

After the Stern Review: reflections and responses

12 February 2007



PAPER B:

'Value judgements, welfare weights and discounting: issues and evidence'

www.sternreview.org.uk

Value judgements, welfare weights and discounting: issues and evidence¹

B1 Introduction

No policy study of climate change can avoid the issue of comparing those impacts of policy action which would affect current and near-term world citizens with those occurring in the future, including in the distant future. The reason is that the effects of policy concerning climate change, in particular reducing greenhouse gas (GHG) emissions, appear, in terms of reduced climate risks, with very long lags. And, the effects are very hard to reverse and thus will stay with us for centuries. These inter-temporal welfare comparisons must inevitably involve value judgements.

The relevant value judgements will be affected by assessments of how well-off future generations are likely to be relative to ours. And that difference in living standards will, in itself, be influenced by policy – business-as-usual (BAU) emissions of GHGs could radically reduce the standard-of-living of future generations. Thus attitudes to transfers between people with different levels of income will be a crucial part of these value judgements. Impacts within generations must be compared too. Whilst climate change affects everyone it will be poor people and poor countries who are likely to suffer earliest and most severely.

Further, we must also think through whether we would want to place a different value on the welfare of a generation purely because it is born some time in the future i.e. should those with later dates of birth have lower weight simply for that reason? Are there any persuasive ethical arguments for discrimination by birth date? These problems of distributional and inter-temporal value judgements are of very long standing in economics and formal treatments in the context of models of saving go back at least to the 1920s², (Ramsey 1928). They were discussed in Chapter 2, and its appendix, in the Review. A number of different approaches were introduced, including sustainability, stewardship rights, justice, freedom and liberty. All of these approaches have a claim on our attention. However, the Review followed much of

¹ We are very grateful to Tony Atkinson, Partha Dasgupta, Roger Guesnerie, Claude Henry, Cameron Hepburn, David Newbery and Bill Nordhaus, Tony Venables and Martin Weitzman for discussion of these issues. Parts of this note draw heavily on the work of Tony Atkinson and Cameron Hepburn.

² The Economics of Climate Change: the Stern Review, Cambridge University Press 2007. Page references correspond to this publication.

the economics literature in placing at centre stage an approach which articulates distributional value judgements in terms of weights on income or consumption changes which are linked to consumption (or income), together with the date in the future when the consumption occurs.

Considerable discussion of the results of the Review (particularly concerning the formal modelling of Chapter 6) has focussed on discounting in the future. Some of this discussion, but certainly not all, seems to have taken place in ignorance of the basic underlying theory of discounting. In particular discounting must be linked to value judgements and discounting in the usual cost-benefit framework applies only to marginal changes. However, much of the analysis of the impacts of climate change must deal with major non-marginal change. Thus we have found most of the criticisms of the Review's suggestions or base case value judgements and implied discount rates to be unconvincing – as we shall explain below. Arguments concerning inconsistency between different aspects of the value judgements are not, in our view, well-founded. Thus the question 'what is the discount rate' is badly posed. There will be many discount rates depending on the period of time and the path. And for non-marginal changes we must go back to the objective or welfare function from which discount rates are derived in the special case of the evaluation of marginal changes.

Thus we must examine value judgments directly: if we have no idea which sets of value judgements have relevance we cannot have a sensible discussion of policy. How then can we throw light on the range of values which will shape intra and inter-temporal value judgements, particularly the weighting of welfare changes?

B2 Values and thought experiments

Different people will have different value judgements. But value judgements are not arbitrary. We can, and should discuss, which of the many possible value judgements have stronger call on our attention. We can cross-question ourselves and each other and bring appropriate evidence to bear. Such exercises will not remove ethical differences of view but they can help us understand, and often narrow differences. A standard way to do this in philosophical and ethical discussions is via simple 'thought experiments'. We can imagine simple circumstances where we can make a judgement about what our policy decision might be and try to infer underlying values in some simple parametric form. This is an 'inverse optimum problem': you start with

the decision and then try to infer the values, much as in standard consumer demand theory and estimation. There are, of course, many problems. The outcome of the process depends on the assumptions about the model structures as well as the representation and parameterisation of values. Sometimes these simple hypothetical thought experiments can be seen as providing axiomatic foundations for broader theories (see, for example, Rawls, 1971) shaping the consequences of decisions.

A second, and related, approach is to look at actual decisions or outcomes and try to infer society's values from these. This has been used in relation to savings rates, taxation, attitudes to uncertainty and so on. For both types of approach there is some literature, e.g. Stern (1977), Pearce and Ulph (1999) etc. For the second approach the problem of underlying model structure is more complex. Is it really the case that we can think of actual savings rates or tax rates as the outcome of an optimisation problem, as opposed to some complex process of interaction, bargaining etc? On the other hand the decisions are real ones rather than hypothetical. Both types of approach can contribute to a discussion but both are limited. The former has been termed 'prescriptive' and the latter 'descriptive'. This terminology is useful in describing the structure of the argument but any choice of focus for a range of relevance for value judgements will inevitably be normative or 'prescriptive'. Thus our focus is on the 'prescriptive'. However at the end of this note we return to the issue of how far market data can "reveal ethics" (see Hepburn, 2007).

We examine briefly thought experiments, both prescriptive and descriptive, and values based on three types of distributional issues: intra-generational; uncertainty; and allocation of over time. We devote more space to the last of these than the other two but all three have strong relevance for the issues raised in the Review. And, on the whole, the Review followed the main economic literature in using similar distributional parameterisations to describe all three. One important element for further research is to disentangle the functional forms associated with the three types of issue (Hepburn, 2006 has made this point strongly). We devote more space to the inter-temporal and intergenerational issues than to uncertainty. We should, however, note that the intra and intergenerational distinction is complicated by over-lapping generations ie many generations are alive at a given point in time. Thus, redistribution within a given time period can be both intra and inter-generational.

The inferring of values from empirical evidence is fraught with difficulty beyond simply the problem already noted that any inference on values will depend on the structural

modelling of the environment, and assumed structures of decision-making, in which a policy decision is taken. We return to these difficulties after describing some of the possible approaches to inferring values.

B3 The level of aggregation

Much of the discussion of values in this note and in the literature takes place at a high level of aggregation. Thus it considers total world consumption or income or aggregate country level income. There is often little distinction between different kinds of goods or allocation of individuals' income across different periods of their lives. And in much of the formal modelling the attention to within country distribution is very limited. Much of this is understandable given the modelling difficulties involved in these long-run issues. And in this note we continue the discussion, for the most part, at a very high level of aggregation since we are mostly concerned with issues of values and discounting over very long periods.

However, many of the issues of disaggregation are of great importance to the economics of climate change. We should be concerned with differences within countries – the poorest within countries are often the hardest hit by climate risk. And the formal analysis of the economics of climate change should, in our view, place still stronger emphasis on differences in impacts between rich and poor countries. A further issue involving disaggregation is that approaches to discounting for allocation decisions within a given generation may raise different issues from allocation decisions across generations (see Review, Appendix to Chapter 2, p.54).

Further, and this is of great importance in understanding the contribution and the role of modelling in this (and other) areas, many decision-makers may feel able to take decisions on policy without an attempt at formal modelling which explicitly aggregates effects over time, space, people, and possible random outcomes. Thus in the Review and in the accompanying papers we argue that decision makers and individuals can form a reasoned view on whether they would spend (say) 1% of income a year to avoid the consequences of climate change. They can form that view from a description of these possible consequences without necessarily formally attaching numbers to all the consequences, weighting them and adding them all up. That is why we saw the modelling of Chapter 6 as providing supplementary arguments to the more disaggregated approach of earlier chapters.

In this more disaggregated approach formality about inter-temporal values and discounting is not required. Individuals or decision-makers simply take a view on the broad description of future effects and do not need precise 'discount rates'. Nevertheless, there is some kind of implicit assessment of future versus present and bringing this out formally in terms of values and discounting can be helpful.

B4 Values and risk

We consider, only briefly, the use of evidence on behaviour towards risk to infer value. The Review had the economics of risk at its core and, for the most part, used that standard workhorse of economic theory, the expected utility model. And further we used, for the most part, the version which has constant relative risk aversion (the isoelastic utility function – see Chapter 2, its appendix and Chapter 6 of the Review) and below. The index of relative risk aversion is the parameter, η , in the Review and was taken to be unity in Chapter 6. In the postscript to the Review (pp 649-671) we investigated higher values of η , that is 1.25 and 1.5 (and see accompanying papers for further sensitivity analysis).

In the analysis, η then plays a dual role as capturing aversion to risk and to inequality. A higher η then cuts two ways in the policy assessment (i) a higher η places less weight on increments in consumption to future and, in this sense, points to less concern with the consequences of climate change far into the future generations in cases where distant generations are assumed to be better off (ii) a higher η points to more concern with the consequences of climate change since higher concentrations of greenhouse gases generate more risk.

How can we use observed attitudes to risk to illuminate the choice of η ? Gollier (2006) has argued that some studies of insurance point to higher values of η from 2 – 4. The problem here is that some interpretations of gambling behaviour can be seen as pointing to low or negative η . And much theoretical and empirical work on choice and risk has argued that the expected utility model performs very badly indeed. Our conclusion on the use of risk-oriented evidence is as follows. It is very difficult to use empirical evidence to narrow down a relevant range for η . The reasons are first that the expected utility model is so often in contradiction to the data and, second, where it is not necessarily in contradiction with the data, the range of possible values of η is very wide.

We could still, in principle, use prescriptive thought experiments to propose normative value judgements on the basis of the theories of risk and uncertainty. There is a long tradition including Harsanyi, Rawls and much subsequent literature. The literature, however, is not of a kind that leads easily to evidence on η for the purpose at hand.

B5 Values and intra-generation distribution

We illustrate the use of intra-generational evidence to examine possible underlying values by drawing on the work of Atkinson and Brandolini (2006).

Leaky Bucket Experiment (Okun) from Atkinson and Brandolini (2006)

The challenge of identifying social welfare weights $\varphi(Y)$ where φ depends only on income Y . Consider a transfer of

-\$1 from person with income Y
 + $\$(1 - \ell)$ to person with income Y/z

Transfer desirable where $(1 - \ell) \varphi(Y/z) > \varphi(Y)$

Whether the inequality holds depends on the elasticity of $\varphi(Y)$. If it is constant at e , then the inequality requires

$$\ell < 1 - z^{-e}$$

In the US (approximately) $P90 = 2 \times P50$; $P50 = 2 \times P25$; $P25 = 2 \times P10$

where P_n is the income below which $n\%$ of the population lie. Thus an elasticity = 2 implies we accept a transfer from US P25 to US P10 where the loss is less than 75%, and from P90 to P10 where loss is less than 98.4%

An elasticity = 1 implies we accept a transfer from US P25 to US P10 where the loss is less than 50%, and from P90 to P10 where the loss is less than 87.5%

An elasticity = $\frac{1}{2}$ implies we accept a transfer from P25 to P10 where the loss is less than 29%, but accept transfer from P90 to P10 where the loss is less than 65%

We highlight two points made by Atkinson and Brandolini which are of strong relevance for our discussion here. First, they examine the use, where $\varphi(y)$ is the social marginal utility of income, of a constant elasticity of φ with respect to y i.e. $y\varphi = y - \eta$. They argue that a constant η , one that does not vary with consumption or

income, is a straightjacket on how welfare weights or social marginal utilities of income vary with incomes: it has no obvious justification. For example, there are many commentators who focus on a poverty line as a key concept. This would imply a low or zero elasticity (constant marginal utility of income in the zero case) below a poverty line. And there would be many who would argue that we would or should not be interested in redistributing income amongst the rich (e.g. the top 5% or 1% of the distribution). These views would point to a curve for φ which is fairly flat at low y , falling more rapidly for 'intermediate' y and then fairly flat for high y . And thus would point to an elasticity which first rises as income rises, then falls.³ This argument is not necessarily to insist on a social marginal utility of income curve of this shape but to illustrate the straightjacket of constant η . It is, of course, a convenience to keep η constant and it has been used in many contexts, but we must be aware of its limitations. Similarly a constant δ also has its problems (see below).

Second, they show in two ways, that much of public discussion of intra-generational transfers and measurement of inequality could be taken as pointing to an η much lower than one. We illustrate the first of these from their slides 13 and 14. The former slide explains Okun's "Leaky Bucket Experiment". In this thought experiment we consider the desirability of a transfer from individual A who has income, say, twice individual B. If $\eta=1$, so that the social marginal utility of income falls as the reciprocal of income, then we would accept as an improvement a transfer of a unit of income from A to B provided not more than 50% was lost 'along the way' or 'leaked out of the bucket'. In Slide 14 they illustrate these ideas using a recent estimate of income distribution for the US. P90 denotes the income at the 90th percentile (position of person with 90% of population below their position), and similarly P50 denotes the median. In the estimates that they use, P90 is roughly twice P50, which is roughly twice P25, which is roughly twice P10. Thus if we were to accept or reject transfers on the basis of these welfare weights a transfer from P90 to P10 would be accepted provided no more than 87.5% is 'lost along the way'.

The 'loss along the way' can stand for many possibilities such as actual administration costs of making transfers, disincentives, corruption and so on.⁴

³ Strictly speaking they conduct their argument – as is appropriate for transfers – in terms of the second derivation of the utility as welfare function rather than the elasticity of the marginal utility.

⁴ From a deeper perspective there would be issues of property rights, liberties and so on.

Nevertheless the numerical point is striking. Many would regard $\eta = 1$ as rather high in this context.

Their slide 17 shows the social marginal utility of income implicit in a Gini coefficient (a standard index of inequality) for the summary of a world distribution of income.⁵ In the diagram the social marginal utility is normalised at 1 for the median to compare across different examples of functional forms. Thus we can see in this context that the very commonly used Gini coefficient, if interpreted as a welfare index (see e.g. Sen 1997), would be associated with a much flatter curve, in this sense similar in effect to a lower η than $\eta=1$.

Our conclusion from this discussion of intra-generational transfers and inequality measures is that if a constant elasticity of income measure is to be used than many observers would view η equal one as rather high. On the other hand with a non-constant η , the value could be higher than one in some parts of the range of incomes and lower than one elsewhere.

B6 Values and inter-temporal allocation

Let us now turn to inter-temporal allocation. We will not repeat the derivations contained in the Review at length. They are, in any case, fairly standard. The objective for the analysis of inter-temporal distributional issues was taken as, where C is total consumption of generation t, and N the population:

$$\int_0^{\infty} Nu(C/N)e^{-\delta t} \tag{2}$$

where δ is a pure time discount rate (of which more below). We discussed in the Review the specification of the functions $u(\cdot)$ and of δ and will now return to some of these issues. Note that the form we have used in (1) takes no account of distributional issues within a generation. That is an issue of great importance which we did not have time, in the quantitative modelling for the Review, to explore in detail. We did however make some heuristic and tentative adjustments to damage assessments to take account of within-generation issues. See appendix to this note for a simple technical discussion of such heuristics.

⁵ Formally this is $2(1-F(y))$ where $1-F$ is the fraction of the population with income above F .

This gives a social marginal utility of consumption at time t of

$$\lambda \equiv u'(c)e^{-\delta t} \quad (2)$$

where c is consumption per head.⁶

Further if we take δ as a social discount rate, the rate of fall in the social marginal utility, i.e. $-\dot{\lambda}/\lambda$, (see appendix to Chapter 2 of the Review, p52) we have a social discount rate of r , satisfying

$$r \equiv \eta g + \delta \quad (3)$$

where $\eta = -cu''(c)/u'(c)$ the elasticity of the social marginal utility of consumption. In most applications, including the Review, η is constant, but, as we have argued this is a rather restrictive assumption.

We must emphasise very strongly the distinction between r , the discount rate, and δ , the pure time discount rate. Unfortunately the two are often confused. The latter is an integral feature of the overall set of values and is relevant for all applications marginal or non-marginal. Its ethical status, however, requires careful examination. The former is relevant only for marginal analysis and thus is not of direct significance for changes involving non-marginal impacts. And such non-marginal changes are important for many aspects of climate change.

We took as our base case, in the Review, for the specification of values, $\eta=1$ and $\delta =0.1\%$. We have already indicated the distributional issues involved in specifying η and we shall comment further. In the Review it was argued that the most straightforward ethical approach to understanding δ , or the pure time discount rate, was through the interpretation of $e^{-\delta t}$ as the probability of existence of the world, in terms of its population at time t . The utilitarian objective of the sum of utilities as in (1), and in many other parts of economics treats individuals symmetrically. Discrimination between them should have a reason. Discrimination by date of birth,

⁶ We shall use consumption and income interchangeably here – for the current discussion of η and related issues, the difference is not crucial.

as in pure time discounting, is difficult to justify on ethical grounds. An exception, as in the argument given above, would be to take account of the probability of existence.

Given this starting point, how can we take the discussion of η and δ forward? Nordhaus (2006) and Dasgupta (2006) have suggested that we can conduct an ethically– relevant thought experiment in terms of levels of savings rates. Others, e.g. Gollier (2006), have emphasised thought experiments in terms of risk preferences and aversion. While the ethical arguments surrounding the specification of η and that of δ are in many ways distinct, in these two thought experiments the savings rate and the discount rate are each influenced by both η and δ . If the ethical observer claims to know what the ethical savings rate should be then there is a link between η and δ . We shall argue, however, that there are major difficulties in inferring ethical savings rates and discount rates from those that are observed. Further, some of these difficulties apply to specify ethical savings rates in simple hypothetical modes, for example, via the specification of model structure (see p.54 of the Review). Thus an insistence on a tight link between η and δ on these grounds is problematic. We examine thought experiments via the savings rate and via the discount rate in turn.

The Review argued, see appendix to Chapter 2, that a simple application of $\eta=1$ and $\delta=0.1\%$ to a model of production with no technical progress could lead to very high optimum savings rates (this had been noted by Ramsey in the 1920s). The Review also indicated, however, that altering assumptions on the model structure would alter that savings rate. Thus the implication of high savings rates in the absence of technical progress is not necessarily an argument against this choice of η and δ .

Brad de Long (2006) makes this argument explicit and shows that adding technical progress at around 3% can bring down savings rates in this type of model to 20-25%. He, like Dasgupta, finds high δ s in this context to be ethically very unattractive. He explains that Nordhaus' suggestion of 3% for the pure time discount rate would imply that someone born in 1960 would 'count' for roughly twice someone born in 1985 simply because of the difference in birth date. Many would regard such ethics as unacceptable.

A second issue is the constancy of η . If η changes with consumption level the savings rate might be lower over regions of a growth path where η is high and lower for other regions of the path.

Our conclusion on our choice of base case in the Review of $\eta=1$ and $\delta=0.1$ is that it cannot be simply dismissed on the grounds of an ethical thought experiment on savings in one particular model. The intra-generational thought experiments, and the sensitivity of savings rates to model assumptions make such a dismissal on the basis of one particular and rigid savings model, unconvincing.

Some commentaries on the Review have, mostly implicitly, conducted thought experiments in terms of the social discount rate r , equal to $\delta\eta+g$. In the model of Chapter 6 the overall growth rate starts around 2% in rich countries and above 4% for Asia and eventually falls to 1.8% by 2200⁷.

Some have argued that with $\eta=1$ and $\delta=0.1$, a (very long-run) social discount rate of 1.4% is implausibly low since there will be a social return on investment much higher than this. This argument is predicated on the apparent knowledge of what very long-run rates of return might be.⁸ It is hard to know why we should be confident that social rates of return would be, say, 3 or 4% far into the future. In particular, if there are strong climate change externalities then social rates of return on investment may be much lower than the observed private returns on capital over the last century on which suggestions of a benchmark of 3 or 4% appear to be based. Indeed, it is not impossible that with BAU growth in greenhouse gases they could become negative. Hence the suggested implausibility of long-run social discount rates of 1.4% is unconvincing.⁹ We should also note that in the shorter run in the model of Chapter 6 with growth rates above 2% and with $\eta=1.5$ (see postscript of the Review) the social discount rate is above 3%.

The same types of argument also show why it is wrong to assert that there are higher long-run rates of return for investment which should rank higher than mitigation investments.

We can deal here also with the Tol argument that the Review's discount rate is inconsistent with that of the UK Treasury. This is simply wrong as was explained in the appendix to Chapter 2 of the Review. The η of the Review and the Treasury's

⁷ Thereafter growth is extrapolated from the average per-capita growth rate of the first two centuries of 1.3% into the indefinite future (the implicit assumption being zero further population growth)

⁸ Incidentally in the Nordhaus DICE model growth eventually falls to zero and thus social discounting arises entirely via δ . The latter position would be regarded by many as ethically unacceptable.

⁹ See also Quiggin (2006) who suggests that this number may be not far away from long-run returns.

Green Book are the same and the growth rates in the early periods of the models are similar. The difference lies in the pure time discount rate. And as was explained in the Review (appendix to Chapter 2, p53) the pure time discount rate applying to the existence or non-existence of the planet should be much lower than that applying to the existence or non-existence of a project in terms of a possible new environment (from unforeseen policies or technical change, for example) which would render that project irrelevant.

Overall, therefore we find the arguments raised by a number of authors, on grounds of savings rates and discount rates, against the choice of the base case of $\eta=1$ and $\delta=0.1$ to be less than convincing. We must, however, recognise that $\eta=1$ and a low δ place strong weight on benefits for into the future. One way of illustrating this is to note that if the long-run growth rate of consumption is g (and suppose that eventually population growth is zero) then the utility integral over infinity converges if and only if (see Review p.58, and postscript, p.670):

$$(1 - \eta)g - \delta < 0 \tag{4}$$

If η is less than one and δ is low this condition would be violated. In other words it would always seem attractive to save or postpone benefits. Newbery (2006) has emphasised that the chosen $\eta=1$ and $\delta=0.1$ implies that the contribution of benefits in the far future to estimates of prevented damage from action to prevent climate is large. In assessing this observation we should note that the convergent condition applies to the very long-run or limiting values of the elements in (4). There is no reason to suppose that in the short , medium and long-run any of them are constant.

Whilst we have found the criticisms in the commentaries of the Review on η and δ to be less than convincing, we must recognise that no discussion of the appropriateness of particular value judgements can be decisive. We should consider a range and different people will focus their attention on different parts of the range. Thus we have provided some sensitivity analysis in the postscript published with the Review (pp649-671) and in the accompanying papers. In our view the ethical arguments for considering higher values of η seem stronger than those for higher values δ . But those who would argue for higher values of η cannot have it both ways. In many practical circumstances they should be arguing for much higher social

transfers than we currently see (as follows from the Atkinson-Brandolini discussion above).

B7 Values, discounting and “revealed ethics”

We distinguished at the outset the “prescriptive” and “descriptive” approaches to narrowing the range of value judgements for inter-temporal analysis. We have focussed on the “prescriptive”, although we have occasionally brought in empirical evidence to help inform judgements on what an ethical observer might see as an appropriate decision. But let us take on directly the question of whether it could ever be reasonable to think that markets could reveal social values for use in discounting benefits into the far future. Our response is a clear ‘no’. We cannot and should not avoid taking on directly the basic ethical discussion. Market observations will not solve the problem for us.

Cameron Hepburn (2007) has recently provided a very thoughtful discussion of these issues and we restate some of his arguments. Some of these issues are discussed in Chapter 2 of the review and its appendix – see e.g. p59 First, Hepburn notes the standard problems of market imperfection which distort market valuations from social valuations or market prices from shadow prices. Drèze and Stern (1997 & 1990) provide a detailed and formal analysis of relations between market imperfections, shadow prices and market prices in a general equilibrium framework.

Second, Hepburn examines directly the challenge of moving from market behaviour to ethical values. He raises five important problems. There is some overlap but they raise distinct issues.

First, individuals in allocating over time take account of their individual prospects. Their pure time discount rate will take account of their own probability of demise. That could be quite high and very different from that of society.

Second, future markets exist only over a few decades. They do not cover the very long periods, i.e. centuries, relevant for the discussion of climate change.

Third, the individual decision does not reflect an answer to the question of what citizens of a society should do when considering together what they would regard as the right or responsible action. Thus, for example, an individual would be influenced

in his or her decision, if there was confidence that, after discussion and political interaction, citizens would together follow a decided route.

Fourth, future generations are not directly represented in current discussions but they are the ones most profoundly affected by climate change.

Fifth,¹⁰ there is a whole host of problems around the link between individual and collective preferences, on the one hand, and what is the right thing to do, on the other. For example, our preferences are probably influenced by past evolutionary effects which are of limited relevance to a very different future. And we can ask whether, there are moral standards of responsibility to the environment and future generations which transcend individual or collective preferences? While the Review adopts a utilitarian perspective as the basis for the modelling in Chapter 6, Chapter 2 makes clear that there are a variety of other relevant ethical perspectives, many of which have considerable normative appeal.

Many of the issues raise very difficult philosophical questions, versions of which have challenged philosophers across the ages. They are not marginal to the great inter-generational issues of climate change. There is no alternative to engaging in this discussion. We cannot suppose that markets will ever fully reveal the answers.

B8 Concluding comments

- Aggregation of all effects into one model is not necessary for a reasoned judgement of whether the costs of taking action on climate change justify the benefits of damages avoided.
- Ethics are central to policy towards climate change: we cannot avoid the discussion.
- We cannot expect market observations to provide the answers to the relevant long-run ethical questions.
- There will always be room for differences of view on ethical questions.
- In terms of specific parameters the Review used in aggregated models, here η and δ , many of the arguments used by commentators are not convincing. In

¹⁰ To Hepburn's list we might add that markets are unlikely to capture the issues associated with non-marginal and irreversible change at the global level.

particular, the arguments for pure-time discounting are weak. And most of the arguments concerning 'inconsistencies' are unconvincing.

- Since there is always room for differences on ethical issues, a range of values¹¹ for η and δ was provided in the postscript to the Review and further ranges are provided in the accompanying papers.
- The result (see the accompanying papers) that the costs of strong action to reduce greenhouse gas are much less than the damages avoided is robust to variation across a broad range of ethical values.
- Very high (i.e. greater than 1%) pure time discount rates would not generally give this conclusion. However, that falls under the heading of the “blindingly obvious” – if you do not care about the long-term future, simply because it is in the future, you will not care about climate change. There is little that science or economics could ever do to convince you otherwise.
- There are ethical arguments for considering higher values of η than unity i.e. stronger preferences for redistribution that may be convincing to some.
- However, if that view is adopted consistency implies strong conclusions for intra-generated re-distributional policies¹² i.e. greater redistribution within given societies than many appear to accept. With a broader ethical perspective, this would include redistribution towards currently poor countries.
- Societies round the world should embark on a serious and sustained discussion of the ethical issues of policy towards climate change.

¹¹ Somewhat surprisingly a number of commentators have not taken proper account of this sensitivity analysis and the robustness that it demonstrates concerns key conclusions of the Review.

¹² Some of the 'happiness literature' emphasises the importance of relative income in examining intra-generational issues.

References

Atkinson, T., and A. Brandolini (2006): 'Talk to Mirrlees 70th birthday seminar' July 2006 and forthcoming.

Dasgupta, P. (2006): 'Comments on the Stern Review's Economics of Climate Change' (prepared for a seminar on the Stern Review's Economics of Climate Change organised by the Foundation for Science and Technology at the Royal Society, London on November 8, 2006).

DeLong, B. (2007):
http://delong.typepad.com/sdj/2006/11/partha_dasguptu.html#comments

Drèze, J., and N. Stern (1987): 'The Theory of Cost-Benefit Analysis', Handbook of Public Economics Volume 2, ed., in Auerbach A.J., and M. Feldstein, Amsterdam: North-Holland .

Drèze, J., and N. Stern (1990): 'Policy reform, shadow prices, and market prices', Journal of Public Economics, **42**(1): 1-45.

Gollier, C. (2006): 'Institute Outlook: Climate Change and Insurance: An Evaluation of The Stern Report On The Economics Of Climate Change', Cambridge, MA: Barbon Institute.

Harsanyi, J. C. (1977): 'Rational behavior and bargaining equilibrium in games and social situations', Cambridge: Cambridge University Press.

Hepburn, C. (2007): 'Valuing the far-off future: discounting and its alternatives', in Atkinson, G., Dietz, S. and Neumayer, E. (eds) Handbook of Sustainable Development, chapter 7.

Hepburn, C. (2006): 'Regulation by Prices, Quantities or Both: A Review of Instrument Choice. Oxford Review of Economic Policy **22**(2).

Hoel, M. and T. Sterner (2006), 'Discounting and relative prices in assessing future environmental damages', Working papers in economics / Department of Economics, Göteborg University, Feb 2006.

Malinvaud, E. (1953): 'Capital Accumulation and Efficient Allocation of Resources.' Econometrica, Vol. 21, 233-273.

Newbery, D. (2006): 'Extract from chapter Calculating the social cost of Carbon', Cambridge: University of Cambridge.

Nordhaus, W. (2006): 'The Stern Review on the Economics of Climate Change' – comment, University of Yale.

Quiggin (2006/2007): <http://johnquiggin.com/index.php/archives/2006/12/09/the-equity-premium-and-the-stern-review/>

Pearce, D.W., and A.Ulph (1999): 'A Social discount rate for the United Kingdom' Economics and the Environment: Essays in Ecological Economics and Sustainable Development, D.W. Pearce, Cheltenham: Edward Elgar.

Ramsey, F.P. (1928): 'A mathematical Theory of Saving', *Economics Journal*, **38** (December):543-559

Rawls, J. (1971): 'A Theory of Justice' Oxford: Oxford University Press.

Sen, A. (1997): *On Economic Inequality*. (2nd Edition with Foster, J. et al).
Oxford: Clarendon Press

Stern, N. (1977): 'The Marginal valuation of income', in Artis, M. and R. Nobay (eds.), *studies in Modern Economic analysis*, Oxford: Blackwell.

Appendix

Changing relative price of 'standard' goods and environmental goods

We might expect the price of the environment to increase relative to consumption or capital goods, due to increasing scarcity of environmental assets. If this is not correctly captured in cost-benefit analysis, then a lower discount rate would be a partial substitute. However, this is not conceptually elegant. The appropriate approach is given in Malinvaud (1953) and Drèze and Stern (1987 & 1990). If the environmental good or asset is numeraire the discount rate might be negative, see the Stern Review pp 57 & 5A more sophisticated argument is advanced by Hoel and Sterner (2006), who note that factoring in the change in relative prices of environmental goods should affect the general discount rate for the whole economy. They examine a two sector economy, so that the applicable discount rate is a function of the growth rate in both sectors, the relative value share of the environmental sector and the elasticity of substitution between sectors.

Measurement of output growth to take account of distribution

$$W = \sum_i u(c_i)$$

$$\dot{W} = \sum_i u'(c_i) \dot{c}_i$$

$$= \sum_i c_i^{1-\eta} \left(\frac{\dot{c}_i}{c_i} \right) \quad \text{where } u(c) = \frac{c^{1-\eta}}{1-\eta}$$

$\eta = 0$, we weight proportional growth rates by consumption

$\eta = 1$, by population – if many c_i 's are the same just add across population

$\eta = 2$, we weight by the inverse of consumption.