or even fall at different rates.

E8: We have seen an astounding 2% worldwide annual per capita growth rate for the last century or so. Some developing countries are now catching up with the OECD countries. This process is believed to be mainly restricted by institutions and infrastructure such as property rights, trade opportunities. The 'frontier' countries, in the meantime continue their innovations and these have also contributed to an surprising 1 to 2% annual per capita growth rate. As more people become engaged in research, and if institutions worldwide support development, I foresee a very bright economic future with a continued 2% growth rate for the coming century. As I like some caution, 1.5% would also have my support.

E9: I believe that exponential growth of any physical sub-system of a finite system is impossible. // Economic growth measurable over a single lifetime is a recent phenomena, dating back only three human lifetimes to the start of the fossil fuel economy. Much of the so-called growth in recent decades has been driven by asset price inflation, which is ignored by the CPI.

E10: My x% were for the UK (high income low growth future) .....Global average discount rate doesn't make any sense to me at all (could back solve but would need to do it properly first) and my responses would be very different in economies with low income high growth future.

E11: The growth rate of per capita consumption is likely to be decreasing (and 0 in the very far future?).

P1: As climate change accelerates, and if the projections are at the medium to high end, this threatens to turn negative. I'd guess somewhere in the range of +2% to -2%. I also think that economists are typically overly optimistic about future growth in the context of climate damages.

P2: 1.5%, although this value assumes that there are no real sustainability issues. If there are real sustainability issues and we fail to take the path towards a sustainable development, then the growth rate of real per-capita consumption will be negative.

P3: By the same token, we must consider projected growth rates in different societies, in different possible states of the world, depending on the project in question.

Pure time preference ($N_E = 10, N_P = 7$)

E12: My personal take on the rate of pure time preference is that it should be very low (like the probability of extinction of the human race).

E13: It's plausible to assume a pure rate of time preference of about 1% at the individual level. I am not, however, persuaded that discounted utilitarianism is a canonically correct way to represent intergenerational social choices. A (classical) utilitarian would attach equal weight to the welfare of present and future persons, which might suggest a "rate of societal pure time preference" of zero. Hence my answer to question 2.

E13: I think there is a strong reason for zero (or very low) rates of societal pure time preference.

E14: My recommended rate of social time preference of 1% per year is based less on the idea that future utilities should be given lower weight than present ones but rather as an admittedly crude way of putting lower weight on very long run forecasts of anything: future technologies, preferences, population sizes, etc.

E4: Pure time preference should probably reflect some catastrophic risk: 0.2% or so.

E5: I see no reason to treat generations not equally.

E15: My recommendation is that discounting generally for time is abandoned.

E8: Whereas the previous question was positive – in the year 2100 one can more or less objectively establish whether the guess was correct, or not – now we enter the domain of normative questions. There are various perspectives on answering this question. I consider it better to inform the decision maker than to propose my preferred choice. For a public project, when choosing the pure discount rate, we can consider ethical guidelines, positive guidelines based on social statistics, positive guidelines based on administration statistics, or we can consider democratic principles. When choosing the ethical perspective, the common position is that there is no a-priori reason to discount future generations vis-à-vis the present; the implication is that the pure discount rate should be close to zero. When choosing the positive perspective based on social statistics, we should choose the pure time discount rate that is consistent with observed behavior. For this purpose, we take a closer look at the Ramsey rule. The typical approach in economics is to state that we observe some rate of return on investments that we observe some growth rate of consumption, and then one can calculate consistent combinations of pure discount

rate and the elasticity of marginal utility. It is not possible to determine one parameter without the other, and for this reason, I cannot answer this question from the positive perspective. There is, however, another problem with this perspective that makes me less sorry for my missing answer. The reality is that there is no empirical support for the use of the Ramsey rule as a positive description of observations at the aggregate macro level. The returns on investments are determined in a complex market where savings and investment opportunities match, and regulation and demography enters. There is no reason to assume the Ramsey rule to hold, and as said, no empirical evidence either. The meaning is that, if we want to employ the Ramsey rule for such decision making, based on a positive perspective, then we need some serious research into the empirics of the Ramsey rule. The third perspective considers the positive view, but focusing on the administration in charge of public decisions, rather than focusing on society en large. We then may notice that most governments in the world seem to have a rather short term view. The administration in office cares most for the coming years while in office. For the sake of consistency, one may argue that any project beyond such an horizon is irrelevant to the administration. The annual pure discount rate may be set at something like 20% per year. Finally, the fourth perspective, which I labeled democratic, is not common in the literature, but for a representative institution, it seems a logical choice. When choosing the democratic perspective, the representative agent attempts to choose a time-preference parameter that in some way represents the variety of preferences within society. The general result in the literature is that this implies a decreasing pure discount rate, with very low discounting for long-term projects.

E16: Rate of societal pure time preference (or utility discount rate) is not very well defined. Better to ask whether 1 util this generation is worth more than 1 util next generation.

E13: It's plausible to assume a pure rate of time preference of about 1% at the individual level. I am not, however, persuaded that discounted utilitarianism is a canonically correct way to represent intergenerational social choices. A (classical) utilitarian would attach equal weight to the welfare of present and future persons, which might suggest a "rate of societal pure time preference" of zero. Hence my answer to question 2.

P4: However crucially I believe that none of these considerations justify the practice of cumulatively discounting future welfare without limit. Whilst I would advocate a 5% discount rate for expected future growth in the short to medium term I believe that the effective discount rate will reduce over time so that eventually there is a maximum cumulative discount rate (e.g. 99.99%) that we should apply to future welfare irrespective of how far in the future it is. This should be sufficient to render even relatively large effects on the welfare of future individuals irrelevant to present policy considerations, whilst retaining the fact that if we can influence very significant future events, such as preventing a future extinction event or rendering it survivable, this will still represent a significant benefit relative to present welfare (even 0.01% of billions of years of human existence will be worth any amount of present welfare).

P5: I see two main reasons to allow for a strictly positive rate of pure time preference: (1) The rate is a useful proxy for existential risks, as in the Stern Review. I mostly buy the Parfitt-Cowen response that if we're concerned about risk, then we should just model risk explicitly, but given the complexity of climate policy evaluation, I think shoehorning existential risk into the discount rate is a reasonable thing to do. (2) I think of climate policy evaluation as something closer to Katie Steele's "moral modeling" than to some kind of Benthamite calculus. And I think it's morally acceptable—-and in many contexts even required-—for us to give greater weight to the concerns of those nearer and dearer to us than to those further away. In a global climate policy evaluation context, that means attaching less weight to those in the distant future. However, I think one cannot *completely* discount others' well-being simply because they are further away, socially or temporally. That's one reason why I prefer a declining discount rate: I think the rate of pure time preference should decline to (almost?) zero over, say, a few generations.

Shorter version: an intergenerational sort of "differentiated love," to use the Confucian term, justifies a strictly positive rate of pure time preference that declines to zero over the course of a few generations. (3) Less importantly, I also have vague concerns about avoiding "hairshirt policy" implications, whereby in the absence of a positive discount rate, each generation might be required to invest a counterintuitively large amount for the future. In a growing global economy, this is obviated by the rest of the Ramsey equation, but in an almost-steady-state economy, you might need a positive rate of pure time preference to avoid those results. I don't currently put much weight on this argument, but it's one I'd be willing to entertain.

P2: 0% for wrongful harm to future generations (e.g. climate damage), 3% for all other effects.

P6: I do not believe in pure time discounting at all. The idea is that time itself has no moral significance in itself (i the same way spatial distance has no such significance). Of course, morally significant features can co-vary with time: we know less of about future harms, future people are strangers to us, and so on.

P3: Pure time preference can legitimately be exercised in assessing benefits to people better off than 'we' are, but not in assessing benefits to those worse off than 'we' are.

P7: This is based on the sum of probabilities of certain types of exogenous risks (of both good and bad outcomes) that would prevent climate change policies from having their expected/intended effects. So, of course, the classic Stern example is of extinction risk and he thinks 10% probability extinction by the end of the century is reasonable—-he infers $\delta = .1\%$. But there is nothing special about extinction risk itself. It is merely a salient example of a broader class of outcomes where a potential event prevents climate policy from having expected output. Assuming his estimate is of the right order of magnitude, I believe there are other relevant outcomes, which are less likely, but have the same structure. So, for instance, I think the probability that humanity leaves earth is something like an order of magnitude smaller than the probability of extinction while the probability of humanity somehow insulating itself from climatic impacts (e.g. a dome world or underground civilization) is of a similar magnitude. After having read some of those literatures, I have a very rough estimate that those are going to sum to something like half of the average likelihood on an annual basis. So working from the Stern baseline, I think the sum of these events is strictly larger than the Stern utility discount rate, but on the order of one and a half times—again, on an annual basis. One might object that what Stern and I are doing is smuggling in probabilities into the discount rate, which is not what a pure rate of time preference is. I do not think there is a privileged "thing" that δ represents, but methodologically the advantage of incorporating these model-independent outcomes in the discount rate instead of an extended-form expected value calculation is that you do not need to assign explicit values to these very abstract outcomes (what is the value of human extinction, for instance-—0 or undefined? What is the privileged 0 value?)

P8: This is an estimate of the pure time preference factually implied by people's behaviour.

Elasticity of marginal utility of consumption ($N_E = 12, N_P = 1$)

E17: The elasticity of MU of consumption is heterogeneous, and using a single value is – it seems to me – a crude simplification. Ideally, the input for our SWF would be a utility function that allows for heterogeneous preferences (cf. Marc Fleurbaey's work on equivalent incomes and [anonymized])), and this would smoothly handle heterogeneity in elasticity of MU consumption.

E13: the EOMUC in the formula, being based on representative agent or constant elasticity formulations that seem unlikely at best, is largely a distributional/equity consideration given its dual importance in describing intra-generational preferences for inequality.

E18: Eta may not be a constant.

E19: Elasticity of marginal utility of consumption has to be greater than zero? So we have convex preferences and are increasingly insatiable in consumption?

E4: My eta estimate coincides with empirical work that I have done, but I think the motive for this value should be introspection in the context of the question here. 1.5 - 2 still strikes me as a likely value to reflect inequality aversion.

E5: I am not a fan of a constant marginal elasticity, but differentiation by poor, well off, and rich, at least. Number I gave you is a Vissing-Jorgensen and Attanasio (2003) best guess with an Epstein-Zin model. Note: This is NOT meant as an intragenerational inequity measure.

E8: I consider the same perspectives as above [E8's answer to Q2]. When choosing the ethical perspective, this is very difficult. I would not know, but would tend to choose cautiously for a high elasticity. When choosing the positive perspective based on social statistics, we should choose the elasticity that together with the pure time discount rate stated above is consistent with observed behavior. But, as noted above, the task is impossible within this perspective. There is no combination of pure time discount rate and elasticity that can receive any empirical support. So we better bin this perspective. I'll come back to it at the end. The third perspective considers the positive view, but focusing on the administration in charge of public decisions, rather than focusing on society en large. We then may notice that redistribution policies have changed, so it seems that the elasticity of marginal utility has decreased over the last decade. So much for exogenous parameters. We go back to Mirrlees and Dasgupta for estimates around 2. Finally, the fourth perspective, which I labeled democratic, does not give us much of a clue here.

E20: The normative approach is based on weighing WTP for different generation, with less weight on the richer ones. It makes no sense to use this in combination with valuation studies where each individuals WTP are not weighted similarly by income. With the elasticity given in 3, WTP from the poorest billion should weigh 20 times as much as the WTP from the richest billion. Few valuation studies does such a weighing. When it is not done, mixing the valuation with the discounting derived from similar weighing across generation is dangerous.

E9: The elasticity of the marginal utility of consumption, by which I understand the percentage increase in utility from a one percent increase in consumption, is completely dependent on income. People unable to meet basic needs have a very high EMUC. I however believe that humans are satiable, and it takes $600 billion per year in advertising to convince us otherwise. Empirically, per capita consumption in the US has more than doubled since 1969, while surveys on happiness and satisfaction with life as a whole show no significant change, suggesting a value of 0 for EMUC. Once basic needs are met, EMUC is largely driven by status, which means that an individual might have a positive EMUC while society as a whole does not. Anecdotally, my own EMUC seems to be zero, to the point where I donated my inheritance to charity last year. I gave a value of zero because I think we could do more to improve overall utility through just distribution than through growth.

E21: Another relevant consideration missed out in the above factors is the change [expected to be increases] in future ability to enjoy income; this offset to some extent the diminishing marginal utility of an increasing income per head.

E22: I do not view Q3 as relevant, besides this is an individual preference parameter that varies widely in population (across countries and time).

P2: 0 in the case of wrongful harm to future generations (e.g. climate damage) although the term "Elasticity of marginal utility of consumption" would not be appropriate in this case. 1.5 for all other effects.

Real risk-free interest rate ($N_E = 8, N_P = 0$)

E4: It would be useful to have the variance predictions for growth and risk free rate. My 1.5 for growth is really reflecting my minor pessimism about technological change but more the likelihood of environmental and resource constraints.

E2: I have assumed no uncertainty about future variables in order to get the risk-free rates.

E23: Again, I think the notion of a global average is problematic. I also think risk free is problematic. I think what we mean is relative risk free.

E13: The finance literature typically takes the risk-free rate to be about 1% based on market returns on financial instruments that carry minimal inflation risk.

E8: Fortunately, here we are back again in the positive domain. If you are a small consumer with moderate savings, in Europe, the risk-free rate of return on your savings is currently negative. There has been a trend in the last 20 years with steadily decreasing returns, also shown through steadily decreasing ratios for earnings over share prices. This may be due to rising assets held by an ageing population. I therefor see no reason to suspect a reversal into the old times with high real risk-free interest rates. So my guess is a 0% risk-free real interest rate. Possibly, rich people with the right connections can strike the better deals for their assets, for some reasons hidden from normal citizens.

E24: I think the question about a real risk-free interest rate is not well posed. If an interest rate is a market price, there is no interest rate for 100 year horizon (to my knowledge).

E25: The risk free interest rate question is quite unclear. If one do not believe in perfect financial markets, which market interest rate it is becomes relevant.

E6: But I do think economists (including me) should take negative rates more seriously, and now is the time to do it (given negative real rates following the crisis).

Normative vs positive ($N_E = 16, N_P = 10$)

E26: These two sets of issues are interdependent, if I understand what is being asked here. Accepting a public project with a rate of return exceeding the rate at which the funds are borrowed implies that the creditors can be paid back and leave value to be given to the future generations. So if the descriptive issues imply the project should be accepted, the normative issue of justice towards future generations is addressed. And if one is thinking that the current generation should sacrifice now to benefit the future generations, it would make no sense to undertake the sacrifice by accepting a project with a rate of return less than the rate at which the funds are borrowed since then the future generations would need to reduce their consumption to repay the creditors. So, I am seeing the two rationales as intertwined in a way that makes trying to separate them difficult.

E23: I'm confused by the question. I don't think normative issues outside of an objective should have much of a role. However, the only reason I can see to focus on mean future returns is easy of computation. Indeed, under a different social welfare function there is a different positive description of the appropriate discount rate.

E27: My main problem is with the framing of question 5. I don't see any trade-off between the two issues. As in any inter-temporal decision, there are preferences (justice toward future generations) and a budget set (determined by the forecasted return on financial assets). Preferences and possibilities result in a decision. Can there be a trade-off between budget and preferences?

E28: My answer to Q5 is, of course, normative in both of its part (as the first part dictates the second). However, I don't think that this is really the right way to deal with equity. Rather I feel it should be dealt with through direct reinvestment of a proportion of proceeds (sometimes from other investments) to ensure the sustainability of service flows into the future. So investments in non-renewable extraction (say fracking and oil extraction) should incur a charge which maintains

the calorific value of energy supplies and an equable climate into the future. That is almost certainly a requirement for investment of those proportional proceeds into renewables and CCS or similar.

E17: I'm also not sure how to answer the question about the relative percentages of normative and descriptive. It seems to me that both are inseparably involved. The choice of (a) the utility discount rate, and (b) the particular conception of well-being, are normative matters. But – conditional on certain conceptions of (b) – descriptive issues come into play. I myself would favor a preference-based view of well-being, which in turns means some deference to individuals' own preference parameters (e.g., elasiticity of MU consumption) which injects descriptive elements. (A different example would be a happiness view. It's a normative matter whether well-being is indeed happiness. Richard Layard and the other new Benthamites in the UK think so, but this is normatively contestable. However, GIVEN a happiness view, it then becomes a descriptive question what the nexus is between consumption and happiness-utiltiy).

E13: On question 5 I answered 50/50. I would have preferred to leave this item blank. It's up to decision-makers to decide what ethical stance to adopt for the purposes of policy evaluation. Once the ethical stance and decision weights are specified, technical analysis can then help decision-makers understand and evaluate tradeoffs.

E13: I am strongly convinced that, aside from the growth rate of real per-capita consumption, the components of the social rate of discount formula are overwhelmingly normative in nature.

E4: On the normative positive, the 20% for positive comes from the need to think about growth, and the fact that some information can be obtained from revealed preference, even it is noisy and problematic conceptually.

E29: The rationale behind my answer is that normative issues are more certain than forecasted average future returns to financial assets. If there was certainty on returns, the calculation would be risk-free and then only normative issues would be of importance.

E30: I don't think normative and descriptive issues can be weighted separately. Its all normative. Once future consequences are transformed into present values then the only thing that matters is normative considerations, and in my view future people and their happiness are worth exactly the same as current people and their happiness. But how can I use your survey to express this?

E31: The considerations of justice are of great importance but should not be addressed through the discount rate.

E24: I put little weight on descriptive issues because I think credible forecast returns over 100 years periods have large uncertainty intervals.

E32: The answer I would prefer to give is that ideally the government should put full 100% weight on market interest rates, but the government should acknowledge that it can affect this market interest rate, e.g. in Diamond 1965 social security does just that. Thus, it's weight on future generations matters, indirectly.

E33: My answers to Q5 are very sensitive to whether the issue is climate change or not. For a bridge, normative issues are not so important; but for climate change the normative issues are critical.

E34: I think that the question 5 is very interesting. We want information about how people care about future generations. This information is extremely difficult to obtain though. Indeed, it can hardly be obtained through axiomatics or philosophy (the normative approach) only or through observed or predictions about financial assets returns only (the descriptive approach).

P4: My assessments here are based on the assumption that people's actual behaviour in discounting reflects their genuine normative concerns, e.g. for inter temporal fairness, the claims of special relationships and the relative value of realising ambitions (forward facing utility) rather than having valuable experiences (backward facing utility). Whilst this this will undoubtedly

turn out to be an incorrect assumption it is my belief that the fundamental justification for our normative beliefs needs to be individuals action guiding moral intuitions and that these play a very significant role in governing behaviour.

P9: This is in large part because of my perhaps idiosyncratic view that many philosophers have a radically different conception (different from that of economists) of the normative role that discount rates play in intertemporal optimization exercises.

P8: My motivation for suggesting a rather low social discount rate is mainly ethical.

P5: This depends on the project and the time frame. For climate change: 80% normative.

P10: To explain my answer to (5): the normative question of what social discount rate is required by justice to future generations can only be answered once the descriptive issues have been answered. Therefore it is not possible to assign proportions to these two.

P11: The reason I chose these percentages is that while actual savings behaviour might indeed reveal some preferences of a society, these preferences are limited to our future consumption and the preferences of future generations are not reflected in the markets. However, the exact percentages would very much depend on the time-frame of the public project, as well as the uncertainties involved; if it was to do with climate change mitigation, I would give much more weight to normative issues (probably something closer to 90%).

P2: I cannot answer this question. Since the social discount rate is a weighted average of both the consumption discount rate and the marginal rate of return on alternative investment, the social discount rate should be fully determined on the basis of both justice and descriptive issues, such as forecasted average future returns of financial assets.

P12: I lean toward the prescriptive approach to setting the SDR, believing that uncertainty and justice should be key determinants.

P13: Question 5 is obscure. The Ramsey formula requires some empirical input, specifically the rate of economic growth. So 100% normative is not clearly the right answer. However, I took it that "descriptive issues" refers specifically to the forecast interest rate, and this gets 0%.

P14: I find the question 5 impossible to answer since the two rationales are not exclusive in my view (and must therefore not sum up to 100%). In determining the discount rate, the government needs to *fully* take into account justice towards future generations and *fully* take into account the returns on assets. Taken together, they yield an answer on discounting. Since I couldn't answer the question, I put in 50% and 50%.

Technical issues

DDR and time horizon ($N_E = 20, N_P = 3$)

E36: The social discount rate should depend on the time horizon of the project evaluated.

E1: I have never understood why economists always assume that consumption will rise at a constant rate [...] That way the Ramsey formula yields a constant (consumption) discount rate.

E2: There are declining productivity and population growth rates, so the estimates are sensitive to the horizon; The survey is misleading because there is no single discount rate over the long horizon. While it is possible to answer, it should be in the context of the 100-year horizon. For the discount rate, the number is a bullet rate, not an average rate.

E3: I am unclear about how to answer your questions about constant growth rates, discount rates etc. over the next 100 years, when I think they will actually be declining. Growth rates and social discount rates are constant rate equivalents of declining rates. I would not recommend anybody to use a constant rate of discount over such a long time horizon. I could answer the questions under a 30 year planning horizon, but that would probably be of little use to your survey. I could compute a constant rate equivalent (as Weitzman did with Gamma-discounting)

and that would yield something in the region around the Stern report long-term discount rate. But it would differ from my actual recommendations of discounting over such a long planning horizon.

E37: For a real social discount rate, I would recommend a rate decreasing from 4 to 0%.

E38: These figures are long-term averages. In practice, differences are expected between estimates for 100 and 400 years.

E39: We should use two rates, conventional (intra) and inter generational.

E4: I would probably use a Declining Discount Rate. Start at no more than 4% for global projects, declining to 2% after 100 years, and then levelling off at 1.5-1% over 300.

E6: You obviously restrict responses to one number for analytical reasons, but we all know that it is a time-varying schedule. And I know you know that. So, in filling this, as you have asked for a long-run average rate, I have given something like this over about 100 years (it would obviously be lower if I considered it over 400 years) and yes this depends on the assumed nature of uncertainty, shape of the distribution and hence the rate of decline.

E15: Certainty equivalence just doesn't apply to discount rates that roll out over time, nor does the habit of adopting a protocol of declining discount rates get round the problem of trying to average negative exponential functions.

E40: I do not believe that necessarily a single rate is applicable, but a hyperbolic one for certain types of environmnental problems.

E8: When choosing the democratic perspective, the representative agent attempts to choose a time-preference parameter that in some way represents the variety of preferences within society. The general result in the literature is that this implies a decreasing pure discount rate, with very low discounting for long-term projects.

E41: For very long time horizons, recent evidence indicates very low social rates might pertain.

E9: This survey begins by assuming that exponential discounting is the appropriate method. This is completely ridiculous. It's well established that humans do not discount in this fashion.

E25: I think that a social discount rate decreasing over time makes sense, even though it raises the issues of temporal consistency.

E11: It is difficult to give a single figure, given than most of these figures will change depending on the horizon (100 years is not the same as 200 years). In particular, the growth rate of per capita consumption is likely to be decreasing (and 0 in the very far future?); the real risk-free interest rate and social discount rate are likely to be decreasing too, because of the risk on growth.

E42: I am more comfortable with declining discount rates calibrated to match real interest rates in historical financial markets. This would include declining rates due both to declining time preference rates and to uncertainty about future consumption growth.

E43: All of the above assume that the "determinants" are constant, which needs (or should) not be the case in general

E44: I WOULD RECOMMEND DECLINING DISCOUNT RATES.

E45: I also felt uncomfortable about being forced to give a *single* constant value, of both the consumption growth rate, and the "recommended" rate, as I don't think these are stationary.

P5: [...] With much greater confidence, I would urge the organization to us a declining discount rate, for both normative and descriptive reasons. (2) I think of climate policy evaluation as something closer to Katie Steele's "moral modeling" than to some kind of Benthamite calculus. And I think it's morally acceptable -— and in many contexts even required -— for us to give greater weight to the concerns of those nearer and dearer to us than to those further away. In a global climate policy evaluation context, that means attaching less weight to those in the distant future. However, I think one cannot *completely* discount others' well-being simply because they are further away, socially or temporally. That's one reason why I prefer a declining

discount rate: I think the rate of pure time preference should decline to (almost?) zero over, say, a few generations. Shorter version: an intergenerational sort of "differentiated love," to use the Confucian term, justifies a strictly positive rate of pure time preference that declines to zero over the course of a few generations.

P4: My assessments here are based on the assumption that people's actual behaviour in discounting reflects their genuine normative concerns, e.g. for inter temporal fairness, the claims of special relationships and the relative value of realising ambitions (forward facing utility) rather than having valuable experiences (backward facing utility). Whilst this this will undoubtedly turn out to be an incorrect assumption it is my belief that the fundamental justification for our normative beliefs needs to be individuals action guiding moral intuitions and that these play a very significant role in governing behaviour. However crucially I believe that none of these considerations justify the practice of cumulatively discounting future welfare without limit. Whilst I would advocate a 5% discount rate for expected future growth in the short to medium term I believe that the effective discount rate will reduce over time so that eventually there is a maximum cumulative discount rate (e.g. 99.99%) that we should apply to future welfare irrespective of how far in the future it is. This should be sufficient to render even relatively large effects on the welfare of future individuals irrelevant to present policy considerations, whilst retaining the fact that if we can influence very significant future events, such as preventing a future extinction event or rendering it survivable, this will still represent a significant benefit relative to present welfare (even 0.01% of billions of years of human existence will be worth any amount of present welfare).

P8: My motivation for suggesting a rather low social discount rate is mainly ethical. In my view, the social discount rate is of key importance in giving due weight to the interests of the members of later generations. These interests count morally to the same extent as present interests do. A discount is certainly justified on the hypothesis that marginal utility of income will decrease with increasing material well-being, especially in countries counting at present as developing countries. But this consideration does not justify a discount merely for temporal distance.

Substitutability ($N_E = 20, N_P = 4$)

E46: The discount rate should be the growth rate (IF ANY) of real per-capita consumption NET OF ENVIRONMENTAL DAMAGES (e.g. from climate change) AND NET OF DEPLETION OF EXHAUSTIBLE RESOURCES.

E47: Delta=0.95 (r=0.05) is assumed to be a high discount factor which avoid the collapse of commercial valuable fish stocks due to the convergence of the optimal policy dynamics to a high optimal steady state equilibrium.

E12: Present discount rates don't seem appropriate, unless maybe climate change doesn't change much. But if climate change doesn't change much it is irrelevant. I mean, if growth rates are unaffected despite climate change, what does it matter? We just don't need a CBA.

E48: However, if the future costs/benefits accrue to non-monetary goods (e.g., environmental amenities, loss of human lifes, etc.) I would argue for a very low discount rate (possibly even a zero one), based on an expectation of increasing relative prices for these goods (so my recommended real SDR of 3% above is adjusted downwards somewhat to account for this possibility).

E28: However, I don't think that this is really the right way to deal with equity. Rather I feel it should be dealt with through direct reinvestment of a proportion of proceeds (sometimes from other investments) to ensure the sustainability of service flows into the future. So investments in non-renewable extraction (say fracking and oil extraction) should incur a charge which maintains the calorific value of energy supplies and an equable climate into the future.

E35: The right discount rate depends on a lot of factors including [...] whether prices already account for increasing scarcity of some environmental commodities...

E49: I do not think that present growth (based on environmental degradation) should be used to justify more environmental degradation.

E50: Generally I stand for very low, even negative discount rates on everything that involves natural resources.

E51: Different projects and their costs and benefits may have a higher or lower substitutability to consumption.

E4: My 1.5 for growth is really reflecting my minor pessimism about technological change but more the likelihood of environmental and resource constraints.

E5: What kind of project do we talk about? How substitutable are its services? If we talk climate change (as I assume), there is no substitute for the climate, so ignore financial markets. If we talk about public projects such as schools or local transport infrastructure, I am not sure what the EOS should be. How can we compare public services to private investment opportunities? I have no general answer to that (yet).

E15: The appropriate rate varies according to the good/service.

E7: Discount rates should be good-specific.

E40: [b]ut a hyperbolic one for certain types of environmnental problems.

E8: It is assumed that the public project can be interpreted as a stream of certainty-equivalent cash flows. Such projects may exist, but more importantly, if I answer these questions, my responses will undoubtedly be applied to projects where this assumption is fundamentally flawed. For climate change, for rainforest, coral reef and biodiversity protection, for nuclear safety, there is no certainty equivalent cash flow. How much are we willing to pay to preserve a climate that warms 2 degrees versus one that warms 3 degrees? How much are we willing to pay to preserve the blue whale, or the Amazon? Only if we assume that such questions have reasonable answers, can we start thinking about the Ramsey rule for related projects. Economists have tried to provide approximations for the costs of climate change, and then typically assume that all costs not evaluated in the market-place are zero, but some earth citizen may object that they believe they have some rights to let their grandchildren inherit a naturally rich world, and that these rights should be balanced against the rights by others to destroy part of the world richness.

E30: I assume that in Q. 6 you are asking a question concerning projects involve cash flows, or at least something that can be translated into cash flows directly and uncontroversially (i.e., not happiness or lives saved, but perhaps a toll bridge or a new train line) and therefore 2% seems a reasonable discount rate.

E52: Set limits in physical terms to the future development that must not be exceeded for reasons of intra- and intergenerational justice, e.g. on climate change, biodiversity loss, infrastructure deterioration/enhancement, education level, life/health expectancy etc...).

E9: For example, if the public project involves infrastructure that will depreciate in value, become obsolete due to technological change, or risks destruction unforeseen disasters, we might discount future values in an entirely different way than if we are restoring a dwindling ecosystem that will become self-sustaining and generate essential ecosystem services that will always be important. // I believe that exponential growth of any physical sub-system of a finite system is impossible. While the flux of welfare we derive from economic activity has psychological components, the economy is ultimately a physical system.

E53: Dominant effect on discount rate is climate damage.

E54: I think ethics and uncertainty are important but sectoral disparities maybe even more so. // I would rather have a somewhat higher average value for consumption goods but then much lower values for sectors that do not grow – like for instance ecosystem services..

P1: For the long-term, 0% for climate change.

P15: Instead of "cost-benefit," or "discount rates," long-term future assessments should be made according to a "sustainability index," which gives primary consideration, not to "market preferences," but rather to sustaining environmental conditions and resource availability. Optimum population size and acceptable population reduction rates should also factor into the assessment. My non-economic policy proposals for the remote future are spelled out in [anonymized].

P2: If there are real sustainability issues and we fail to take the path towards a sustainable development, then the growth rate of real per-capita consumption will be negative. SDR=0.6% for wrongful harm to future generations (e.g. climate damage): 20% marginal propensity to save times 3% risk-free marginal rate of return on alternative investment; 3% for all other effects.

P16: Because the discount rate is dependent on assumptions about future scarcity, future problem-solving capacities, uncertainties, cultural change etc., there should be no single discount rate across the board. Natural assets, monetary investments, infrastructure project etc. should be discounted at different rates.

Uncertainty ($N_E = 20, N_P = 4$)

E2: I have assumed no uncertainty about future variables in order to get the risk-free rates; Omitting considerations of risk is a central problem with the survey. Risk is everything over a 100-year horizon.

E55: [I am] very interested in the way uncertainty enters the effective discount rate.

E35: The right discount rate depends on a lot of factors including [...] the persistence of shocks.

E56: Discounting rates are useful but do not provide (accurate) market values of risky assets... but what does?

E13: Certainty equivalents should be discounted at the risk-free rate of return. The finance literature typically takes the risk-free rate to be about 1% based on market returns on financial instruments that carry minimal inflation risk. Long-term government bonds pay higher yields that reflect a positive risk premium that covers inflation risks. So the revealed preference criterion implies a low discount rate for certainty-equivalents.

E51: Also the nature of the uncertainty involved is important (e.g. are catastrophic outcomes possible).

E4: It would be useful to have the variance predictions for growth and risk free rate; the SDR is less than implied by Ramsey due to a moderate prudence term, although I am not wedded to the Ramsey Rule other than as a benchmark. Max is greater than 2 due to uncertainty about growth and/or eta (either could be 2) and the prudence effect.

E5: I need to account for uncertainty.

E6: I see the distribution of consumption growth as having pretty high variance and possibly even being bipolar. Over 100 years, humanity could be in a total mess (average growth rate zero or negative), and here's hoping we don't get the nukes out, or remarkably positive – a new wave of smart, clean innovation leads to delighted humanoids enjoying Keynesian levels of leisure or more. Who knows? 2% is merely some kind of unimaginative number that lies within the bounds and sounds plausible.

E15: Certainty equivalence just doesn't apply to discount rates that roll out over time, nor does the habit of adopting a protocol of declining discount rates get round the problem of trying to average negative exponential functions.

E29: The rationale behind my answer is that normative issues are more certain than forecasted average future returns to financial assets.

E8: When we assess projects, we need to admit that the current state of the world is full of uncertainties – does anyone know the precise size of the informal sector, or the increase in

happiness with income and employment and its variety between individuals – and that these multiply when we look further away in time. We necessarily abstract from most uncertainties and develop a model that helps us to bring all information together into one denominator. In such a model, most uncertainties are neglected, and sometimes a few remain when these are considered most important, most interesting, or easiest to accommodate.

E57: Not possible to answer in general as it depends on the precise public project: which risks does it involve or protect against, and are these risks insurable (if not, then a lower SDR makes sense).

E24: I think uncertainty about future growth is important, but your questionnaire does not ask about this.

E58: The economy we consider is under uncertainty, and uncertainty should not be ignored when determining which discount rate should be used. However, I find it a bit difficult to imagine what the variance of growth rates would be in the next 100 years or so.

E59: Risk matters.

E11: The real risk-free interest rate and social discount rate are likely to be decreasing too, because of the risk on growth.

E42: [...] declining rates due both to declining time preference rates and to uncertainty about future consumption growth.

E54: I think ethics and uncertainty are important.

E45: My "recommended" real rate accounts for a prudence effect

P5: The rate is a useful proxy for existential risks, as in the Stern Review. I mostly buy the Parfitt-Cowen response that if we're concerned about risk, then we should just model risk explicitly, but given the complexity of climate policy evaluation, I think shoehorning existential risk into the discount rate is a reasonable thing to do.

P12: I lean toward the prescriptive approach to setting the SDR, believing that uncertainty and justice should be key determinants.

P16: Because the discount rate is dependent on assumptions about future scarcity, future problem-solving capacities, uncertainties, cultural change etc., there should be no single discount rate across the board. Natural assets, monetary investments, infrastructure project etc. should be discounted at different rates.

P3: By the same token, we must consider projected growth rates in different societies, in different possible states of the world, depending on the project in question.

Project risk ($N_E = 6, N_P = 0$)

E2: Moreover, we would have to consider very carefully the risk structure of the investment (in the standard consumption CAPM approach) to get a correct discount rate. So while I am willing to contemplate a risk-free rate, it makes little sense for anything at a long time horizon.

E26: Public investment projects entail risk and uncertainty, so in my opinion their required rate of return should exceed the real rate of return on an asset for which the nominal returns are known with certainty or on a constructed asset with a real risk-free rate of return. will belong to different risk classes, and will have different required rates of return.

E23: The problem is that we need to [...] adjust for [...] correlation with the baseline risk profile.

E35: The right discount rate depends on a lot of factors including [...] the risk or uncertainty of the project and the correlation of mitigation or adaptation payoffs to general economic growth.

E4: Project risk is an important factor missed out here.

E57: Not possible to answer in general as it depends on the precise public project: which risks does it involve or protect against, and are these risks insurable (if not, then a lower SDR

makes sense).

Opportunity cost of funds etc ($N_E = 8, N_P = 2$)

E60: Discounting is approached as a descriptive way to assess return to private investors (if involved), while public sector priorities should guide that decision under financial constraints.

E2: All of this abstracts away from additional issues such as taxation, imperfections of capital markets, and identity of the borrowers and lenders. The final issue is that the discount rate discussed here applies primarily to borrowers and lenders who have no capital constraints. So this would be a few governments today (US, Japan, Germany) and not much else. We would therefore need to think carefully about the opportunity cost of the funds, for example are they coming from funds for RD, education, infrastructure, health care?

E26: I'd recommend using society's view of the opportunity costs of the funds for the project at the time that the decision about the project is made. A specific one-size-fits-all-projects at all times single number such as the OMB mandates of 7% and 3% as discussed above never made a great deal of sense to me other than as a solution in the absence of a practical way to know the theoretical answer for a particular project. It's a political process (difficult at the national level and even more difficult at the international level) that allocates resources to the government projects, and perhaps the best we can do is a simple recommendation such as that in the OMB memoranda and then use that as the starting point for discussion. In the end though, the political process, rather than our formal cost-benefit evaluations, will determine the allocation decisions.

E15: An opportunity cost of investment funds should be the instrument of capital rationing.

E61: Social Discount rates should reflect the social opportunity cost of borrowed funds.

E31: No mention is made here of the opportunity cost of government funds.

E10: Restrict (or distinguish) discounting to represent opportunity cost (conditional on valuation of future consequences) rather than use it to also embed (implicit) social values (implicit and restrictive). Apply social valuation on long term consequences explicitly then discount at rate representing opportunity cost.

E62: You need one rate to weed out public projects that are dominated by the private sector and another to evaluate which of the remaining projects pass the social present value test.

P2: Or one uses the social discount rate, which is a weighted average of the consumption discount rate and the marginal rate of return on alternative investment. Still the best source on this issue: Lind, R. C. (1982). A primer on the major issues relating to the discount rate for evaluating national energy options. Discounting for time and risk in energy policy.

P13: As you know, the correct way to handle the "opportunity cost of capital" is not by adjusting the social discount rate.

Heterogeneity and distribution ($N_E = 19, N_P = 1$)

E26: In any case, there will be disagreement about the choice of the social discount rate because the participants in the political process will have different opinions about the opportunity cost of the funds for the project. Such disagreement will be great even within one country. I think the disagreements will be greater still across countries, so the problem for the international government organization will be even greater than within a country.

E23: Wouldn't this depend on the country in question? In the US I would guess around 1.5% over the last few years with a long-term average of maybe 2.5% However, for China it would be higher.

E28: My answer to Q5 is, of course, normative in both of its part (as the first part dictates the second). However, I don't think that this is really the right way to deal with equity. Rather I feel

it should be dealt with through direct reinvestment of a proportion of proceeds (sometimes from other investments) to ensure the sustainability of service flows into the future. So investments in non-renewable extraction (say fracking and oil extraction) should incur a charge which maintains the calorific value of energy supplies and an equable climate into the future. That is almost certainly a requirement for investment of those proportional proceeds into renewables and CCS or similar.

E3: Moreover, the assumption of a uniform discount rate across countries that differ significantly by risks and green growth potentials is not without problems

E17: The elasticity of MU of consumption is heterogeneous, and using a single value is – it seems to me – a crude simplification. Ideally, the input for our SWF would be a utility function that allows for heterogeneous preferences (cf. Marc Fleurbaey's work on equivalent incomes and [anonymized]), and this would smoothly handle heterogeneity in elasticity of MU consumption.

E35: The right discount rate depends on a lot of factors including who is affected by the project.

E13: [b]ut the EOMUC in the formula, being based on representative agent or constant elasticity formulations that seem unlikely at best, is largely a distributional/equity consideration given its dual importance in describing intra-generational preferences for inequality.

E5: I am not a big fan of average GDP growth alone, but rather looking at the distribution of income/wealth and opportunities for those affected by the project... // I am not a fan of a constant marginal elasticity, but differentiation by poor, well off, and rich, at least. Number I gave you is a Vissing-Jorgensen and Attanasio (2003) best guess with an Epstein-Zin model. Note: This is NOT meant as an intragenerational inequity measure. // I cannot exclude the possibility that some of the affected are worse off than their counterparts today. Hence I want a discount rate that puts weight on those living 1 or two centuries from now. Of course I should model this explicitly but you asked for the number, not me.

E7: Discount rates should be country-specific.

E63: This assuming a global average over the world. There should be a clear intention of reducing differences, heading towards a global equilibrium.

E31: Rates should vary by country. There is no global rate.

E64: Sorry for not answering 6, this is not a meaningful question because you don't give the distribution of shares among investors and beneficiaries. The discount rate should be negative if rich people pay today for poor people in the future. Different investments have different distributions of beneficiaries and should therefore be discounted differently.

E65: Any project that has significant intergenerational effects and where costs or benefits fall disproportionately on present or future generations should not employ discounting. To do so requires acceptance of the Kaldor-Hicks rule for dealing with social welfare changes among individuals and groups in society. Although a 0% discount rate does not solve all of the equity flaws conventional benefit/cost analysis, it takes one small step toward doing so.

E20: The normative approach is based on weighing WTP for different generation, with less weight on the richer ones. It makes no sense to use this in combination with valuation studies where each individuals WTP are not weighted similarly by income. With the elasticity given in 3, WTP from the poorest billion should weigh 20 times as much as the WTP from the richest billion. Few valuation studies does such a weighing. When it is not done, mixing the valuation with the discounting derived from similar weighing across generation is dangerous.

E66: Moreover, thinking of global warming it is important who are affected in the future, and whether they are poorer than average.

E9: People unable to meet basic needs have a very high EMUC. I however believe that humans are satiable, and it takes $600 billion per year in advertising to convince us otherwise. Empirically, per capita consumption in the US has more than doubled since 1969, while surveys

on happiness and satisfaction with life as a whole show no significant change, suggesting a value of 0 for EMUC. Once basic needs are met, EMUC is largely driven by status, which means that an individual might have a positive EMUC while society as a whole does not.

E10: No such thing as a global average only PV of global consequences.

E54: I object to just focusing on one average growth and discount rate. I was now forcing myself to give some kind of average value.

E45: The most difficult part of this exercise, in my view, is trying to think of this problem on a globally aggregated level, as the answers to your questions (at least on interest rates and consumption growth) will vary wildly between different countries. I somehow had to make an intuitive guess as to how that variation would aggregate up to the global scale, but I'm not very confident that I've done it well.

P2: In the case of a project that potentially benefits people living abroad, these benefits may be fully neglected (discounted) in project appraisal. In the case of a project that potentially harms people living abroad in health and property, these harms should be given equal weight in project appraisal. Nevertheless, (international) law allows for cost-benefit analysis as long as all costs and benefits are counted equally. This is the consequentialist part of my approach. The intergenerational context is more complicated since capital is productive in time. Therefore, one has to calculate the consequences of different policy options through time and discount the different consumption streams against the consumption discount rate.

Methodological issues

The role of expert ($N_E = 7, N_P = 4$)

E68: I do not think surveys are the best way to get at this issue which is why [we] wrote the paper we did years ago.

E26: I'd recommend using society's view of the opportunity costs of the funds for the project at the time that the decision about the project is made. It's a political process (difficult at the national level and even more difficult at the international level) that allocates resources to the government projects, and perhaps the best we can do is a simple recommendation such as that in the OMB memoranda and then use that as the starting point for discussion. In the end though, the political process, rather than our formal cost-benefit evaluations, will determine the allocation decisions.

E13: I really think economists have very little special expertise in knowing the "right" number. These are parameters that should be chosen in an open, iterative way with an eye toward understanding the consequences of different choices. I hope this explains the "999" and ".999" values above. The survey should have been designed to allow for ambiguity or missing values. Failure to do this may lead to a perception that economists have an ability/willingness to supply these values, when that is not universally the case. Just to be clear, I definitely think economists have an important role at the table in the public discourse over these matters - just no special normative expertise! // I hope my remarks didn't come off as unnecessarily critical. I simply think there are certain parts of the social discount rate that are unavoidably ethical/normative in nature. I don't think economists have any special claims to expertise for these, but I would also object that even a mathematically inclined philosopher lacks the appropriate expertise. As a matter of fact, I don't think the social discount rate for long-range public investment decisions affecting multiple nation states should be chosen by experts. This will ultimately need to be chosen on the basis of social discourse and likely will involve getting to a "fuzzy set" of values through iterative examination of the ethical acceptability of the outcomes that result from using particular rates. While I'm sure there are a number of very smart and informed economists that

disagree with me, there are certainly some that more or less agree as well (for example Partha Dasgupta).

E8: Finally, the fourth perspective, which I labeled democratic, is not common in the literature, but for a representative institution, it seems a logical choice. When choosing the democratic perspective, the representative agent attempts to choose a time-preference parameter that in some way represents the variety of preferences within society. The general result in the literature is that this implies a decreasing pure discount rate, with very low discounting for long-term projects.

E69: I don't think my value judgments (which are answers to 2, 3, 5, 6 and 7) should play any larger role than anyone else's opinion. This is not a question for academics to decide, we can explain the differences and that is it.

E70: I do not believe in "ask the experts" exercises: experts are not oracles. Besides, they may have hidden incentives and hidden agendas of their own.

P9: philosophers/political philosophers do not well understand social discounting, and so I do not expect your survey to provide meaningful results; philosophers/political philosophers have no empirical expertise to answer question 1 (or question 4, for that matter).

P11: This is an important topic, but very hard for an economist to give precise answers to, let alone a philosopher. More significantly, I think no one person (or even a few) are qualified to making such value judgements, not even the experts. Therefore, when it comes to big public policy decisions with long-term intergenerational consequences, like the ones to do with climate change, I think the discount rate should be deliberated politically. Now, how to actually go about this is the big question and I do not have a definite answer unfortunately. One plausible solution would probably run along the lines of putting together a focus group consisting of experts, policymakers and members of the general public (how to choose among them is no simple question either, but my view in general is that democracy has to be made more inclusive, open and participatory for it to work in the current world). The focus group would first of all cover the basic issues involved: the economists would explain discounting practises, maybe a philosopher would be around to explain what value judgements go into them. The policy makers further explain each option from their point of view. The discussions and deliberations that follow could even be made available to anyone interested, i.e. put a video online etc. The focus group comes up with a suggestion and this is then put to the public consultation still in some way — there is a period people can put in objections or alternative suggestions. After this, the focus group meets up again and comes up with the final rate(s) that will be put forward. This might sound time-consuming, and it will likely be so, but with time best practice would emerge. Note that I am not arguing that we should go through this process for ALL policy decisions, just the ones that are genuinely large-scale and future-oriented.

P17: To virtually all of the questions you sent me regarding the social discount rate, the ideal response in my view would be to present alternative viewpoints and their various practical implications within larger-scale, participatory and deliberative, integrated scientific assessment processes. This is also the way IPCC Working Group III treated these enormously heated issues "fact/value bundles"). Even though there is also the possibility to come to philosophically well-justified judgments regarding the normative issues in this climate policy context, I think presenting and discussing disputed alternative scenarios with different social discount rates etc. would help decision-makers to understand and learn – much more than simply presenting fixed numbers, be they more "descriptive" or more "normative".

P12: Ideally, I envision an inclusive, democratic process for determining the SDR, but I do not know how such a process could be implemented in practice. At least, experts from multiple disciplines (including philosophy, economics, political science) should be consulted.

Comments on the survey ($N_E = 14, N_P = 10$)

E71: As far as I know, there is no objective way of giving guidance on these issues beyond just using the private discount factor.

E72: These questions assume a certain way of doing the analysis, which I disagree with.

E73: I am not comfortable with the delphic method in choosing a discount rate.

E23: I really think these questions are confusing. I understand that we want to get at a base rate. However, I don't think that really matters much. What matters are adjustments for appreciation, depreciation, risk profile, etc. Mostly, we are choosing among investment opportunities. Two identical opportunities should have the same discount rate. Two different opportunities should start with the same rate, and then make the correct adjustments.

E35: Stating an average is somewhat misleading. I consider pushing for a more useful model, avoiding inefficiencies necessarily implied by the present approach, more important than coming up with a number.

E13: I really think economists have very little special expertise in knowing the "right" number. These are parameters that should be chosen in an open, iterative way with an eye toward understanding the consequences of different choices. I hope this explains the "999" and ".999" values above. The survey should have been designed to allow for ambiguity or missing values. Failure to do this may lead to a perception that economists have an ability/willingness to supply these values, when that is not universally the case. Just to be clear, I definitely think economists have an important role at the table in the public discourse over these matters - just no special normative expertise!

E74: This is not the right framework to address the issue of discounting.

E50: Perhaps it would more useful (and educational) if you could also explain the meaning of some of the values that you are asking us to provide.

E75: Q5 assumes too much structure on the way the social discount rate should be determined.

E5: I envision a project that has impacts a century or two from now. I need to account for uncertainty, and I cannot exclude the possibility that some of the affected are worse off than their counterparts today. Hence I want a discount rate that puts weight on those living 1 or two centuries from now. Of course I should model this explicitly but you asked for the number, not me.

E15: [...] I am very uncomfortable with collapsing the issue into a few numbers like this, which no doubt will be reported without caveats. // The sought Holy Grail of a single number discount rate is among the most dangerous ideas that economists (and psychologists and people) have ever promulgated. // I have completed the questionnaire, in the required format, but am very uncomfortable with any single number being taken as THE discount rate. The questionnaire actually begs the important question: is discounting for time an appropriate way to value future acts, events, etc.? I'm also unhappy about the way the questions are posed. In every case I answered initially in accordance with the specifically requested format, and every single numerical answer was rejected – but only at the end of the questionnaire. By allowing only single number answers, you accept the concept of a single discount rate, and line yourselves up for a meaningless averaging. The most valuable result of the survey would be a descriptive compilation of caveats about the process – though that said I think non-respondents will include some who refute the entire idea involved in discounting by a single number.

E30: To be honest I did not think that with your survey I was able to express my answers even to the questions you wanted answers to.

E64: The search for THE discount rate, if that is your project, is deeply flawed.

E9: This survey begins by assuming that exponential discounting is the appropriate method. This is completely ridiculous. It's well established that humans do not discount in this fashion.

P18: I've assumed by "international" thins means truly global rather than some more restricted grouping such as the EU or OECD.

P1: I struggled with whether to fill out this survey. I'm afraid that I think the SDR framework is a problem for climate change, and that no one should have much faith in their numbers. I decided ultimately to submit something largely on the grounds that you are trying to get a sample of a range of opinion.

P15: When at first I examined your "Survey Text" several weeks ago, my immediate reaction was, "I am not qualified to assign values to your X-s". I am not an economist, and so am not competent to deal with these "utility calculations." And so I set it aside. On reflection, I find myself asking, why should I, or anyone (e.g. an international governmental organization), attempt to calculate a social discount rate based upon "certainty-equivalent cash flows?" My answer: they should not. Such an enterprise is misbegotten at the get-go.

P19: I WOULD REFUSE TO ANSWER THESE QUESTIONS BECAUSE THEY PRESUPPOSE A FALSE AND MISLEADING WAY OF THINKING ABOUT LONG-TERM PROBLEMS.

P17: As explained in various academic publications, I would never provide such numbers in such a way without any explanation, and without transparency over assumptions, uncertainty, etc. That is why I cannot fill the survey. Just to clarify: it was not my intention to say that the survey as such is meaningless. Rather, I certainly believe you that there is a high demand for such numbers and I also like the way you are dealing with the difficulties related to these complex questions. To virtually all of the questions you sent me regarding the social discount rate, the ideal response in my view would be to present alternative viewpoints and their various practical implications within larger-scale, participatory and deliberative, integrated scientific assessment processes. This is also the way IPCC Working Group III treated these enormously heated issues "fact/value bundles"). Even though there is also the possibility to come to philosophically well-justified judgments regarding the normative issues in this climate policy context, I think presenting and discussing disputed alternative scenarios with different social discount rates etc. would help decision-makers to understand and learn – much more than simply presenting fixed numbers, be they more "descriptive" or more "normative".

P20: I'll do this – I've been worried that my responses might be outliers that could throw a wrench into your study, but I see that there's space on your form to provide additional comments or explanations. I agree with the premise of your study, that it's important to address the format that governments typically use in setting discount rates. I still worry that the concepts "utility discount rate" and "social discount rate" are ambiguous, and my response would be different for different disambiguations of these key terms.

P21: I can't answer it since I would question the presuppositions of the survey. For example: "For its calculations, the organization needs single values for the components of the real, i.e. inflation-adjusted, social discount rate." If I was approached by an organisation and told this I would question that any such single value exists that is ethically defensible. Justifying that claim would require a long response and I'm afraid I'm too pressed to give one here.

P9: Philosophers/political philosophers do not well understand social discounting, and so I do not expect your survey to provide meaningful results; In my view, philosophers do have useful things to add to the debate over social discounting, but not in contexts like this. I would be very interested in working with you to devise a survey that could provide what I think are meaningful results. It would be along the lines of some of the explicit trade-off questions that Frederick has used in the past, although even there the questions would need to invoke philosophical distinctions that Frederick is not attuned to (central among these is a distinction that Broome labels the distinction between "good" and "ought"; see e.g. Broome, *Weighing Lives*, pp. 31-36). I actually do think that your survey of economists has much merit, and that its results help

us think better about the issue. But I am still have significant doubts that the same can be true of a survey of philosophers. This is in large part because of my perhaps idiosyncratic view that many philosophers have a radically different conception (different from that of economists) of the normative role that discount rates play in intertemporal optimization exercises. So I worry very much that any disagreement you find between philosophers and economists is a disagreement that would, in fact, dissolve to some degree if philosophers understood better what economic models seek to do/represent. I also worry that any agreement you might find will, likewise, be poorly informed agreement, and that this will lend undue support to recommendations by economists as recommendations that are (to use your phrase) "representative of a broader expert population."

P22: Thanks, but I am afraid that too many of the questions are either unclear of lacking specificity or in need of interpretation for me to be able to respond to them. Both the questions, and the time I would need to answer those I can grasp, elude me.

P3: The approach being described here doesn't just "fail to capture all the important complexities of social discounting". It's fundamentally wrong-headed. I realise that those sort of answers don't lend themselves to surveys, but perhaps you have a residual category such as "Refused to answer the questions because disagreed with the problem framing".

Alternatives to discounting ($N_E = 15, N_P = 9$)

E60: My approach disregard discounting as a proper technique to assess social public projects with intergenerational consequences.

E12: Instead of imposing a social welfare function (including pure rate of time preference, rate of inequality aversion, etc.) and calculate the corresponding optimum, it is "better" to depict a set of feasible paths of consumption, production, temperature, income distribution, etc. and let the policy maker make a choice.

E47: Delta=0.95 (r=0.05) is assumed to be a high discount factor which avoid the collapse of commercial valuable fish stocks due to the convergence of the optimal policy dynamics to a high optimal steady state equilibrium. However, there is potential danger of collapse in fisheries with increasing returns in effort (non-concavities) even for high discount factor values. In this cases, we recommend using both a high discount factor delta¿0.95 and the strict application of the Precautionary Approach.

E28: My answer to Q5 is, of course, normative in both of its part (as the first part dictates the second). However, I don't think that this is really the right way to deal with equity. Rather I feel it should be dealt with through direct reinvestment of a proportion of proceeds (sometimes from other investments) to ensure the sustainability of service flows into the future. So investments in non-renewable extraction (say fracking and oil extraction) should incur a charge which maintains the calorific value of energy supplies and an equable climate into the future. That is almost certainly a requirement for investment of those proportional proceeds into renewables and CCS or similar.

E13: I have doubts that a representative agent model with a standard Ramsey social welfare function is adequate in either descriptive or normative terms. Descriptively, key sets of problems relate to the equity premium puzzle and the need to use life-cycle models to evaluate intergenerational tradeoffs. Prescriptively, discounted utilitarianism is hard to justify morally (the Koopmans axioms notwithstanding), and there are richer ways of framing questions of intergenerational justice than simply tweaking the discount rate. I am not, however, persuaded that discounted utilitarianism is a canonically correct way to represent intergenerational social choices. A (classical) utilitarian would attach equal weight to the welfare of present and future persons, which might suggest a "rate of societal pure time preference" of zero.

E49: I do not think that CBA (and discounting) is an appropriate framework (or at least the most relevant one) for assessing the correct decisions in climate change policies.

E76: Essentially, you allow people to choose between being utilitarian with a zero utility discount rate or utilitarian with a positive utility discount rate. I disagree with both these criteria, as the first one essentially gives zero weight to the present generation, even if it is the worst-off, while the second one treats generations at different points in time unequally. There are attractive alternatives to both these criteria.

E51: In particularly with long-term intergenerational projects I have strong doubts that discounted utilitarianism is the way we do or should think about future generations.

E8: But from my experience I conclude that the Ramsey rule cannot be applied to long-term social questions, without information on the context. My objection stems from the very first paragraph written by the committee that invited me. It is assumed that the public project can be interpreted as a stream of certainty-equivalent cash flows. Such projects may exist, but more importantly, if I answer these questions, my responses will undoubtedly be applied to projects where this assumption is fundamentally flawed. For climate change, for rainforest, coral reef and biodiversity protection, for nuclear safety, there is no certainty equivalent cash flow. How much are we willing to pay to preserve a climate that warms 2 degrees versus one that warms 3 degrees? How much are we willing to pay to preserve the blue whale, or the Amazon? Only if we assume that such questions have reasonable answers, can we start thinking about the Ramsey rule for related projects. Economists have tried to provide approximations for the costs of climate change, and then typically assume that all costs not evaluated in the market-place are zero, but some earth citizen may object that they believe they have some rights to let their grandchildren inherit a naturally rich world, and that these rights should be balanced against the rights by others to destroy part of the world richness. The question is about rights for the future, not about costs. How much do you believe society should be willing to pay for children's rights for education, or women's rights for voting, or freedom of slavery? If you consider such questions out of place, you may consider the typical long-run public project assessment equally out of place.

E52: Rather than using a discounted-utilitarian approach, with a single social discount rate, to decision-making with intergenerational relevance, I would recommend to the government body to use a "Tolerable Windows"-approach. That is: set limits in physical terms to the future development that must not be exceeded for reasons of intra- and intergenerational justice, e.g. on climate change, biodiversity loss, infrastructure deterioration/enhancement, education level, life/health expectancy etc...). Then, use a discounted utilitarian approach to optimize development only within these limits. To me, this seems to be more appropriate in terms of intergenerational justice and efficiency than the procedure of maximizing a discounted-utilitarian welfare function.

E77: Question 6 addresses a GLOBAL Project With intergenerational consequences. I would not recommend any discount rate for such a Project (e.g. climate mitigation). The reason being that the "Project" that are evaluated generate to pathways for the discount rate. For example, mitigation gives a low Return in near future and high Return in far future, while "no action" gives high Return in near future and low Return in far future. To Select only one rate to compare the two does not make sense. To evaluate these kind of Projects, one needs to use other criteria than merely to compare the net present values.

E65: Any project that has significant intergenerational effects and where costs or benefits fall disproportionately on present or future generations should not employ discounting. To do so requires acceptance of the Kaldor-Hicks rule for dealing with social welfare changes among individuals and groups in society. Although a 0% discount rate does not solve all of the equity flaws conventional benefit/cost analysis, it takes one small step toward doing so.

E20: The normative approach is based on weighing WTP for different generation, with less

weight on the richer ones. It makes no sense to use this in combination with valuation studies where each individuals WTP are not weighted similarly by income. With the elasticity given in 3, WTP from the poorest billion should weigh 20 times as much as the WTP from the richest billion. Few valuation studies does such a weighing. When it is not done, mixing the valuation with the discounting derived from similar weighing across generation is dangerous.

E9: This survey begins by assuming that exponential discounting is the appropriate method. This is completely ridiculous. It's well established that humans do not discount in this fashion. Conventional economists claim that subjective preferences are paramount, so why ignore them here? How we should discount depends on what we're investing in // I believe that economists use exponential discount rates because it facilitates the math, not because it makes sense.

E78: Given the intergenerational framework, a discounted sum of flows (as suggested) may not be the appropriate approach for a normative analysis of very-long term policies.

P5: I think of climate policy evaluation as something closer to Katie Steele's "moral modeling" than to some kind of Benthamite calculus.

P1: I'm not at all convinced that the social discount rate is the right theoretical lens through which to look at the climate problem.

P15: Moral values (e.g. responsibilities to future generations) cannot be reduced to, or be expressed as, cash-values (i.e., "costs"). Instead of "cost-benefit," or "discount rates," long-term future assessments should be made according to a "sustainability index," which gives primary consideration, not to "market preferences," but rather to sustaining environmental conditions and resource availability. Optimum population size and acceptable population reduction rates should also factor into the assessment. My non-economic policy proposals for the remote future are [...] summarize[d as] [...]: The economic approach to policy is objective, quantifiable, formal and determinate, and thus very attractive to policy-makers. But in the final analysis it is, by itself, inadequate to the task of determining and carrying out our moral responsibilities to the future. One of the primary proclaimed "strengths" of the economic approach – "value neutrality" – turns out to be its fatal flaw. "Public policy" is a deliberate attempt to make an optimal choice among alternative futures, each of which will variably affect the rights and welfare of future persons. As such, policy-making is fundamentally a morally significant enterprise. Thus any "value neutral method" such as economic analysis, however useful as an ingredient to policy-analysis, must fail as a sufficient determiner of public policy. To the policy-maker, the economist's methodology of pricing and its entailed discounting of the future, while an invaluable servant, can be a cruel master.

P17: To virtually all of the questions you sent me regarding the social discount rate, the ideal response in my view would be to present alternative viewpoints and their various practical implications within larger-scale, participatory and deliberative, integrated scientific assessment processes. This is also the way IPCC Working Group III treated these enormously heated issues "fact/value bundles"). Even though there is also the possibility to come to philosophically well-justified judgments regarding the normative issues in this climate policy context, I think presenting and discussing disputed alternative scenarios with different social discount rates etc. would help decision-makers to understand and learn – much more than simply presenting fixed numbers, be they more "descriptive" or more "normative".

P2: My view on discounting is a bit deviant: a mixture of deontology and consequentialism (utilitarianism).

P23: I will tell you my general opinion about social discounting. The rationality and ethical legitimacy of social discounting is controversial. For most economists, social discounting – no matter for how distant in the future – is simply axiomatic. In doing so, they implicitly suppose there was an immortal individual who would represent the continued existence of the society, and they derive a "social discount rate" from that assumption. Yet, that is inadmissible: an

individual can discount his own benefit without violating moral obligations (except maybe for obligations towards himself). But it would be immoral to discount the benefit of others. What I am trying to make clear is that the social discount rates in these contexts (nuclear waste etc.) should be zero.

P3: My advice to the organization would be to read up on rank-discounted utilitarianism's approach to discounting, and then do something like that.

P4: My assessments here are based on the assumption that people's actual behaviour in discounting reflects their genuine normative concerns, e.g. for inter temporal fairness, the claims of special relationships and the relative value of realising ambitions (forward facing utility) rather than having valuable experiences (backward facing utility). Whilst this this will undoubtedly turn out to be an incorrect assumption it is my belief that the fundamental justification for our normative beliefs needs to be individuals action guiding moral intuitions and that these play a very significant role in governing behaviour. However crucially I believe that none of these considerations justify the practice of cumulatively discounting future welfare without limit. Whilst I would advocate a 5% discount rate for expected future growth in the short to medium term I believe that the effective discount rate will reduce over time so that eventually there is a maximum cumulative discount rate (e.g. 99.99%) that we should apply to future welfare irrespective of how far in the future it is. This should be sufficient to render even relatively large effects on the welfare of future individuals irrelevant to present policy considerations, whilst retaining the fact that if we can influence very significant future events, such as preventing a future extinction event or rendering it survivable, this will still represent a significant benefit relative to present welfare (even 0.01% of billions of years of human existence will be worth any amount of present welfare).

P14: For me, it is very hard to answer all of these questions since I do not believe that projects with very long-term consequences should be pursued if and only if the NPV is positive. (Personally, I believe projects with present costs and future benefits should be done if two conditions are fulfilled: (i) we owe the benefits to future generations (i.e. intergenerational justice) and (ii) the project is cost-effective, i.e. we can't achieve these benefits with lower costs than the costs of this project (i.e. roughly: the NPV of the project using the market interest rate is positive). For me, these two conditions are roughly necessary and sufficient for pursuing a project. And thus I think there are some projects that we should forego even if the present value of future benefits exceeds present costs. Summing up: Agencies need an SDR in order to calculate the NPV of projects. And they think they need to calcluate the NPV in order to decide whether to pursue a project. But: I think they shouldn't decide on the basis of the NPV. By extension, I don't think that they need an SDR. And, therefore, it is of course difficult for me to provide answers on the appropriate SDR – since I don't think an SDR should be used in the first place. Rather one should make decisions in a way that doesn't necessitate determining an SDR, i.e. my two conditions mentioned above (which,admittedly, do involve reliance on the interest rate).

Confidence intervals ($N_E = 8, N_P = 2$)

E36: [D]id not know how to find a central value to respond to your survey.

E72: I would also insist on providing confidence intervals.

E79: I don't consider global average to be specific – basically there is no "specific figure that is best" – just do sensible sensitivity analysis to assess how robust or variable your results are.

E14: Any point estimates above are central values of rather wide subjective probability distributions, and my minimum and maximum recommended rates in question 7 are not the lower and upper bounds per se of those subjective probability distributions but rather are intended

to give a wide enough range for conducting meaningfully informative sensitivity analysis as a routine matter of best practices for long run benefit-cost or social welfare analysis.

E4: It would be useful to have the variance predictions for growth and risk free rate.

E6: I see the distribution of consumption growth as having pretty high variance and possibly even being bipolar. Over 100 years, humanity could be in a total mess (average growth rate zero or negative), and here's hoping we don't get the nukes out, or remarkably positive - a new wave of smart, clean innovation leads to delighted humanoids enjoying Keynesian levels of leisure or more. Who knows? 2% is merely some kind of unimaginative number that lies within the bounds and sounds plausible.

E11: I regret that we cannot give range for these values (except the SDR).

E54: I object to just focusing on one average growth and discount rate. I was now forcing myself to give some kind of average value.

P11: This is an important topic, but very hard for an economist to give precise answers to, let alone a philosopher.

P3: I've tried to fill out the form, but it insists on my entering in decimal numbers into the blanks. I can't answer the questions in that way, because I believe there is no single correct rate of time preference, no single correct growth rate, and thus no single correct discount rate.

Comparison to Ramsey or risk free rate ($N_E = 17, N_P = 3$)

E1: I have never understood why economists always assume that consumption will rise at a constant rate. Everything you have sent me (sans those on risk) presumes that it does. That way the Ramsey formula yields a constant (consumption) discount rate, which is presumably the attraction of the assumption, but there is no justification. Take for example the Ramsey model in its pristine form (single good; constant population; and so forth). If the production function is strictly concave, then consumption growth along the optimum will be a declining function of time, implying that the consumption discount rate will also be declining function of time. So you have "hyperbolic discounting" in even that model.

E48: If future costs and benefits are solely monetary, I would recommend a high discount rate; e.g., in line with the Ramsey rate of 6% from my underlying parameters. However, if the future costs/benefits accrue to non-monetary goods (e.g., environmental amenities, loss of human lifes, etc.) I would argue for a very low discount rate (possibly even a zero one), based on an expectation of increasing relative prices for these goods (so my recommended real SDR of 3% above is adjusted downwards somewhat to account for this possibility).

E67: Incomplete futures markets justify social discount rates lower than real market rates.

E80: Allow survey respondents to compare the Ramsey discount rate calculated from the responses to the first questions to their recommended real social discount rate.

E6: In short, I recognise that my answer is not 0.2x (4) and 0.8x [(1).(3)+(2)].

E8: Almost a century ago, a great mathematician analyzed the rules for optimal investment. He set up a model with an infinite living agent that maximizes some cumulative measure of welfare, and derived mathematically a rule for optimal investment, which is named after him, the Ramsey rule. The rule has gained enormous popularity in economics; it is elegant and easy to understand. The rule states that the marginal productivity of investments should be positive for two reasons. First, the marginal utility of consumption tends to go down when consumption levels increase. Thus, if future consumption is higher, then present consumption is worth more, and if I have to invest one consumption good in present, I want more than one consumption good in return in the future. The strength of this mechanism depends on the growth rate of consumption, and the so-called elasticity of marginal consumption. Then, Ramsey noted that people may also dislike to give up current consumption for the benefit of the future purely on

the basis of the time-line: we give more weight to the present vis-à-vis to the future. In the literature, this is called pure discounting. I have been asked to provide you with my estimate of the elements of the Ramsey rule, so that you can decide on the return that you will require from investments in long-term projects, such as investments in clean energy that may limit climate change. I object. I have sympathy for the play with models, in which I also engage. But from my experience I conclude that the Ramsey rule cannot be applied to long-term social questions, without information on the context. My objection stems from the very first paragraph written by the committee that invited me. It is assumed that the public project can be interpreted as a stream of certainty-equivalent cash flows. Such projects may exist, but more importantly, if I answer these questions, my responses will undoubtedly be applied to projects where this assumption is fundamentally flawed. For climate change, for rainforest, coral reef and biodiversity protection, for nuclear safety, there is no certainty equivalent cash flow. How much are we willing to pay to preserve a climate that warms 2 degrees versus one that warms 3 degrees? How much are we willing to pay to preserve the blue whale, or the Amazon? Only if we assume that such questions have reasonable answers, can we start thinking about the Ramsey rule for related projects. Economists have tried to provide approximations for the costs of climate change, and then typically assume that all costs not evaluated in the market-place are zero, but some earth citizen may object that they believe they have some rights to let their grandchildren inherit a naturally rich world, and that these rights should be balanced against the rights by others to destroy part of the world richness. The question is about rights for the future, not about costs. How much do you believe society should be willing to pay for children's rights for education, or women's rights for voting, or freedom of slavery? If you consider such questions out of place, you may consider the typical long-run public project assessment equally out of place. /// The Ramsey is NOT obviously a good rule to use for evaluations of long-run projects. When the real return on investments is endogenous to market regulation, demography, retirement institutions, and other variables, we better ask ourselves what we would consider a proper mechanism to determine the social costs of carbon, and the Ramsey rule is not necessarily the best candidate for discounting future benefits of current policies. /// When choosing the positive perspective based on social statistics, we should choose the pure time discount rate that is consistent with observed behavior. For this purpose, we take a closer look at the Ramsey rule. The typical approach in economics is to state that we observe some rate of return on investments, that we observe some growth rate of consumption, and then one can calculate consistent combinations of pure discount rate and the elasticity of marginal utility. It is not possible to determine one parameter without the other, and for this reason, I cannot answer this question from the positive perspective. There is, however, another problem with this perspective that makes me less sorry for my missing answer. The reality is that there is no empirical support for the use of the Ramsey rule as a positive description of observations at the aggregate macro level. The returns on investments are determined in a complex market where savings and investment opportunities match, and regulation and demography enters. There is no reason to assume the Ramsey rule to hold, and as said, no empirical evidence either. The meaning is that, if we want to employ the Ramsey rule for such decision making, based on a positive perspective, then we need some serious research into the empirics of the Ramsey rule.

E81: Questions 6-7: the real social discount rate should be the risk-free interest rate.

E57: The first questions drive the respondent towards thinking that s/he should use the Ramsey formula (even though one might not accept this as a general model) and then in question 6 be consistent with this. Would have been better perhaps to start with question 6 and not allow respondents to go back to it (to change its answer) to avoid consistency seeking behavior (by rational economists).

E24: My discount rate is less than implied by the Ramsey rule because I use the extended

rule, incorporating uncertainty about long term growth.

E82: The Ramsey formula suggests a somewhat higher real social discount rate (6%), but for moral and political reasons (future generations can't vote) I prefer 3 %.

E66: There are reasons for deviation from the Ramsey discounting formula e.g. due to relative consumption concerns.

E10: This means don't need to know 1,2 and 3 (STPR) only 4 (same in undistorted equilibrium) with adjustment for distortions (externality, risk premium and those not able to participate in market (future generations).

E32: The answer I would prefer to give is that ideally the government should put full 100% weight on market interest rates, but the government should acknowledge that it can affect this market interest rate, e.g. in Diamond 1965 social security does just that. Thus, it's weight on future generations matters, indirectly.

E83: I understand the motivation for this questionnaire, but the Ramsey discounting formula (leavened by a bit of ethics) plays too large a role in it for my taste.

E33: My answers are probably not consistent but I tried to answer each question separately. If I had to be consistent, I would probably change my answer to Q2 to 1.

E45: My "recommended" real rate accounts for a prudence effect, so is a bit lower than the rate implied by the deterministic Ramsey rule, given the parameters I've provided.

P5: Less importantly, I also have vague concerns about avoiding "hairshirt policy" implications, whereby in the absence of a positive discount rate, each generation might be required to invest a counterintuitively large amount for the future. In a growing global economy, this is obviated by the rest of the Ramsey equation, but in an almost-steady-state economy, you might need a positive rate of pure time preference to avoid those results.

P2: Or one uses the social discount rate, which is a weighted average of the consumption discount rate and the marginal rate of return on alternative investment. Still the best source on this issue: Lind, R. C. (1982). A primer on the major issues relating to the discount rate for evaluating national energy options. Discounting for time and risk in energy policy.

P13: The Ramsey formula requires some empirical input, specifically the rate of economic growth.

Confidence

Limited expertise ($N_E = 5, N_P = 11$)

E71: Sorry, I really don't feel comfortable answering these questions. As far as I know, there is no objective way of giving guidance on these issues beyond just using the private discount factor. Because of this, I'm not willing to give you my opinion beyond that.

E55: I don't feel that I am any expert on this. These numbers reflect more randomly picked up values from the literature than in-depth knowledge based on a serious study or analysis

E84: I am not comfortable with any recommendation since long-run discounting is not my field, although I do work within macro/growth/environment.

E50: I am not an economist and am not comfortable with (do not know) some of the terms that you are using in your survey. So I don't expect my input to be of any value to you. Generally I stand for very low, even negative discount rates on everything that involves natural resources.

E85: I am not a real expert on these issues.

P15: When at first I examined your "Survey Text" several weeks ago, my immediate reaction was, "I am not qualified to assign values to your X-s". I am not an economist, and so am not competent to deal with these "utility calculations." And so I set it aside. // Perhaps I too carelessly tossed out those terms "market values" and "certainty equivalent cash flows." These

terms have precise meanings to economists with which I am unfamiliar. So I confess to dealing with technicalities above my pay grade.

P20: I've been worried that my responses might be outliers that could throw a wrench into your study.

P24: I do feel that I do not have sufficient expertise for your survey.

P25: I really don't have the kind of expertise needed to be of any use to you.

P26: I concluded that I lack the expertise to provide meaningful responses to the questions; even providing numerical ranges would feel far too random for me to have any conviction in my answers, and I would not be comfortable providing what would amount to mere 'noise' in the survey.

P9: Philosophers/political philosophers do not well understand social discounting, and so I do not expect your survey to provide meaningful results; philosophers/political philosophers have no empirical expertise to answer question 1 (or question 4, for that matter).

P13: Answering questions 1, 4, 6 and 7 involve economic forecasting, which I can't do.

P6: Not sure how to fill this in. I do not believe in pure time discounting at all. And for the other questions I do not have the relevant empirical information.

P27: Just looked at the survey but feel totally incompetent to provide these figures. Sorry about it.

P22: Thanks, but I am afraid that too many of the questions are either unclear of lacking specificity or in need of interpretation for me to be able to respond to them. Both the questions, and the time I would need to answer those I can grasp, elude me.

Limited confidence ($N_E = 13, N_P = 2$)

E5: I am not a forecaster.

E55: I can only give my opinion about the standard discount factor (delta) used in dynamic optimization models.

E17: I've been hesitating to answer because I'm not quite sure how to answer all the questions. My only firm answer would be that the utility discount rate should be zero.

E37: This formular does not allow not to answer to some questions, therefore all the 999's that I have entered stand for "no anwser".

E49: I was requested to and I did not want to be unkind, and so gave somewhat arbitrary answers.

E86: Please regards my responses as fairly tentative.

E87: Please ignore my response to Q4: I don't have the knowledge to make a meaningful forecast.

E29: Please note that I do not feel equipped to answer questions 3 and 4.

E81: Question 3: I have no idea.

E88: Only that I haven't thought about the issues much (I don't do dynamic growth models) and therefore perhaps my vote should be weighted less than others. I would trust Robert Topel's views on discount rates (he has modeled optimal carbon taxes) about as much as anyone else's.

E89: I'm not sure about my answer for the real risk-free interest rate, though I also don't sense this to be a controversial issue and would expect to support whatever the consensus estimate is.

E90: I have no opinion on question 3.

E45: I somehow had to make an intuitive guess as to how that variation would aggregate up to the global scale, but I'm not very confident that I've done it well.

P5: I attach *very* low confidence to the numbers I give here.

P10: I have left the "X" where the question falls outside my expertise.

Non-response and strategic response biases

We have already shown in [20] that non-response and strategic response biases are of no concern for the economists sample. Here, we repeat the same conventional tests for the philosophers sample [44–46].

First, we compare early and late respondents to test for strategic response bias due to the standard concern that early early respondents select into responding. We do so by splitting the sample of responses in two by date of response. When comparing these subsamples, there is no effect on the recommended pure time preference, elasticity of marginal utility, real growth rate, normative weight, real risk-free interest rate, or real social discount rate ($p > 0.1$, t-test).

Second, we compare quantitative and qualitative respondents to non-respondents on the basis of characteristics such as gender, location and seniority at the time of the survey, and academic age proxied by PhD year to check for response bias and find no predictive power ($p > 0.1$, t-test). We reach the same conclusions when comparing quantitative to non-quantitative respondents for the same covariates to check for determinants of quantitative response.

Invitation e-mail and survey text

Invitation e-mail

Subject line: Discounting the future: your expertise is required

E-mail text:

Dear X,

We are targeting you as part of a select group of philosophers/political philosophers with expertise in long-term public decision-making. The objective is to elicit recommendations on fundamental issues related to social discounting to inform long-term public investment decision-making.

The very short survey appended below is set in a format that makes the answers comparable to those of economic experts, from whom we have previously elicited responses. However, the survey provides the possibility to make suggestions beyond this structured format.

We would be most grateful if you could find the time to complete the survey, appended in the link below. Your individual response will be held in the strictest confidence.

https://www.surveymonkey.com/s/discounting-survey

In case you have any questions, do not hesitate to contact us.

Many thanks in advance for your time and cooperation,

Ben Groom (LSE), Moritz Drupp (Kiel), Frikk Nesje (Oslo), Mark Freeman (York)

Survey text

Imagine that you are asked for advice by an international governmental organization that needs to determine the appropriate real social discount rate for calculating the present value of certainty-equivalent cash flows of public projects with intergenerational consequences.

For its calculations, the organization needs single values for the components of the real social discount rate. While this does not capture all of the important complexities of social discounting,

it does reflect most existing policy guidance on the matter. Your answers will therefore help to improve the current state of decision-making for public investments.

Specifically, you are asked to provide your recommendations on the single number, global average and long-term (>100 years) values of the following determinants of the social discount rate:

1. Growth rate of real per-capita consumption [X% per year].

2. Rate of societal pure time preference (o r utility discount rate) [X%];

3. Elasticity of marginal utility of consumption [X];

4. Real risk-free interest rate [X% per year]; Remember that this should be a global average and long-term forecast.

5. What relative weight (summing up to 100%) should the governmental body place on the following rationales for determining the social discount rate:
Normative issues, involving justice towards future generations [X%];
Descriptive issues, involving forecasted average future returns of financial assets [X%].

6. Your recommended real social discount rate: What is your recommended real social discount rate for evaluating the certainty-equivalent cash flows of a global public project with intergenerational consequences [X% per year]?

7. What minimum and maximum real social discount rate would you be comfortable with recommending? Minimum real social discount rate [X% per year] Maximum real social discount rate [X% per year]

8. Do you have any additional comments?

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