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Government discounting controversies: the valuation of social time preference

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Abstract

The conceptual basis and numerical quantification of the time discount rate (or rates) to use for the comparison of policies or projects from a national perspective have been extensively debated for over half a century. Many differences remain, some continuing over many decades and some emerging more recently. Over recent decades the concept of a social time preference rate, derived from estimates of pure time preference (δ) and an elasticity of marginal utility (η), has become fairly well established in practical application, at least in Europe. There has however been much recent debate about the ethical basis of δ and possibly η. It is suggested here that the arguments made for a zero or near zero value for δ do not stand up well to close investigation, and that the case for any significant ethical element to η is weak. Also discussed are the valuation of marginal utility in developing countries and the application of government discounting to the very long term.

1. Introduction

Derivation of the social discount rate to use in analysis undertaken from a public interest perspective was a fashionable topic in the 1950s, 60s and early 70s. It came to prominence again in the late 1990s with the rising profile of very long term policy concerns, notably climate change and nuclear waste disposal. The Stern Review (Stern, 2006) stimulated a new peak of debate.

The emphasis has changed over the years. In the 1950s and 60s debate was dominated by argument about whether the rate should be a private sector "social opportunity cost" (SOC) rate or a separately estimated social time preference (STP) rate. The late 1960s saw debate about the relevance to social discounting of the revolution at that time in financial economics,[1] and this saw a further flurry in the UK around the turn of the century. From the mid 1990s a strong focus developed on discounting over the very long term. The Stern Review prompted wider discussion than before of the ethical aspects of valuing an STP rate.[2]

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1 That is the revolution building on the work of Markowitz on the 1950s, later developed especially by Sharpe and Lintner, and leading in particular to the capital asset pricing model (CAPM).

2 The debate prompted by the Stern Review focused primarily on discounting over the very long term and most of the more recent citations in this working paper (for example to Dasgupta, Beckerman and Hepburn, Stern, and Dietz and Stern) refer to papers written with this long term perspective in mind. However most of the issues those paper discuss are also relevant to conventional discounting over a few decades.

This paper addresses the valuation of the social time preference (STP) rate derived, as is the norm, from the Ramsey equation or Ramsey Rule STP = $\delta + \eta g$, where δ is pure time preference for marginal utility, η is the elasticity of marginal utility, with sign reversed, and g is the growth rate of per capita income.

Leading early exponents of an STP rate for public sector analysis (as opposed to a market rate) were Eckstein (1958) and Feldstein (1964) and later an influential paper by Bradford (1975). Others, taking a growth theory perspective, were Marglin (1963a, 1963b) and Arrow (1965, 1966), the latter work being developed into a powerful book by Arrow and Kurz (1970). All these authors adopted the principle that the social value of a proposal is the present value of all its impacts on consumption (including of course non-monetary impacts valued in consumption equivalent terms), discounted at the STP rate for consumption. Most proponents promoted the Ramsey equation as it is generally used today, though at one time Marglin (1963a) boldly proposed deriving an STP rate from macroeconomic optimisation of the growth rate and the level of investment, as these were in principle variables on which politicians could be expected to express policy preferences. This might now be seen as an unrealistic view of public expenditure planning in a modern democracy.

A very few authors (e.g. Rabl (1996) and Nordhaus (1994, 1999), view the Ramsey equation, even today, as a model whose parameters must give a value for STP that would be consistent with a market commercial rate of return. Ramsey created the equation as an element in the development of growth theory, and many later works developed the concept of STP within a growth theory framework. However in recent decades the equation has been used as a simple framework for valuing STP for microeconomic analysis. The equation is widely accepted within welfare economics, but there is only limited consensus on the valuation of δ and η.

This paper reviews the ethical and empirical basis for the valuation of the parameter δ in section 2 and of η in section 3. Section 4 briefly discusses the issue of valuing marginal utility in developing countries. Section 5 reviews the additional technical and practical issues that arise when the application of discounting is being considered for substantial costs or benefits over the very long term, of say half a century or more. Section 6 draws some general conclusions.

The paper is written largely for economist readers, but will be accessible to anyone with an interest in these issues.

Two separate working papers address the arguments for and against using a market rate for government discounting and issues of practical application of discounting in government.

2. Pure time preference, δ

Pure time preference is the extent to which the weight given by the current population (or its government) to expected future marginal utility declines over time.

This is mainly an ethical choice, about the relative weighting of the marginal utility of today's population and that of future populations. However there appear to be no solid empirical data on such preferences of people in general.

A much cited series of three papers concluding with Cropper et al (1994) reported empirical work that implied implausibly high rates of pure time preference for government safety programmes (e.g. "saving six people in 25 years is equivalent to saving one person today, while for a horizon of 100 years, 45 persons must be saved for every person saved today"). A subsequent study funded by the Center for Integrated Study of the Human Dimensions of Global Change (Frederick, 2003) demonstrated that such responses depended very much upon how questions are asked and wisely suggested that "if one is interested in the importance or moral significance of future people vs. current people, it seems better to simply ask about this directly." I am not however aware of any such work.

Debate about the valuation of δ is in practice dominated by judgement based on largely anecdotal evidence or, sometimes, by the personal ethical judgements of individual experts.

2.1. The view that δ should be zero or near-zero

Pigou (1920) and Ramsey (1928), like some later authorities[3], considered that giving less weight to future marginal utility was irrational for individuals and ethically unsatisfactory for governments.

However it is uncontentious that people in general do not care equally about all of their national and global contemporaries. In the words of Schelling (1995), "we may prefer beneficiaries who are closer in time, in geographical distance, in culture, surely in kinship". It is at least reasonable to suppose that, while people's concern for future generations (and for those in other countries) may be considerable, it is less than their concern for those with whom they have a closer affinity.

Most welfare economists appear content to accept this as the basis for public policy.

Kopp and Portney (1999) commented as follows on the handling of discounting by the Intergovernmental Panel on Climate Change, which took the line that public preferences with regard to future generations should be overridden: "The [IPCC's] prescriptive approach is premised on the view that there is an ethically or morally "correct" rate of discount to use in project evaluation – a rate that is independent of the views of the present generation (save, of course, those who get to determine what the morally just rate is). Yet those of us who teach benefit-cost analysis and advocate its use in public policymaking generally point approvingly to its democratic nature. That is, we argue that BCA is attractive because it is based in the preferences of all those around today."

Marglin (1963a) expanded on the same point nearly fifty years ago: "I consider it axiomatic that a democratic government effects only the preferences of the individuals who are presently members of the body politic". Earlier, Eckstein (1957, p75), expressly refuting Ramsey, commented that: "I assume [discounting of future

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[3] Including Harrod (1948), Koopmans (1965), Solow (1974), Broome (1992), Cline (1999) and the 2006 Stern Review (except for a factor of 0.1% for risk of human extinction). Dasgupta (2008) says that he "does not know how to justify a δ that is much in excess of zero, but if [anyone] is not persuaded by me, her view should count equally …"; and he explains (Dasgupta, 2011) that "I always work with positive values of δ when in my applied-theoretic mode; but then, I am an incurable pluralist".

utility] because I believe that a social welfare function based on consumer sovereignty must accept people's tastes, including their intertemporal preferences."

Dasgupta (2008) comments that "it is all very well for the ethicist to assume the high moral ground and issue instructions like a philosopher king or a Whitehall Mandarin, but social ethics commands an irremediably democratic element".[4]

A more pragmatic objection often made to a zero rate of pure time preference is that it implies an unrealistic level of investment, as first noted by Ramsey (1928, p 548), and later set out in qualitative terms by Hayek (1936, p 46), and much more formally by Koopmans (1960) and Koopmans et al (1964), and explained more clearly by Arrow (1995b, p 16). Given some simplifying assumptions (whose appropriateness has been challenged as outlined below), a zero rate implies, regardless of the return on investment (provided the return is positive), a savings rate of $1/\eta$. A plausible value for η of around 1.5 would thus imply an unrealistic savings rate of about 2/3.

This is sometimes presented as an important objection, although Dasgupta (2008) interprets the numbers quite differently. Instead of following Arrow in taking as given a plausible range for η, Dasgupta takes as given, in this context, a zero or near-zero value for δ. He consequently suggests that the analysis of plausible savings rates is evidence that η should be much higher, as discussed in section 3 below.

Dasgupta's acceptance in this context of the simple assumptions underlying the derivation of a savings rate of $1/\eta$ has been challenged by DeLong (2006, which includes Dasgupta's response) and the assumptions are challenged more generally by Dietz et al (2008), in terms further developed by Smith (2010). The central point is that future growth is not only a function of capital investment: much of it arises from so-called total factor productivity.

However it is not difficult to think of impacts whose future marginal impacts on welfare do not decline over time. This might apply to, for example, preservation of species, or of natural and cultural heritage, or elimination of specific diseases. A zero or near zero δ would in such cases give present value benefits so high as to imply much higher levels of current sacrifice than, rightly or wrongly, are now made.

There are also more pragmatic arguments made against a near zero δ.

One is that future societies are likely to be very different from those of today. Nordhaus (2007, p693) makes this point in some specific dimensions. Societies in say 100 years time may be quite alien to those of today, perhaps with structures and values that we would not much like: they may of course be even more likeable than those of current democratic countries, but is that equally likely?

Another pragmatic argument is that the annual risk of civilisation largely destroying itself may be much more than near-zero. Work supporting the Stern Review (Hepburn, 2006) suggests that "for δ=0.1 per cent there is an almost 10% chance of extinction by the end of a century. That itself seems high – indeed if this were true,

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[4] The reference to Whitehall rather misrepresents the role that finance ministry officials generally play in this field. I address this in a parallel paper on the practical application of government discounting.

and had been true in the past, it would be remarkable that the human race had lasted this long". But this is a questionable view: it is only recently that the human race has started developing combinations of technologies and social structures that could very plausibly end civilisation as we know it. Dietz et al (2008) also suggest that "Many would see the implied 90% chance of human civilisation seeing out this century to be alarmingly low", although they also note, as do Beckerman and Hepburn (2007), that Lord Martin Rees, the Astronomer Royal, has written that 'I think the odds are no better than fifty-fifty that our present civilisation on Earth will survive to the end of the present century' (Rees, 2003). Beckerman and Hepburn note that "if all the extinction risks [Rees] considers were exogenous the appropriate component of *delta* to account for extinction risk would be 0.7%." Many people might feel the latter is closer to realism that 0.1%. It would be interesting to see research on this.

Beckerman and Hepburn (2007) present the ethical arguments within an academically rigorous framework. They record the firm position taken by the Stern Review, which stated that it takes "a simple approach … : if a future generation will be present, we suppose that it has (sic) the same claim on our ethical attention as the current one". Beckerman and Hepburn note that this would be consistent with "an *impersonal* consequentialist principle, like most versions of Classical Utilitarianism. …In this approach, the goodness of any outcome is measured by the total utility resulting from the actions in question, irrespective of who gets the utility." They then develop an extended and thoughtful discussion, noting that such agent-neutral consequentialism, giving equal weight to all people without qualification, "at best … might be said to underpin the ethical basis for national policy when it is adjudicating between competing claims of citizens within the one nation-state. However, it clearly fails to describe national decisions that have different impacts on different nation-states. Second, there *are*, in fact, plausible ethical justifications for attaching more importance to people alive today than to distant generations."

They thus conclude that *agent-relative* ethics deserves serious consideration here, as elsewhere: "the reasons for giving serious consideration of agent-relative ethics include (i) a long philosophical tradition stretching back at least to Hume; (ii) probably universally held public preferences; and (iii) within limits, its instrumental value. It is, at the very least, a respectable and traditional ethical structure that contrasts with the Review's impersonal consequentialism." They add somewhat brusquely that "Since the [Stern] Review does not address the implications of alternative ethical assumptions, it brushes under the carpet the most crucial ethical questions underlying the economics of climate change."

The ethical case for a zero or near zero value for δ seems never to be *defended* other than by assertion, or by the use of arguments that seem to miss the point at issue.

Thus the Stern Review, as quoted by Beckerman and Hepburn, acknowledges that "… it is, of course, possible that people actually do place less value on the welfare of future generations, simply on the grounds that they are more distant in time", but then surprisingly asserts that "… it is hard to see any ethical justification for this". It goes on to say later that placing less value on the welfare of future generations "… is not a position which has much foundation in ethics and which many would find acceptable" – a statement that seems clearly wrong on both counts: a positive δ has a foundation in ethics and would be found acceptable by most people.

In responding to the Stern Review the Environmental Audit Select Committee declared that "we most certainly endorse the Review's use of a very low value for its 'pure time discount rate', meaning in effect that Stern treats future generations as being of equal importance to those alive today. To think otherwise would be morally reprehensible, condemning future generations to an uncertain and, in many parts of the world, possibly calamitous future, out of sheer indifference." The Government response was more measured, implying some doubts, but a concern not to seem to criticise the Review. It said that "the approach to discounting used in the Stern Review reflected the special nature of climate change." This special nature was explained in terms of four qualities: the issues required international cooperation, were intergenerational, involved "the economics of risk" and were intramarginal. (House of Commons, 2007) Both the Select Committee response and the Government response at least in part confuse discounting with valuation.

It is not uncommon to find advocates of equal weight for future generations simultaneously applauding the fact that people in practice give more weight to those with whom they more closely identify (such as their own children relative to other children). For example:

> "Remoteness in time roughly correlates with a whole range of morally important facts. So does remoteness in space. Those to whom we have the greatest obligations, our own family, often live with us in the same building. We often live close to those to whom we have other social obligations, such as our clients, pupils, or patients. Most of our fellow citizens live closer to us than most aliens. But no one suggests that, because there are such correlations, we should adopt a spatial discount rate." (Cowen and Parfit (1992) p 159)

It is true that no one suggests a discount rate of *n* per cent per yard. It would not be useful instrument: British people may generally care less about say the Congolese than the French, but more about New Zealanders. But nations clearly discount the interests of aliens relative to their own fellow citizens. No one questions that governments should serve the interests of those whom they are governing, even to the cost, fairly often, of other communities. The confinement of the quotation to formal obligations – to family, clients, pupils and patients, is also not wholly appropriate. The point at issue is more about how much people care about others more widely, including fellow citizens with whom they never expect to have direct dealings.

Dasgupta (2011) similarly approves explicitly of people giving more weight to their children, and to specific charities about which they care, than to other people in general: "Feelings of altruism are what prompt us to donate time and money to charity and support international aid. Our feelings for our children are different. We love our children and want the best for them. This too is a deep and enduring fact, not an incidental one …".

The mismatch between, on the one hand, recognition and acceptance, with no moral disapproval. that people care more about those with whom they more closely identify and, on the other hand, insistence that today's society should care no less about future populations than about itself implies a mismatch in attitudes to collective resources (e.g. of taxpayers and energy consumers) as opposed to personal resources. It seems clear that advocates of equal weighting to all people do not carry this through to their personal resources.

More generally, the case for a zero or near zero value for δ is often set against one or another "straw man" argument for a higher rate that few people would choose to defend.

Thus for example, from Ramsey onwards, any discounting of marginal utility continues to be routinely attributed to "myopia" or "impatience", neither of which has much if any bearing on the issue of people caring somewhat more about those people and societies with whom they have a closer social affinity.

And sometimes it is implied that there is no position between the extremes of 'super altruistically' having *equal* concern for all others at all times and 'selfishly' having *much* less concern for anyone other than one's current neighbours. And confusion between discounting and valuation is widespread. Both these traits are illustrated in the following example from the Stern Review Postscript.[5]

"Choosing a high rate of pure time preference to analyse a long-term issue that affects the global environment with, in this case, irreversible effects on future generations, is to make a profound ethical choice. It is as though a grandparent is saying to their grandchild, because you will live your life 50 years after mine, I place *far* less value on your well-being than I do on myself and my current neighbours and therefore I am ready to take decisions with *severe and irreversible* implications for you." (emphasis added)

The reference to grandchildren is also inappropriate, since the issue here is about social spending, not personal bequests.

Also in the wake of the Stern Review, Dietz, Hepburn and Stern (2008) and Dietz and Stern (2008a) presented δ as being about "ethical discrimination by date of birth": "When interpreted as discrimination by birth date, extreme values of δ are difficult to justify. For example, if δ = 2%, then someone born in 1972 would have twice the ethical weight of someone born in 2007. So if these two individuals were expected to have the same income, an extra unit of consumption by the one born in 2007 would be given only half the weight of an extra unit of consumption by the one born in 1972. Would many people regard this as ethically acceptable in terms of responsible social action? We think not." Many people might agree that 2% per year is on the high side (though not necessarily "extreme") as a rate of decreasing concern for future populations. But the idea of "discrimination by birth date" is misleading. It muddles a cross sectional with a time series framing. Perhaps this is done to add force to the 'zero delta' argument. But perhaps it reveals some confusion between the ethics of the two different policy contexts.

Thus the population at any time includes those born over a range of birth dates spanning a century or so. And most people regard discrimination by birth date as wrong, beyond some policies reflecting age-specific needs, such as school education and pensions and a bias to the young in some medical treatments, such as kidney dialysis. In society more widely there is some ageism in social and corporate attitudes. Thus throughout their lives, those born in 2007 will suffer no material discrimination relative to those born in 1972, if anything perhaps slightly the contrary. People regard this as ethically acceptable and generally responsible social action. Pure time preference, δ, with respect to increasingly distant future populations, is a quite different ethical issue.

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[5] http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/Postscript.pdf

Claims that equal concern for all people at all times is the moral high ground may be driven by a belief that people in general are too selfish or unthinking to understand the moral issue, and that with persistent pressure society may be reformed to a more enlightened understanding. This has certainly been true of many ethical issues in the past and hopefully will be in the future. But does the principle of universally *equal* concern fall into this category? This seems implausible.

Conspicuous examples of what most people would now see as moral enlightenment, from the fairly distant to the fairly recent past, in much of the Western world, include attitudes to slavery, women's suffrage, race and homosexuality. But these, and other examples that could be called upon, address particular categories of people who, in certain important respects or generally, have suffered denials of rights under the law (and social prejudices) that people have come to see as unacceptable either because they are so extreme (e.g. slavery) or because they greatly reduce some people's welfare for no material social benefit. There is little analogy here with the fact that people are generally more concerned about the welfare of those close to them than those who are not. This fact is not a trait that greatly reduces the marginal welfare of any group of people. And, far from bringing no material social benefit, it is a trait on which the cohesion of society and much of human happiness depends.

That said, there are contexts in which equality of concern *is* widely accepted as morally sound.

One already mentioned is the principle of no discrimination by age throughout people's lifetimes.

Another context is that of rescue. Individuals and institutions generally feel an imperative to rescue people in imminent danger, regardless of who they are. This is distinct from but related to the institutional willingness to accept very high expenditure in such cases, for example in sea rescue generally, or recovering people from mining or other such disasters. This is described in the health care context as the Rule of Rescue (RR). McKie and Richardson (2003) define this as "the imperative people feel to rescue identifiable individuals". They note that "it is almost self-evidently true that by this or some other name the RR describes an almost universal response to an impending catastrophe."

The rescue context provides a rationale for seeing the potentially catastrophic hazard of climate change as demanding exceptional concern. But if put into a CBA framework this is a matter of valuation of that hazard, not of the weight to give to future marginal welfare.

Another, more pragmatic context is that of the weighting of safety risks to foreign visitors. This is sometimes debated within transport ministries, and the norm is to accept that, in prioritising safety spending within a national territory, equal weight should be given to the safety risks faced by all travellers, whether local nationals or foreigners. This choice has ethical dimensions, but it is not based on moral absolutes. It is a partly pragmatic judgement based on principles such as reciprocal obligations, hospitality and national reputation. It is never suggested that British tax revenue on the safety of roads, or airports, or ferry services should be spent on facilities of other countries.

Examples such as rescue and foreign visitors are special cases that have no clear relevance to pure social time preference.

A nation's resources available for spending are primarily the product of the efforts of the current population. They depend of course on the inherited physical, intellectual and institutional capital and each generation is usually content to maintain and develop this capital for its successors.[6] But it is hard to see a case for representation, in the fora that decide upon the allocation of a country's resources, of either future populations, were this possible, or of people of foreign countries. The decisions are overwhelmingly about the allocation of the current generation's resources. Allocation of these resources by a government to spending on other people, in ways that are clearly inconsistent with the informed preferences of the current population, would seem extremely elitist, with no clear ethical or other justification.

2.2. The setting of δ in practice

Some of those who accept the concept of positive pure social time preference estimate values from the individual risk of death (e.g. Eckstein, 1961; Kula, 1984, 1985; Pearce and Ulph, 1995; Evans, 2005; Evans and Sezer, 2005). Evans (2005) reports average death rates in recent years of about 1% of France, Germany, the UK, Japan and the USA. However the rationale for such estimates seems weak.

If people were super altruistic, individual mortality would be irrelevant. It would have no effect on δ. If, at the other extreme, people cared not at all for those surviving them, mortality would imply an increasing δ, with discount factors for marginal utility declining to virtually zero within less than a century. Authors applying the risk of death approach generally adopt the second, "zero altruism" rationale for the first year (i.e. discount at a rate equal to the risk of death for an average person in the next year) and then apply this rate as a constant rate for all time. In other words, if this year is year 1, year 2's population is discounted by a zero altruism factor, say $1/(1+r)$, then year 3's population is discounted by $1/(1+r)^2$ – i.e. by the factor applied to year 2 times year 2's zero altruism factor for year 3. However the relevant preferences are those of today's population over all future years, including some altruism. The approach skates over the core issue of how much today's society cares (or should care) about future societies.

Moving beyond pure time preference as such, in practical terms there is a presentational case for explaining that δ also subsumes any small factor for the miniscule systematic risk arising from the correlation of many public sector costs and benefits with GDP. More substantially there is a case for explicitly including, as noted above, and as in the UK Treasury guidance, a small factor for the many exogenous optimism bias risks to future benefits that are not conventionally included as project-specific risks in investment appraisal: risks of this kind might reasonably be seen as having a roughly exponential path through time. But these are issues for pragmatic judgement.

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[6] Or at least the physical (including environmental) and intellectual capital. The development of institutional capital depends upon the emergence of people of influence and vision.

Aside from those who believe that pure time preference should be zero or near zero, there is perhaps some consensus in the literature on a value over a few decades of around 1.5% per year, if an element is included for the risks not normally included in appraisal as project-specific risks, but which might nonetheless prevent some of the prospective costs or benefits. This implies a weighting over one generation of thirty years of about 65%, about 40% over sixty years, and 25% over ninety years.

Few authors, apart from those advocating a zero or near zero rate, commit themselves to an explicit estimate of δ. Little and Mirrlees (1974, p266), while expressing sympathy with the zero rate view, suggest that "in any case it would probably not mean an addition [to time preference] of more than 2% or 3% per year". Rabl (1996) suggests that "it is reasonable to take a value for δ in the vicinity of 3%" and Nordhaus proposes the same number; but both these authors are looking for values of δ and η that give a discount rate equal to a commercial market rate (taken by Nordhaus as 6%). Scott supposed that, in periods of stable inflation, STP had been indicated by the post tax return on low risk savings. Scott and Dowley (1997), on the basis mainly of data for the half century before World War I, estimate a value for δ of 0.5%, but suggest, "since the risk of total destruction of our society has increased", "a best estimate" for δ of 1.5%. Subsequently, using post WW II and pre WW I data on post tax returns to equity, Scott (1989, pp 230-231) estimates a value for δ of 1.3% and also examines (p233) a higher value for δ of 2.5% suggested by Stern (1977).

3. The elasticity of marginal utility, η

The term ηg is usually taken in government analysis as the extent to which the utility of a future pound declines over time because of increasing income. The elasticity of marginal utility, η, can be estimated in many different ways. All are open to criticism, but the results are sufficiently clustered to give some comfort in their practical application. But before addressing these there is the sometimes contentious question of whether the value used in the derivation of an STP discount rate has or should have a moral dimension, in the sense of including some ethical judgement about whether relatively more weight should be given not only to poorer people's marginal income, which is uncontentious, but also to poorer people's marginal welfare.

3.1. The moral dimension of η

In practical application in government, as in the STP literature generally, η is usually seen as being no more nor less than the elasticity of marginal utility. And the same assumption is normally made, as a matter of course, in the estimation of η from income tax regimes as described later below. But in academic comment it is sometimes, and since the 1990s fairly often supposed that a stronger egalitarian principle is or should be involved. For example Newbery (1992, p11) commented that "[HM Treasury's] preferred value of [η] is 1.5, which is quite egalitarian, and one might quite reasonably defend a value of 1.0 or even less." But the idea of η incorporating any such ethical judgment was no part of the Treasury's logic at that time. Beckerman and Hepburn (2007), in reviewing discounting in the context of the Stern Review, also take it for granted that η in this context has an ethical dimension. This contributes to their conclusion that "η is being overworked". Similar views and conclusions are reported by Atkinson et al (2009). Dasgupta sets out his view of η as an ethical quantity in some depth, as outlined below.

Prima facie it might seem reasonable that "fairness" or "egalitarian" concerns justify rather less redistribution (and certainly no more) from poorer to richer than implied by the simple utilitarian criterion of maximising the sum of individual marginal utilities. This might imply, for STP purposes, a higher η.

It is fairly uncontroversial, though muted in political debate since the 1970s until recently, that people are averse to inequality that they see as avoidably unfair and that such inequalities are evident in most economies.

The political philosophy literature, driven especially by Rawls (1971), and also the related political economics literature (e.g. Sen, 1997, Atkinson, 1996), discuss distribution and utilitarianism with insight, but without extending to empirical measurement of people's preferences. From the psychology and behavioural economics literature Cowell and Gardiner (2000, p23) report some "empirical measurement of inequality aversion", but with widely dispersed results. Carlsson et al (2005) report some results for Swedish undergraduates, largely to compare inequality aversion and risk aversion. Of the results for inequality aversion, sixty per cent implies a value for η of between 0.5 and 8 and ten per cent implied values of more than 8.

Atkinson et al (2009) report the results of a large internet survey of attitudes to risk aversion, inequality aversion and intertemporal substitution. Of the valid results for inequality aversion nearly seventy per cent implied a value for η of between 0.5 and 7.5 and the other thirty per cent implied values of more than 7.5. Michelbach et al (2003) report that nearly 20% of their American subjects supported the Rawlsian principle of maximising the welfare of the least advantaged, a further 15% were strict egalitarians preferring, within wide limits, to maximise equality at the expense of efficiency, and only some 13% were strict efficiency maximisers, as the neutral utilitarian criterion would imply.[7]

Dasgupta (2008), in responding to the Stern Review, assumes without question that η is an ethical parameter. He comments that if, as he would support but not impose, δ is taken as approximately zero, "the whole weight of the ethics regarding the distribution of consumption across the generations is borne by η. That's an awful lot of work for a single number to do adequately." It is indeed, although this workload is not generally imposed by governments.

Dasgupta comments that, as many would agree, "today's rich world, which has been and continues to be the site of the largest emissions of carbon per person, has particular obligations toward tomorrow's people in today's poor countries" and he implies that this strengthens the case for a high value for η. He concedes that that he does not believe that what he has offered in his paper "is anything like an airtight argument". However he offers a thought experiment (summarised later below) which illustrates the trade off that would be implied between costs to an average EU citizen and someone with a hundredth of that income, if η =2,. He suggests that "some

[7] As with most such studies, the subjects were university students. They were however from two institutions and diverse backgrounds; and the authors found no correlation of preferences with age. This, like most such studies was concerned with contemporary income distribution within a nation, rather than comparisons across nations or over time, where egalitarian preferences might be less.

people, but perhaps not many, would find this trade-off to be reasonable" and that η therefore should be higher than 2.

There is however a fundamental problem with the case for giving significantly more weight to the marginal social welfare of poorer people than to richer people: it is inconsistent with well established public policy conventions and with what in most situations most people would see as fair.

For example a health authority might allocate proportionately more resources to poorer communities in attempts to achieve equal access for all. But few people would see it as fair, let alone politically acceptable, to prioritise say surgical waiting times so that a patient's perceived greater poverty would place him or her higher on the list, independently of relative medical or social needs.

In other areas, such as transport flood protection and workplace safety, benefits are often measured in terms of the beneficiaries' willingness to pay (WTP) and often appraised in terms a *national average* WTP rather than a value specific to the income of the particular beneficiaries. This does not however mean that such appraisals are assuming that η=0. The appraisal is simply excluding income distribution effects from the monetised calculation. If distributional effects are important they will typically be presented in parallel, perhaps in quantified form in a summary table.

It is not seriously contentious that social welfare is reduced by substantial inequalities of income and that there is a role for government in restraining or offsetting the divergences that markets tend to create. But the issue here is the unsuitability of the parameter η in the social time preference rate as an instrument for this purpose. It would be implying that the marginal welfare of poor individuals should be given more weight that that of richer individuals, which in most public service contexts would be widely seen as unfair.

3.2. Methods of estimating η

Important qualifications apply to all methods of estimating η. One general qualification, noted above, is the usual assumption that η is constant over income. This may be a reasonable approximation for nearly all applications as income distributions are in statistical terms generally fairly modest. In the UK for example the average income in the ninth decile is roughly three times that in the second decile and average incomes over time have been doubling only over several decades. But a constant η assumption may be more questionable for comparisons between populations in the richest and the poorest countries.

The conventional application of η to STP also assumes that the utility function is additively separable, but there seems little reason to regard this as a serious limitation. It assumes that the attributes that contribute to utility, such as income and health, can be treated for practical purposes as if they are independent. In some applications this is clearly not a reasonable approximation, but it is applied in economics generally to most practical situations, albeit in part because it is computationally very much more manageable.

In a good review of UK evidence Cowell and Gardiner (2000) note in passing that most of the evidence available is more relevant to the social valuation of

(contemporary) inequality and to attitudes to risk, than to marginal satisfaction from income or consumption. They also note that there are three broad approaches, namely inference from how governments appear to incorporate distributional issues into their decision-making, inference from private behaviour, and direct enquiry, to which might be added a fourth (albeit unpromising) approach of applying intuition. These four approaches are taken in turn below.

3.2.1. Inference of η from government behaviour

Many government policies are concerned with income distribution, but most are either too simple or too complex to lend themselves to inference of an implied elasticity of marginal utility. Some state benefits, such as the UK Winter Fuel Allowance, are for administrative simplicity not means tested. Others are embedded in complex webs of benefits, incorporating many social objectives, related for example to child welfare and the social mix of housing. Taxes on assets or capital gains are only loosely tied to household income. However personal income tax, discussed below, is relatively simpler, in structure and policy objectives.

- **The personal tax regime**

Estimation of η from the tax regime conventionally assumes that the schedule of income tax rates against income is based on the principle of "equal absolute sacrifice" (i.e. an equal loss of utility for each marginal pound of tax paid). Combining this principle with a constant elasticity of utility function leads to an implicit value for η.

Strengths of this approach are its conceptual simplicity and measurability, and perhaps that it may also include concern about fairness as well as marginal utility; but it has evident limitations.

One is that social concern about contemporary inequality probably differs from that about inequality over time. Another, perhaps the most serious, is that personal taxation in many countries has become influenced, especially in recent decades, by concerns about incentives and personal freedom as distinct from fairness. This will bias downwards estimates of η based on the assumption of equal absolute sacrifice. The derivation by Stern (1977) for the UK income tax regime in 1973-74, before concerns about tax incentives became so prominent, may give a better measure of social judgments about the utility of marginal income across the income distribution. Stern derived a value for η of 1.97.

Further problems are that personal tax schedules may be interpreted in different ways with regard to, for example, the inclusion or exclusion of the standard personal allowance or other allowances; and that they are by no means the only policy instrument geared to income distribution. These latter concerns are discussed by Evans (2005), who suggests that Stern's inclusion of the standard personal tax allowance gives a strong upward bias to η at relatively low levels of income.

Cowell and Gardiner use this method to derive UK values for η in the late 1990s of 1.42 if applied just to income tax, and 1.29 if applied to income tax and National

Insurance Contributions.[8] Evans and Sezer (2005) and Evans (2005) present results for a large number of OECD countries, deriving an average value close to 1.4 with a perhaps surprisingly narrow spread of about ± 0.2. For US income tax from 1948 to 1965, Mera (1969, p469) found that "for a major portion of the income range" the rates implied a value for η of 1.5.

3.2.2. Inference of η from private behaviour

There are three ways in which values for η have been inferred from private behaviour: estimation from price and income elasticities, estimation from personal saving behaviour, and estimation from a specific welfare function. Estimation of η from income and price elasticities is surprisingly neglected in more recent academic debate. It was for example not included in Cowell and Gardiner's review; it deserves to be a more significant contributor to policy debate. Estimation of η from personal savings behaviour has perhaps more serious limitations, given the necessary assumptions and the complex determinants of personal saving. A third approach, which defines a welfare function and derives a value for η from the ratio of working to leisure time, is included here for completeness.

- **Estimation from income and price elasticities**

An approach with a long history (Fisher, 1927, Frisch, 1932, 1959) estimates η from the income and price elasticities of a preference independent good such as food (i.e. a good that contributes a component to the user's utility that can reasonably be treated as additively separable, that is independent of the other components). Frisch (1959, equation 64) shows that $\eta = -E_i(1 - a_i E_i)/(e_{ii} + a_i E_i)$, where E_i is the income elasticity of demand for the ith good, a_i the budget share and e_{ii} the own (uncompensated) price elasticity.

This approach has the great merits of being a direct measure of η, albeit without the possible extra moral component, and of having been subject to empirical studies in many countries and over different goods.

Brown and Deaton (1972, p1206) report studies by other authors of data from several countries, and also work of their own on UK data for 1900-1970 that gave a value for η of 2.8. They conclude that "though estimates obtained this way [from linear expenditure systems] fluctuate considerably and some are very large, an average value of -2 for [-η] seems consistent both with most such studies and with the results from fitting other models".

Kula (1984) reports values for η derived in this way for the US of 1.89 and for Canada of 1.56. For the UK, Kula (1985) derives a markedly lower value of 0.71. More recently Evans and Sezer (2002) derive for the UK a value of 1.6. Subsequently Evans (2004a) has further examined alternative specifications, deriving values for the

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[8] Evans (2005) suggests that NICs should be ignored because the notionally insurance-based rationale for such deductions is "completely different" from that underlying income tax rates. In practice the contributions are widely seen to serve in effect as a (politically convenient) form of income tax, but, as Evans implies, it is hard to believe that the regime was ever designed other than to minimise disincentives for a given total NIC revenue. This however has for many years been increasingly the objective of income tax regimes as well!

UK of 1.6 (as above) by a CEM (constant elasticities model) and 1.2 by an AIDS (almost ideal demand system), and for France (Evans 2004b) values of 1.8 and 1.3 respectively. The validity of some of the assumptions, such as the constancy of the relevant demand functions over time and income, is difficult to assess, and there are problems of data and definitions. The substantial effect of the model specification sounds a note of caution.

- **Estimation from personal savings behaviour**

Many econometric studies of household savings behaviour over the life cycle estimate the intertemporal elasticity of substitution of household consumption. Under certain fairly restrictive assumptions, as set out by Cowell and Gardiner (2000, Appendix A3), the reciprocal of this quantity is equal to the household elasticity of marginal utility.

Cowell and Gardiner consider some of this work, in particular Blundell et al (1994) on UK data. They note that the two principal models in Blundell et al imply, for η, values of 1.2 to 1.4, or of 0.34 to 1.0 (both sets of values increasing with income). However, as noted by Evans (2005), the sample period of 1970-1986 ends in the year of the UK Building Societies Act, which deregulated retail financial markets. It is unclear what either model would produce for the subsequent, very different financial environment. Pearce and Ulph (1995) propose, on the basis of a somewhat selective presentation of the Blundell et al results, a value for η of 0.8 to 0.9.[9]

As noted above, for $\delta = 0$ and given some simplifying assumptions, the optimum savings ratio is $1/\eta$. Thus the actual savings ratio, together with assumptions for δ and for the long run rate of return, yields an implicit value for η. Stern (1977, p220) records that for a savings ratio of 10%, a post tax rate of return of 5% (plausible figures for the UK in the 1960s) and $\delta = 2.5\%$, the implicit value of η is approximately 5 (and is higher for lower values of δ).

The severity of the assumptions underlying the derivation of these diverse estimates suggests that, while relevant, they may merit less weight than those derived from some other sources.

- **Estimation from the ratio of work to leisure time**

A novel, "Life Quality Index" approach to deriving the value of a prevented fatality emerged in Canadian engineering circles in the late 1990s. This appears to have been fully published first in a book (Nathwani et al, 1997), but was further developed in Pandey and Nathwani (2003) and again in Pandey, Nathwani and Lind (2006). It defines the Life Quality Index as $G^q X_d$, where G is GDP per head and X_d is life expectancy, adjusted for time discounting. q is shown on the basis of simplifying assumptions, as in Box 3.1, to be equal to the ratio of working time to leisure time of the working population.

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[9] Pearce and Ulph consider only one of the two principal models of Blundell et al; and they do not discuss the implications of the very strong increase, for that model, in the elasticity with income. The strong income dependence in this model (in which also a dummy variable is introduced to allow an adjustment for the high real interest rates of the early 1990s), and the substantial change in the estimates relative to the alternative model, invite serious doubt about the reliability of this particular result.

Box 3.1
The Life Quality Index derivation of the income elasticity of utilty

The Life Quality Index is specified initially as $Q = \alpha G^{\beta} T^{\gamma}$, where G is earnings or consumption, T is expected lifetime leisure time and α, β and γ are constants. Some algebraic manipulation transforms this to $Q = G^{q} X_{d}$, as in the main text above. The exponent (or elasticity) q is derived by replacing leisure time, T, in the initial equation by $(1-w)X$, where w is the average fraction of time spent working and X (years) is life expectancy. G is then replaced, temporarily, by kw, where k is pay per unit time (£/y). It is then assumed that "individuals in the nation will have adjusted their 'work-life balance' [*viz* the ratio $w/(1-w)$] so as to optimise their quality of life." Differentiating Q with respect to w shows that Q is maximised when $w = q/(q+1) = w_0$, from which it follows that $q = w_0/(1-w_0)$.

Pandey and Nathwani suggest typical values for industrialised countries for working lifetime and length of working week that imply a value for q of about 0.14. If G were taken as a measure of "absolute utility" the implied elasticity of marginal utility, with sign reversed, would of course be $1 - q$, which by construction must be less than 1.

This approach is ingenious, and has the advantage of simplicity, but at the cost of many questionable assumptions. For example the assumption that people's welfare, for a given income, is a linear function of their discounted expected lifetime leisure time is at best contentious; and the assumption that individuals are free to adjust their ratio of working time to leisure time to optimise their quality of life seems unpersuasive. And the constraint on the elasticity of marginal utility to be less than 1 is a limitation. But it is recorded here as it has been taken up, in the context of valuing fatality risks, by a UK university school of engineering and has attracted Research Council and government departmental funding.

3.2.3. Inference of η from direct enquiry

Direct enquiry into international happiness has provided a new and significant data source for deriving η. However direct measurement of intertemporal substitution and of risk aversion has proved less promising for this purpose. (Direct measurements of inequality aversion, which imply very high values for η, were discussed in section 3.1 under the heading of the moral dimension of η.)

- **International happiness data**

Recent years have seen the development of literature, now evolving into several strands, on the measurement and determinants of happiness and life satisfaction.

Much work has been done on international measurement and Layard et al (2007) use data from six surveys to estimate η. Three of these surveys were in single countries, two were Europe wide and one worldwide. The highest and lowest values estimated for η were 1.34 and 1.19 and the combined value was 1.26. The results were similar for subgroups in the population.

The authors quote a 95% confidence interval (of about ±0.1 percentage point) for the statistical uncertainties. They also estimate a "maximal implied correction" of - 0.2 percentage points, reducing η from 1.26 to 1.24, for true utility being convex with respect to reported happiness. But other questions arise.

It may be for example, since people's satisfaction with their income is largely judged relative to those around them, that the reported increases in happiness with income are higher (and hence the implied η lower) than would be relevant to comparisons over time. Perhaps more seriously there may be a correlation, in the world over the past two to three decades, between national per capita income and other factors that influence quality of life, such as corruption. This is of no consequence where such a link is permanent, but this seems unlikely as incomes grow over the next few decades, let alone centuries. This might lead again to some over estimation of the rate of increase in happiness or life satisfaction with income alone, and a corresponding underestimation of η.

- **Direct evidence on intertemporal substitution**

Barsky et al (1997) measure the intertemporal elasticity of substitution directly by means of survey questions from the US Health and Retirement Survey. They obtain a mean value of 0.18, which implies a high value for η of 5.6.

An internet survey reported by Atkinson et al (2009) drew on Barsky et al, but "applied their structure to national borrowing and saving and lengthened the timeframe to 200 years to make the choice situation similar to climate-change policy decisions." Respondents were "asked to choose between different government plans for spending and saving, each with different implications for living standards in two time periods: 2007-2107 and 2107-2207." Most respondents "displayed a very low elasticity of inter-temporal substitution, or in other words, a very high aversion to inequality in income across time, η_t". For each valid response the authors derived the range of values for the elasticity of inter-temporal substitution consistent with the choices made, reporting that "for the median respondent, the midpoint of this range is 0.11, which corresponds to a value of η_t of 8.8."

These results are so far from those derived by intuitively more plausible methods that they probably deserve little weight.

- **Direct evidence on relative risk aversion**

Barsky et al (1997) report empirical measures of personal relative risk aversion, which is algebraically the same as the elasticity of marginal utility[10], of US respondents between the ages of 51 and 61 in 1992. The arithmetic average value was 12.1. However the distribution of values was very skewed and the authors give more weight to measures of the reciprocal, which they define as relative risk tolerance, for which the arithmetic average value was 0.24, implying a value for η of 4.2. These high values relate however to very significant risks to income, where other factors such as the potential for regret would be expected to increase risk aversion.

An internet survey reported by Atkinson et al (2009) also borrowed from Barsky et al but was framed in terms of societal rather than individual risk. Attitudes were measured to options to engage in large prospective risks to national average income,

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[10] It is sometimes assumed that these two quantities are identical in all respects. But this is true only at a simple algebraic level. In practice 'risk aversion' to income uncertainties and social preferences with respect to income distribution may both entail more than a static relationship between utility and income, but in different ways.

such equal chances of doubling it or reducing it by one third. The implied values of η were generally very high: about a third of the valid responses implied values of less than 3, about 30% between 3 and 5, and 20% more than 7.5.

Barsky et al examined the correlation between their responses on relative risk aversion and intertemporal substitution and concluded that, although the average values they obtain are similarly high, there was *no* correlation across individuals between their intertemporal elasticity and risk aversion. Atkinson et al undertook a similar analysis, looking also for correlations with their responses to inequality aversion. The found correlations that were statistically significant but very weak, the correlation coefficients between each of the pairs of variables being about 0.1. They found that a relatively large number of respondents displayed a high aversion to equality over time but low aversion to risk and/or inequality over space; and that more respondents displayed high risk aversion coupled with low spatial inequality aversion than low risk aversion combined with high spatial inequality aversion.

As in the case of intertemporal substitution, direct evidence on relative risk aversion would seem to merit little weight as a basis for estimating η. This is unsurprising given the many complicating factors that influence people's choices with respect to specific risks.

3.2.4. Estimation from intuition

Another approach is thought experiment. A value for η of 1 implies that, ceteris paribus, an extra £1 to someone with an income of £x gives twice the marginal utility as does an extra £1 to someone with an income of £2x. Values for η of 1.5 and 2 would imply factors of respectively 2.8 ($2^{1.5}$) and 4 (2^{2}). However although the judgement required is conceptually fairly simple, there are few points of reference by which to judge what is plausible.[11] However Scott and Dowley (1977) and Scott (1989) put forward the suggestion, which they report has the support of Little and Mirrlees and of Stern, that "it is reasonable to suppose that there is a maximum level of utility which anyone can derive from income", in which case "*[η]* must exceed one at least above some income level, although it could still be less than one for low levels of income". This seems a fairly persuasive argument.[12]

The problems of applying intuition more precisely than this are illustrated by the opposite intuitions of experts familiar with the issues. Dasgupta (2008, p152) takes the case of two individuals, A and B, with consumption levels differing initially by a factor of 100 (for the richer person A, an income about 20% above the annual income of the average EU resident; and for the poorer person B, an income just below the World Bank's "dollar a day"). Dasgupta says that if $\eta = 2$ then a 50% decrease in A's consumption would be "ethically equivalent" to a 1% decrease in B's consumption. He notes that 50% of A's original consumption "is still a huge figure" and concludes

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[11] Although the view once expressed by Stern (1977, p243), on the basis of evidence at that time, that a value "of around 5 does not seem ludicrously large" might for most applications today be questioned.

[12] One obvious counterargument is that the ultra rich may gain utility from knowing that they are relatively richer even than the super rich. However it is hard to imagine that this is material to the personal utility impact of a marginal change in taxation; and in any case such comparative concerns apply more weakly to a nation as a whole than to individuals within it.

that "some people but perhaps not many, would find this trade-off to be reasonable", so implying that η should be greater than 2. In contrast Dietz and Stern (2008, p106), while agreeing with Dasgupta that η "is an ethical parameter" and adopting a very similar thought experiment, reach the opposite conclusion, that η should be less than 2. They ask how, in redistributing income from person A to person B, where A has five times the income of B, "how much would we be prepared to lose along the way, for example, through administrative costs?" They say that if $\eta = 2$ then taking $1 from A and giving a mere 4 cents to B is a social improvement, even if the remaining 96 cents is lost. This they say illustrates that $\eta = 2$ "seems inconsistent with many decisions taken to day". Both of these thought experiments are vulnerable in several respects.[13] But taken together they illustrate the limited scope for intuition in helping to value η.

3.2.5. Expert views on η

In the American literature there has over the years been some consensus around values for η, in the context of STP, of about 1.5. For example Eckstein (1958) considers a range of 0.5 to 2.0, and Feldstein (1965) a range of 1 to 2; Cline (1999) opts for 1.5; Boscolo et al (1998, p7) conclude that "the few available estimates suggest that the elasticity of marginal utility [ranges] from 1 to 2"; and Arrow (1995a, p 6) suggests, on the basis of "rather thin evidence", 1.5 to 2.0.

In the UK literature, Stern's review of 1977 concluded that the evidence then pointed to the range of 1 to 10, with measurements based on consumer behaviour pointing to the middle of the range, and those based on government behaviour to around 2. Scott (1977, 1989), working back from market rates, estimated a value of 1.5. Little and Mirrlees (1974, p 240) suggested that "on admittedly extremely inadequate evidence, we guess that most people would put *[η]* in the range 1-3". Cowell and Gardiner (2000) concluded that the evidence supports a value in the range of 0.5 to 4, within which they give most weight to the range of 1.2-1.4 derived, as explained above, from the UK personal tax regime of the late 1990s. Evans (2005) regards a figure of 1.4, derived from the personal tax regimes of a large number of countries, and not inconsistent with derivations from food income and price elasticities, as a plausible result for many countries, but subject to more work on consumption behaviour.

My own reading of the evidence is that it suggests overwhelmingly that for today's developed economies η (defined simply as the elasticity of marginal utility) is greater than 1, but probably no greater than 2. A first glance at the results of the seemingly more reliable methods of estimation suggests a value a little below rather than above 1.5. However it looks as if the estimation biases tended to be downwards rather than

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[13] In first example, while most people would see the loss to an EU resident of 50% of his or her income and the loss to a very poor person of 1% both as serious welfare losses, few might feel confident about ranking one higher than the other. And in the second example, while it may or may not be the case that $1 to someone with an income of $50,000 has the same welfare value as 4 cents to someone with an income of $10,000, the transfer of money by the state from one to the other raises profound issue of property rights and incentives that make the question of administrative costs all but irrelevant.

upwards. On balance the case for 1.5 therefore looks to me more robust than that for any lower figure.[14]

One rarely discussed issue promoted by Dasgupta is that of the possible systematic change of η with increasing income. The most plausible assumption seems to be that, at least for current developed economies, η increases somewhat with further income growth. This might possibly be relevant for very long term analysis, but it seems unlikely that the incorporation of assumptions about future changes in η will in the foreseeable future add to the usefulness of economic analysis.

4. Valuing marginal utility in poor countries

This not formally a discounting issue but usually arises in parallel with discounting and is a source of persistent confusion.

It is fairly uncontentious among welfare economists that the real (say purchasing power parity) monetary value of a given change in marginal utility (say a small change in the risk of death from some specific cause) is generally less for poorer people than for richer people. It would therefore be unfair to insist that imports from much poorer countries should be manufactured with the same standards of workplace safety as those in the importing rich country. The government of the poorer country, if it reflects the will of its citizens to much the same extent as the government of the rich country, will tend to impose less costly regulations on producers.

Even the notion that poor countries value fatality risks less than rich countries sometimes raises hackles, as in the case of the (politically naïve, even for an internal memo[15]) notorious suggestion by Lawrence Summers, while at the World Bank twenty years ago, that perhaps the Bank should "be encouraging MORE migration of the dirty industries to the LDCs."

But tricky ethical problems arise when the risks are being imposed more directly by a rich country, for example as an employer. This was one aspect of the 1984 Bhopal disaster, where safety standards at the Union Carbide India Limited plant were far below what would have been tolerated by the parent company in the US (though also below the official standards in India). It might be argued that a foreign employer from a rich country in a poor country should apply its rich country safety standards. Or it could conversely be argued that this would be imposing a cost benefit trade off that did not reflect the preferences of its host country or its local employees.

The issue arises in a similar way with climate change. It is widely accepted that most of the costs of greenhouse gas mitigation will fall on rich nations and most of the benefit will accrue to poor nations. It could be argued that poor country utility gains should be valued in monetary terms as highly as those in rich countries. But this would imply spending more per unit of utility benefit than the value of that benefit to the beneficiaries, which looks like poor value.

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[14] And there is at least an asymmetry in the ethical dimension favoured by Dasgupta and others: no one would wish to favour the marginal utility of the rich over that of the poor. This may provide a case for some slight leaning towards higher rather than lower values of η.

[15] http://www.whirledbank.org/ourwords/summers.html

There are no clear answers to these issues and they have a combination of complexity and political sensitivity that make open discussion of them very difficult. In the context of climate change they may have a low profile given that, in the setting of international or national mitigation targets, very broad judgements about self-interest, ethical obligations and political and technical feasibility may have more influence than CBA. They may also be more amenable to other analytical approaches.

5. Discounting and the long term

5.1. The case for a declining long term discount rate

It is widely accepted and appears to be nowhere challenged that, if social discounting is to be applied to substantial impacts projected beyond 30 or 40 years ahead, the assumed discount rate should decline over time because of uncertainty about its value. As a stylised illustration, suppose that the discount rate were believed to be either 2% or 6%, with equal likelihood. Table 1, adapted from the relevant background paper to the Stern Review (Hepburn, 2006), shows how, as the discounting period increases, the effective discount rate declines from 4% (the average of 6% and 2%) towards 2%.

There is uncertainty about the rate even if the future continues much as in the past, but the uncertainty is compounded by the increasing uncertainty over time about the components of the STP rate, namely the rate of per capita income growth, the marginal utility of income of distant generations, and the extent to which we would empathise with them.

Weitzman (2001) applied more rigorous algebra (if ad hoc theory) to data collected from some 2,000 economists of their "best point estimate of the appropriate real discount rate to be used for evaluating environmental projects over a long time horizon". But the data quality is dubious and it would be troubling if a government institution used it for policy analysis. It is not surprising that Dasgupta felt unable to respond to Weitzman's questionnaire, largely because it appeared to impose a constant future consumption growth rate over hundreds of years. As Dasgupta (2008, p 161) notes, Weitzman later revisited the work and suggested a hyperbolic formula for long term discounting, but again embedding a constant consumption growth rate. There has also been other academic work on algebraic sophistication of long term discounting, notably Gollier (2002), but there seems to be a limited prospect of this finding practical application.

Table 5.1 The effective discount rate, if the true rate may equally probably be 2% or 6%

		Present value (PV) of £1 million, discounted over:				
		1 year	**30 years**	**100 years**	**200 years**	**400 years**
1	PV with discount rate of 2%	£980,000	£552,000	£138,000	£19,000	£363
2	PV with discount rate of 6%	£943,000	£174,000	£2,950	£8.68	£0.000
3	Expected PV *(equal to mean of rows 1 and 2)*	£962,000	£363,000	£70,500	£9,530	£183
4	Effective discount rate *(corresponding to PV in row 3)*	3.96%	3.43%	2.69%	2.35%	2.17%

Rows 1 and 2 show the present value obtained by discounting £1 million at respectively 2% and 6%. Row 3 shows the average of these present values. Row 4 shows the discount rate that would give the present value in row 3. The period of 30 years, in the first column, is towards the end of or beyond most practical discounting periods and the effective discount rate, at 3.43%, is still close enough for practical purposes to the average of 2% and 6%. However over longer periods the effective discount rate continues to approach 2%.

Dasgupta (2008, p 163) adds an interesting qualification by showing that variance in the expected income growth implies a lower, but *not* a decreasing discount rate. However in practice the variance of the projected income growth might be expected to be increasing over time.

Newell and Pizer (2003) examine the long term uncertainties about time preference, and also test the model of the discount rate in future years following a random walk, which greatly increases the chance of reaching very low values.[16]

It is also fairly uncontentious, though not often discussed, that society's rate of discrimination over time intervals declines somewhat in the long term. Few people in the 2010s would discriminate quite as much between say 2125 and 2130 as they would between 2025 and 2030.

And it might plausibly be argued, as in the Stern Review, that in the very long term rates of consumption growth are likely to fall.

It is sometimes argued that use of a discount rate regime that declines from the present into the future would be bad practice because it would imply time-inconsistency. It is sometimes suggested that time inconsistency arises only from a declining pure time preference rate δ. But it will arise from a continuing regime of a rate that declines because of uncertainty about δ and η – although not of course from a rate that is projected to decline because an *expected* decline in g. Often cited as explaining time inconsistency is the elegant paper by Strotz (1955-56), although Strotz was concerned with individual behaviour, not social discounting.

A hyperbolic discounting schedule does of course mean that the relative weights given to specific future years change as time goes by. But it seems unlikely that this ever has been or will be a problem in policy application, given the nature of expenditure decisions that are made by governments on the basis of CBA. More substantial in any case, though rarely an issue of academic concern, are the inconsistencies generated by the often partly politically motivated changes in the social discount rate decided upon fairly frequently by governments. (In the UK a social discount rate was introduced in 1967 and subsequently changed in 1969, 1978, 1989 and 2003 – that is about once every ten years.)

Groom et al (2005) reviewed the situation at that time with respect to discounting over the long term, They concluded, perhaps rather surprisingly, that the case for a declining rate was "still not proven without doubt" and suggested that time inconsistency might turn out to be problematic.

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[16] This is reminiscent of the common assumption in financial economics that equity returns follow a random walk, even in the long term (rather than wandering around a smoother long-run trend), so contributing to the high risk premia and prospective returns to equity often estimated in that literature.

5.2. The case for and against long term discounting

Discounting is an invaluable tool in the analysis of those costs and benefits that can be monetised across nearly all public projects, programmes and policies. But even with run-of-the-mill projects the precision of present values can unhelpfully conceal uncertainties in the data from which they are calculated. Over the long term there is more danger of hiding important but contentious assumptions in the black box of the discount rate (or rates). And there are dangers, especially in long term analysis, in allowing conventional CBA to be applied to impacts for which it is inherently unsuited.

There are lessons to be learned from hindsight. Lind's outstanding paper of 1982 quoted as an example of the *importance* of discounting the range of figures current in the 1970s for the US fast breeder nuclear reactor (FBR) programme. The estimated net present value of this programme fell from $46.8 billion to $16 billion when the discount rate was raised from 7.5% to 10%. Lind further commented that "small variations" in the discount rate will often tip the balance between a positive and negative present value. In the event the net present value of the US FBR programme was probably substantially negative with any positive discount rate. Strategic issues, such as the costs and public acceptability of nuclear power and the associated availability and price of uranium and perhaps of other fuels, were seriously misjudged, and there has been as yet no commercial demand for FBR technology. The story was repeated in the UK, which also produced optimistic present values to justify the continuation of that costly development programme. These now stand as striking examples of the dangers of discounting diverting attention from key assumptions, which may be more important than even a few points either way on the discount rate.

A decade later Lind (1995) wrote a prescient piece on the analysis of climate change policy, concluding that "the cost-benefit criterion cannot provide a definitive basis for deciding whether we should commit to a longer-term programme to moderate climate change; the issues of intergenerational equity are not that global climate change will significantly lower the GNP of future generations, but relate to the possibility of … catastrophic effects in the future; and the typical way in which the cost-benefit problem is posed obscures the basic choices that we should be evaluating."

Experience following the Stern Review would seem to confirm Lind's doubts.

It was a pity that the Review chose a super altruistic value for δ (and a value for η that was lower than could be well supported by the evidence). The former attracted sound criticism which may have affected the Review's impact. With hindsight it might have been better to have adopted more justifiable parameters, but also to have adopted a declining rate beyond that implied by declining growth alone: the outputs might then not have been so very different.

But the difficulties arising from the use of discounting went beyond those arising from the choice of a particular rate or rates. Thought was clearly put into providing an easy-to-present-and-understand framework for discounted values, but with limited success. It was perhaps hoped at the outset that numbers achieved by formal discounting would give the Review more credibility, but this must with hindsight be doubted. The force of logic in the end required focus on the 550ppm maximum CO2e

concentration, deduced from the science, and estimates of the costs of achieving this. There would still have been merit in presenting estimates of long term damage costs, but by quantities expressed in real time, rather than the use of present values discounted over a century or more.

The real easy-to-present-and-understand framework has proved to be that forecast by Lind, and as recognised in the excellent Final Rejoinder of Dietz and Stern (2008b) and in the wider debate. It is expressed as clearly as anywhere by Krugman (2010): "Stern's moral argument for loving unborn generations as we love ourselves may be too strong, but … what I end up with is [that] it's the non-negligible probability of utter disaster that should dominate our policy analysis. And that argues for aggressive moves to curb emissions, soon."

A similar story is to be found with Defra's derivation of social costs of carbon. The initial approach was based on long term discounting of damage costs. But that too was overtaken by the more robust and defensible costs derived from the estimated marginal cost of achieving the UK commitments to emissions targets.

In practical terms the approach of discounting costs but not the long term benefits was well set out as follows by Toman (1999) in his contribution to the seminar reported by Portney and Weyant: "… the present value of the risk reduction costs to be borne by the current generation could be presented to decisionmakers and the public along with estimates of the ultimate effects (monetary and otherwise) of risk reduction, and their incidence in time and space. Decisionmakers and others then have to weight whether the benefits justify the costs". This well describes how practice has evolved in the subsequent twelve years.

Another example of very long term impacts is the back-end costs of nuclear power generation: these costs typically extend to well over a century from the commissioning date of the plant. But in this case different considerations arise from those of climate change. One difference is that the costs are much less uncertain than even the mitigation costs of climate change. Another is that the issue is essentially manageable by national policies, with no major international dimension. A third, perhaps most important, is that nuclear power generation is a market activity. The costs of decommissioning and the subsequent fuel processing and waste disposal therefore need to be reflected in costs charged to the producer and ultimately the consumer.

The convention now adopted for such long term nuclear costs is that of a "decommissioning fund". During the operating life of the plant the producer is required to build up a ring fenced fund, which will ultimately be used to meet the long term costs of decommissioning and beyond. Derivation of the size of the required fund of course requires a figure for the assumed financial return. This assumed return is described as a "discount rate". However it is not generally taken as the social discount rate but as an actuarially based figure, perhaps similar to that advised by actuaries for use by pension funds. This ensures at least in principle that, when the time comes in the distant future for expensive disposal costs, there will be a sufficient, dedicated fund available to pay for them.

This is not in fact a wealth transfer from the present to future populations. But it does achieve fairness in charging consumers at least broadly the full cost of the resources

they are using. It also assigns property rights to the fund in a way that should avoid future commercial or political disruption.[17]

Nuclear power however is exceptional. There are many other situations in which major capital assets, in for example energy, transport and flood risk management are expected to continue in use for fifty or sixty years or more, but most of the present value costs and benefits generally arise well before then. It is hard to envisage cases in which it is helpful to calculate present values of proportionately large costs or benefits more than half a century or so into the future.

The main problems with doing so are those of uncertainty about the values of the components of the discount rate (and hence the discount rate schedule), the extent to which the discount rate hides important assumptions, uncertainty about the valuation of the monetised costs and benefits that are being discounted, and the way in which the precision of present values (or annuitised costs per year) diverts attention from adequate consideration of these uncertainties and from adequate consideration of non-monetised impacts, which are often especially important in very long term applications. This is all compounded by the fact that very long term impacts include some to which discounting is particularly inappropriate, because current willingness to pay to reduce them depends so weakly on their timing. Risk of world catastrophe has already been noted. The same applies to risks of species extinction and many other irreversible impacts.

These doubts about the general use of discounting over the very long term are not however to downplay the value of exploratory work to address some of the problems. There is always potential for the development of new approaches to discounting to provide new insights into some special long term situations, such as the work described in Dietz and Asheim (2011) to develop a procedure that would give high weight to costs and benefits falling to groups whose absolute welfare was projected to fall over time.

6. Conclusion

The valuation of pure time preference, δ, and the elasticity of marginal utility, η, in a social time preference rate are likely to be debated indefinitely. However it is helpful to clarify the areas of debate and to put forward reasoned proposals.

With respect to δ the main divide appears to be between those who believe that its value should reflect the informed preferences of people in general, as is the norm in cost benefit analysis, and those who believe that future populations should be given the same weight as the present population. Examination of the arguments made against reflecting informed preferences of people in general does not find these arguments persuasive. They appear to arise in part from a confusion of differing

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[17] The financing logic here is similar to that of internally financed national debt, as debated many decades ago: such lending by a nation to itself does not transfer wealth over time, but it does assign property rights in a way that imposes discipline on the government, as the money raised, unlike taxation, has to be repaid. As for the attribution of long term costs to electricity consumers, this would strictly be derived by discounting the costs at a social discount rate, rather than an actuarial commercial rate return. But for practical purposes it seems satisfactory in this case to use the actuarial rate. It is not clear whether social time preference over such a long period would be higher or lower.

ethical situations and in part from a confusion between the roles of discounting and valuation – for example of future catastrophic risks.

It is not contentious that individuals, groups and nations care about, and in their actions generally favour, people with whom they have more rather than less affinity. In the normal run of politics and domestic life this is accepted as the way in which nations, communities and families function. The associated group loyalties, while they can sometimes be unpleasant, and worse, are seen as a fundamentally virtuous glue rather than immoral selfishness. In public policy, as often within families, this normally entails strict impartially in the weighting of the marginal welfare of individuals or households within the relevant (e.g. nationwide) group. This follows the utilitarian tradition. And people normally see themselves as belonging to a hierarchy of groups, each demanding its own different degrees of loyalty, from close family to the nation and to the global community. And in some circumstances, such as the stranger in deadly peril, tribal loyalties are normally overridden.

Among those involved directly in public policymaking it appears to be uncontentious that future generations are not quite the same group as the current generation, who are creating the resources which the current government is redirecting in much of its policy making. So that giving somewhat less weight to future generations raises eyebrows no more than giving does less weight to contemporary nations.

It is therefore hard to see why the future marginal utility of future populations should not be discounted at a modest annual rate. There is also a fairly uncontentious argument for including in such a rate an addition for risks that would otherwise probably not be reflected in the analysis. Interpretation of the literature in this way would suggest, for a developed economy, a value for δ in the region of 1.5%, although a somewhat higher figure would not seem unreasonable.

It is unfortunate that there appears to have been no reliable empirical work to estimate people's preferences in this field.

The valuation of η, in contrast to δ, has been subject to numerous empirical studies, by many methods over many years. No method is free from significant weakness, and some appear to be so weak that their results (typically implying values for η in high single figures) should be set aside. However the convergence of other results is sufficient to give confidence in their use for practical application.

It is sometimes argued in academic work, though never it seems in government guidance in the UK or elsewhere, that the value of η in the social discount rate should be increased to a value higher than the estimated elasticity of marginal utility, so as to act as an instrument for reducing welfare inequality across generations, or at least that the value chosen for indicates a measure of the present population's aversion to inequality. It seems unlikely that this will ever gain traction in practical application by governments. Social welfare is reduced by large or very unfair income inequalities, but η is not a suitable instrument for helping to address this. The concept of giving more weight to the marginal welfare (as distinct from marginal income) of poorer people relative to richer people would offend against most people's perception of fairness in most public policy contexts. The most that can be said is that such ethical concerns may justify some leaning up rather than down in interpreting the

empirical evidence on η, insofar as probably more people would favour giving more weight to the marginal welfare of the poor than giving more weight to that of the rich.

The empirical evidence suggests on balance a value for η in the social discount rate for a developed economy, of about 1.5.

An issue that usually arises alongside discounting in the context of overseas development is the valuation of utility impacts, such as marginal changes in risks to health or life. There is no unambiguously correct balance between the considered wishes of the low income people affected and ethical pressures to apply higher standards. Much depends upon who is ultimately paying the financial costs. CBA may not always be a suitable analytical approach. However this appears not to be a substantial issue in the context of climate change policies.

Discounting substantial cost or benefits over a period of more than around 50 years raises serious problems of transparency. It is widely accepted, correctly, that if an annual discount rate is used, it should for a number reasons decline over time. However experience suggests that in most cases it is best to set out very long term impacts in real time, with clear explanations that enable decision makers and others to form their own judgements about the trade offs between costs and benefits.

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2.2. Valuation versus discounting More generally in public debate, there is often confusion between the concepts of time discounting and the real time valuation of future impacts.Â In this case commercial 2 A rather special case is Nordhaus, who appears to agree that the social discount rate should be based on the concept of social time preference, but whose climate change models incorporate the assumption that markets are so perfect that the STP rate is equal to the financial rate of return on private sector investment.Â But the huge diversity of real rates of return at which people save and borrow, from negative to well into double figures, casts little light on the value even of personal time preference Social discounting is both controversial and confusing. Social discount rates are bundles of different concepts and the ensuing confusion feeds the controversy. The controversy often falls along disciplinary lines, suggesting that dialogue may help resolve it. "The concept of 'discounting the future' is a point of fundamental contention between economists and moral philosophers.Â The first is the problem of valuation. For instance, in a CBA of a forestry investment, the future price of timber must be predicted. But there is a more intractable valuation problem, namely the attempt to place dollar values on goods and services that are not sold. Keywords: social discount rate, social rate of time preferences, social opportunity cost of capital, shadow price of capital. Introduction. A social discount rate is the rate which enables to make intertemporal comparisons in the public sector of economy. This rate has been calculated for developed countries since 19th century. Such economists as Ramsey, Baumol, Diamond, Lind, Bradford, Newbery, Weitzman, Zhu, Moore, Boardman and many others worked on this problem. However different researches connected with determination of a social discount rate and investigations of various approaches to ev