Clive L. Spash (2002) Greenhouse Economics: Value and Ethics. London: Routledge pp.184-200

7 Loading the dice?

Values, opinions and ethics

Economists and natural scientists often seem to perceive their role as filling an information vacuum. Yet the process of learning requires restricting the focus of understanding and accepting limitations. That is, partial ignorance is part of the methodology, but the hope is that central issues will be included in any analysis rather than excluded by assumption. A fundamental method of trying to prevent such exclusion of relevant alternatives is peer review. In this chapter examples of disputes over the calculation of costs and benefits are used to reflect upon the content and character of the academic debate. The tension in this debate has already been touched upon.

The parameters of the debate are set by the economic model. Thus, Nordhaus (1991b: 936) states:

> The efficient degree of control of GHGs would be essentially zero in the case of high costs, low damages, and high discounting; by contrast, in the case of no discounting, and high damages, the efficient degree of control is one-third of GHG emissions.

In this framework the key issues of economic concern are valuing costs and benefits and deciding upon the appropriate discount rate.

There is a clear desire to produce calculations which can be regarded as 'rigorous', 'scientific' and 'objective' while still maintaining relevance to a subject which is complex, uncertain, politically charged and raises numerous moral questions. Rather than becoming too immersed in technical debates over fine points of models and mathematical calculations, the aim in this chapter is to draw out some of the (often implicit) judgements lying behind apparently objective scientific choices. In doing so the debates over discounting and the value of life are used to exemplify underlying value conflicts. The relevance of strong uncertainty is then explored in the context of the numbers being produced by economists as estimates of the damages due to the enhanced Greenhouse Effect.

Inconsistency and disputed values

A typical practice when facing complex value issues is to note the many possible critiques and drawbacks of work in the area while then going on to employ a methodology which denies the relevance of those same critiques. This may be accompanied by a statement of faith in future research somehow resolving the difficulties. Thus, for example, Fankhauser (1995) raises many of the problems discussed in the last chapter while going on to produce damage estimates he regards as 'fairly robust' (p. 56). Similarly, different authors raise concerns over the results of others but then draw comfort from the proximity of those same results to their own. There is then a tendency to seek validity by comparing results, although the basis for doing so is doubtful. These inconsistencies in research seem to indicate an underlying tension over fundamental values. Purely from the statements made by various authors, their predisposition to certain world views can be discerned.

Perhaps the clearest expression of the underlying conflict and uncertainty over the expression of values can be seen in the exchanges between Nordhaus and Cline. The statements of Nordhaus in response to Cline's work show the antithesis of value commitments. In reply to Cline's critique of the agricultural damage estimates given by Mendelsohn and Nordhaus (1996: 1,315) the authors refer to Cline's own work as unlikely 'gloomy prognostications'. Nordhaus (1994: 57–8) states that Cline's 'extensions outside the marketed sectors are extremely tenuous', that he is 'over-estimating the impacts', relying on 'ambiguous' information and is giving 'a generally pessimistic cast'. This despite the fact that the estimates are then noted to be 'only marginally above those used here at the low end' and actually 'marginally lower' for 5°C or more.

In his own earlier work Nordhaus (1991a: 148) was clear about reliance upon hunches, and on that basis alone was prepared to increase his final results fourfold to account for the 'unmeasured and unquantifiable factors'. Yet the adjustment of net damage estimates upwards is regarded as something of a bias in other studies. In this regard, Nordhaus (1994: 59) believes that the problem with 'many studies of climate change is that people look for problems and ignore opportunities; it is as if there exists an unconscious impulse to find costs and ignore benefits of climate change'. He gives examples of benefits as being leisure activities such as camping (Nordhaus, 1994: 57), space heating, construction, and agriculture (Nordhaus, 1991b: 932). Potential savings from a warmer climate are recognised by Cline (1992b: 55) with regard to non-electric heating. However, he is more sceptical of net gains elsewhere and, for example, notes that the impacts on construction may be either net costs or net benefits. As discussed in chapter 3, where there appear to be benefits they are usually offset by costs, adaptation is costly, the possibility of net benefits seems transitory, and those who benefit are different from those that lose.

There is a very different view of the future between these authors and their expectations as to the impact of global climate change on future generations. For Nordhaus the impact of global warming is apparently expected to be of minor importance compared to other changes and he dismisses long-term implications as follows:

> Simply put, humans live, move, and die faster than climatic impacts are likely to be noticed. This point can be seen by asking what the effect today would be if one's grandparents or great-grandparents had contemplated a warmer globe. Many of them would have given the prospect a loud hurrah.
>
> (Nordhaus, 1994: 59)

Interestingly he goes on to question the sense of talking about future health impacts. He asks rhetorically: 'Can one sensibly talk about health effects when we don't even know what the next century's major health problems will be or what the population distribution will look like?'

The concern here may have arisen because he neglected health impacts while others have pointed out their size and potential importance. Cline estimated them at about 10 per cent of total damages. Fankhauser is cited by Nordhaus (1994: table 4.3) as attributing just under 50 per cent of damages to 'health and amenity' (although Fankhauser's published work gives less weight). The derision in the above quote with regard to health impacts is interesting given the speculative character of all CBA estimates. The difference between projecting future health impacts and predicting carbon taxes, various damages and control costs for a hundred years is hard to fathom. Nordhaus happily recommends that future generations respond to disasters by accumulating capital in 'normal times', and states that his 'DICE model is well designed to examine the appropriate degree of consumption smoothing' and can specify consumption losses and utility functions for different generations (Nordhaus, 1994: 173). In fact, a change of position seems to have occurred four years later when potential health impacts became one of the seven areas included in the calculated damages of his models, and is then stated to be 'one of the major concerns about global warming' (Nordhaus, 1998: 8). Estimates there are given for health impacts from a 2.5°C warming with a breakdown by regions of the globe. The next two sections take a closer look at the debates over how to treat the future and the valuation of mortality and morbidity.

Addressing the future

Many regard the key variable for considering the future to be the discount rate. Cline is described as employing an empirical estimate because it 'fits neatly into his philosophical stance'. 'Hence, from both empirical and theoretical points of view, Cline's argument for the extraordinarily low discount rate is unsupported and

unrealistic' (Nordhaus, 1994: 133). This rate is based upon the rate of growth of per capita income and in the order of 2 per cent per annum (Cline, 1992a: 5). In the DICE model the rate settles at 3 per cent. Elsewhere, Nordhaus has employed discounting scenarios at 0 and 1 per cent above the growth rate (e.g. see Nordhaus, 1991a; 1991b; 1992). In fact, Nordhaus (1991b: 926) explains his own use of these rates 'that are very low (either 0 or 1 per cent per year) to reflect the possibility that the future equilibrium will come in a low- or no-growth economy with a low rate of time preference'. His (preferred) middle level of damages in that study were given for a discount rate 1 per cent above a growth rate which, as stated, may be 0, i.e. a 1 per cent discount rate is then required. Price (1994: table 2) notes the lowest discount rate used by Nordhaus as 0.25 per cent.

The real dispute appears to be over the way in which these discount rates are justified. Cline (1992a: 74) follows the argument, used by many, that a discount rate which includes pure myopia should be rejected due to the impact on future generations, and he cites work by both E.J. Mishan and Amartya Sen (Nobel Laureate in Economics). Nordhaus rejects the argument on the basis that such philosophy should be kept out of economic analysis, or in his own words:

> While this argument may be compelling to ethicists from a philosophical point of view, it is completely unrealistic from an economic point of view because it ignores the difficulties of imposing a discount rate that does not correspond to market pricing … What if a philosopher argues that it is unethical and indefensible to pay royalties to rich people or oil companies? Does that imply that we should use $2 per barrel in our cost–benefit calculations for energy policy though it will cost us ten times that to buy oil? If we consider all the ramifications of this issue, we quickly see that if we decide to override market prices because of ethical objections, this raises countless paradoxes and contradictions.
>
> (Nordhaus, 1994: 132)

Despite the poor wording in the last sentence the message is clear, i.e. ethics and philosophy have no place in economics. This tension between two fundamentally different approaches to economics is apparent in the IPCC SAR when addressing discounting. Here the argument is stated to be a 'conflict' between a descriptive approach from mainstream economics and the prescriptive approach of authors such as Cline (one of the chapter's co-authors). The case of the defenders of the mainstream neo-classical position is that:

> The alternative – over-riding market prices on ethical grounds – opens the door to irreconcilable inconsistencies. If ethical arguments, rather than the revealed preferences of citizens, form the rationale for a low discount rate cannot ethical arguments be applied to other questions?
>
> (Arrow *et al.*, 1996)

As should be clear, the ethical questions fail to disappear just because a market price and economic analysis are substituted for ethical debate and public discourse. Economists are, no more than moral philosophers, in a position to dictate policy in this area or resolve the paradoxes and contradictions, and, as will be explored in the next chapter, ethics is inseparable from the subject. The contradiction is that economics takes a very specific philosophical and ethical position and then, as above, tries to deny the relevance of ethics in economics. The conflict of values remains despite the attempts to remove their explicit discussion from the economic debate.

The value of human life

Studies in economic valuation of environmental impacts have over many years developed various measures for placing a value on life or, more precisely, the risk of death (for an early contribution see Jones-Lee, 1976). Pollution can lead to premature death (mortality) and impacts on health (morbidity). Thus economic studies try to associate a monetary amount with life and health in order to assess the optimal level of resources to be diverted to preventing morbidity and mortality. For example, the willingness to pay to avoid illness is calculated from a contingent valuation survey to estimate the level of air pollution control in an urban area (e.g. see Dubourg and Rodriguez, 2001). Such results are used in transportation assessment to decide upon road building programmes and the installation of safety equipment.

There are two main methods for assessing the risk of death or value of a statistical life. First, an individual may be directly asked their willingness to pay to avoid a risk or their willingness to accept compensation for incurring a risk. Contingent valuation surveys have been most commonly applied in this area but have also been severely criticised in this specific context (Jones-Lee and Loomes, 1997). Contingent valuation also remains more generally controversial (see Spash, 1998). There is in addition an on-going debate concerning the divergence between willingness to pay and willingness to accept and which is the appropriate measure of a welfare change. Willingness to accept, which is normally larger, is the theoretically correct measure when damages are imposed on individuals, although a US expert panel has ruled that willingness to pay should be used as a 'conservative' measure (for a discussion see Knetsch, 1994). The other main alternative for valuing a statistical life is to use measures related to earnings. This approach might, for example, use actual wage differentials in jobs with a range of risks.

As shown earlier, the estimates of mortality and morbidity could swamp other values if the hunch of those such as Tol is correct. Thus, if a CBA approach is being employed, analysts will find themselves either trying to include all values in monetary terms, or stating that a category is impacted but is impossible to value in monetary terms. The obvious problem with the latter route is that the validity of the resulting numbers is brought into question and they then have a doubtful meaning, e.g. stating

that GDP loss is 2 per cent but that there is an additional unknown amount to add. Economists using environment CBA have therefore often given a monetary value to loss of life, preferring to have what is regarded as an 'uncertain' positive number rather than nothing in their calculations. They often express the belief that this is necessary because the institutions of government will otherwise neglect these aspects of the decision, which suggests the actual problem lies in the institutional structure, but the tendency is also to avoid questioning the institutional context that deeply.

The result is the philosophy of valuing everything in monetary terms even if individuals refuse to make such trade-offs. In transport policy the public rejection of this monetary approach is exposed when there is a train crash, people are killed and the public discover that the lack of safety equipment is due to the calculation that providing it cost more than expected fatalities times the value of a statistical life. Politicians rarely defend the numbers in such circumstances, although their transport departments may continue to use them on a daily basis.

The GHG control literature has also employed estimates of mortality and morbidity. Cline (1992b: 44–5) briefly reviews some of the options. He calculates the value lost in the US from an increased number of deaths under a doubling of CO_2 at $595,000 per person on the basis of lifetime wages. That is, he takes the lifetime earnings as reflecting the amount society is willing to pay the individual and therefore a reflection of their social worth. He also explains the value could be much greater using a value for a statistical life on the basis of the relationship between wages and the risk of death by occupation and industry. The range might then be $2–$6 million per person. Contingent valuation studies that ask workers how much they would be willing to accept in order to take on more dangerous work result in values between $2–$3 million. Lower estimates arise from actual behaviour with regard to hazard avoidance.

Fankhauser (1995: 47) also includes an estimate for mortality and in doing so states the need to elaborate because this is 'a potentially controversial issue'. He cites estimates from willingness-to-pay studies in the range from $0.2–$16.0 million with an average of $3 million, and then adopts $1.5 million for developed countries, although the basis for the choice of the final estimate seems rather unclear. He goes on to note this estimate is dependent upon various contextual factors, including income. While no adjustment is made for most of these contextual factors, one is made for income to give 'an arbitrary value of $300,000 for middle-income and $100,000 for low-income countries'. The outcome is carefully qualified with emphasis as follows:

> This of course does *not* mean that the life of, say, a Chinese is worth less than that of a European. It merely reflects the fact that the *willingness to pay* for increased safety (a lower mortality risk) is higher in developed countries.
>
> (Fankhauser, 1995: 47)

As has been remarked earlier, this work informed chapter 6 on economic benefits under the SAR by the IPCC. The result of using this arbitrary differential of a factor of 15 between high- and low-income countries was to create considerable controversy.

The storm that raged over the numbers presented in the IPCC chapter can be judged by various letters and short editorial pieces which appeared in journals such as *Nature* (Bruce, 1995; Masood, 1995; Masood and Ochert, 1995; Meyer, 1995b) and *New Scientist* (Meyer, 1995a; Pearce, 1995a; Pearce, 1995b). Representatives from industrially developing nations, led by India and China, refused to accept the report due to the differential weighting given to the value of a statistical life (Masood, 1995). The Indian Environment Minister, Kamal Nath, wrote to other heads of delegations at the first meeting of the Conference of the Parties rejecting:

> … the absurd and discriminatory Global Cost/Benefit Analysis procedures propounded by economists in the work of IPCC WG-III … we unequivocally reject the theory that the monetary value of people's lives around the world is different because the value imputed should be proportional to the disparate income levels of potential victims … it is impossible for us to accept that which is not ethically justifiable, technically accurate or politically conducive to the interests of poor people as well as the global common good.
>
> (Quoted in Grubb, Vrolijk and Brack, 1999: 306)

Nath called for industrially developing countries to veto all discussions under the Framework Convention on Climate Change until the offending calculations were removed from the process (Pearce, 1995b).

A short news item in *Nature* on the issue expressed the common interpretation of the numbers in the report as reflecting a case for little or no action because costs outweighed benefits (Masood, 1995). The Secretary to the IPCC, Narasimhan Sundaraman, wrote in response, objecting to their interpretation of his views on valuing life, and the co-chair of Working Group III, James Bruce, did likewise to explain where he regarded their coverage as erroneous (Bruce, 1995; Sundaraman, 1995). A month later a much fuller piece appeared (with cartoon) explaining how the Working Group III report might appear without the offending chapter 6 (Masood and Ochert, 1995). The politically negotiated policymakers summary for Working Group III proposed to make statements rejecting the basis of the calculations and the authors demanded a right of reply which the IPCC rules did not allow. Critics of chapter 6 were raising questions over the claim that the IPCC report could be an objective scientific document. Shortly afterwards, a letter petitioning removal of the chapter signed by about 40 scientists and academics, including some IPCC lead authors and one from Working Group III, was published in *Nature* (Meyer, 1995b).

IPCC procedures require that the Summary for Policymakers is approved by country representatives and the text therefore needs to be politically negotiated.

Government-nominated experts from Brazil, China, Cuba, India, Colombia and the Alliance of Small Island States, amongst others, objected to the Policymakers' Summary of the work. The result of the dispute was for the Summary to diverge from the underlying chapter. The preface to the report states that during negotiations 'some of the draft text recommended by the Working Group III Bureau was deleted' and that where disagreement persisted differing views are presented. The disclaimer continues: 'Although the country representatives of the Working Group accept the underlying technical report, it is not reviewed in detail and its contents remain the responsibility of the lead authors'. The policymakers summary then states that monetary valuation should avoid obscuring the consequences of climate change and that 'the value of life has meaning beyond monetary considerations' (p. 10).

There were suggestions that a willingness-to-accept approach would produce higher values and should have been used for the calculations (Meyer, 1995a). Certainly a willingness-to-accept measure would be the theoretically correct one to use in this case. However, this would seem unlikely to address the differential issue or the ethical concerns underlying the use of monetary valuation in this context. Respondents might be expected to protest against the valuation method where rights or justice are involved in the decision being considered, or their monetary valuations may be inherently based upon ethical motives. Contingent valuation has also proven unable to address refusals to make trade-offs on ethical grounds in other environmental policy areas which many would regard as less controversial (Spash, 2000b; Spash, 2000a).

Fankhauser, Tol and Pearce (1997) have attempted to explain their position and show how welfare economics provides their calculations with 'consistency and rigour'. In essence they argue that ethical issues are partially separable from those which concern the derivation of the benefits of GHG control.

> Much of the confusion seems to have arisen from the fusion of the two separate issues: the valuation of environmental damages at an individual level, which is a matter of empirical analysis, and the comparison and aggregation of these effects, which is a political process involving ethical judgements on, among other things, the socially desirable distribution of income.
>
> (Fankhauser, Tol and Pearce, 1997: 250)

Their defence is then that distributional concerns should be kept separate from GHG abatement policy and dealt with as an independent policy issue (a point also made in Fankhauser and Tol, 1999). This approach is clear in chapter 6 which, following the same approach as found in the IPCC chapter on discounting, separates valuation of a statistical life into 'descriptive' and 'prescriptive'; the authors claim they perform only empirical investigation under the former approach while the latter would mean employing moral judgement.

Strong uncertainty revisited

The main approach to addressing uncertainty over information content remains scientific peer review and the IPCC has placed much faith in this process (Houghton, 1997: 157–60). This process runs into difficulty because of the pervasive ignorance associated with global environmental problems (Dovers and Handmer, 1995). In order to control for complexity, boundaries are drawn around knowledge and peer review aims for a consensus as if there were an underlying truth to be discovered. Peer review can then become self-reinforcing and the boundaries of partial ignorance heavily defended. Thus, for example, Demeritt and Rothman (1999: 390) question the credibility of the work in chapter 6 of the IPCC Working Group III SAR because the lead authors review and present their own work – in particular, the PhD work of Fankhauser and Tol, whose respective supervisors, Pearce and Villenga, are also lead authors. More generally the economic perspective throughout the report can be seen as suffering from social and disciplinary insularity, which prevents critical thought about the boundaries drawn and taboos of the discipline.

When explaining how the IPCC handles uncertainty, via the peer review process and negotiated policymakers summaries, John Houghton, Co-Chair of Working Group I, totally ignores the entire episode concerning the value of life (Houghton, 1997: 157–60). This may be because moral value conflicts are generally regarded as unscientific. Interestingly, as mentioned previously, Houghton has raised the personal importance of his own religious beliefs as a motive for research into environmental problems, while defending an ability to dissociate these values from scientific research. Similarly, many economists claim that economic values and scientific research are separable from the moral and ethical dimensions of the problems they study. However, whether discounting or valuing damages, ethical and distributional issues are central to discussing the enhanced Greenhouse Effect. That there are contested social values and multiple perspectives on these issues means the boundaries drawn around research agendas are central points of debate and concern.

The dispute over values for loss of life described above is a clear sign of the partial ignorance and indeterminacy involved in this problem. There is general agreement that the issues being discussed here are highly uncertain but there is a general failure to adequately address that uncertainty. For example, uncertainty over future damages is meant to be addressed by insurance markets, although how they should operate in the absence of knowledge of the potential impacts is unclear (as noted in Bruce, Hoesung and Haites, 1996: 15). Distribution is meant to be politically decided, although the time and geographical scale of potential damages and gains mean distribution is the defining problem for economic analysis. An economic assessment of the enhanced Greenhouse Effect which ignores the impact of income, costs and benefit distribution on the analysis would appear to have withdrawn from the realm of relevance.

The desire to refute strong uncertainty has lead to excessive faith in the numbers being produced from economic assessments. That these numbers produce rankings

Table 7.1 Author weighting of impacts in CBA studies of GHG control for the US

	Nordhaus 1991b (%)	*Cline 1992* (%)	*Cline 1992* (%)	*Nordhaus 1994* (%)	*Fankhauser 1995* (%)	*Tol 1995*[g] (%)	*Nordhaus 1998* (%)	*Max*
Losses avoided[a]								
Agriculture	6	28	28	12	12	13	8	28
Forest loss	0	5	2	0	1	0	0	5
Species/ecosystem loss	0	6	5	0	12	7	0	12
Sea level rise	72	11	10	21	13	11	15	72
Energy consumption	22	19	20	4	11	0	0	22
Human morbidity/ mortality	0	9	10	0	16	51	3	51
Migration	0	1	1	0	1	1	0	1
Hurricanes	0	1	2	0	0	0	0	2
Leisure	0	3	1	0	0	16	0	16
Water supply	0	11	16	0	22	0	0	22
Urban infrastructure	0	0	0	0	0	0	14[e]	14[e]
Tropospheric ozone	0	6	6	0	10	0	0	10
Miscellaneous[d]	0	0	0	63	0	0	60	63
Total[c]	100	100	100	100	100	100	100	
Gains missed[b]								
Agriculture	0	0	0	0	0	0	0	
Energy consumption	–16	–2	–1	0	0	0	0	
Outdoor recreation	0	0	0	0	0	0	–38	
Temperature rise °C	3.0	2.5	10.0	3.0	2.5	2.5	2.5	
by year	by 2050	by 2025	by 2280	by 2050	by 2100	by 2100	by 2100	
Measurement basis	$1,000 m	$1,000 m	$1,000 m	$1,000 m	$1,000 m	$1,000 m	GDP	
Net GDP loss %	0.25[f]	1.10	6.00	1.00	1.30	1.50	0.45[f]	
Base year	1981	1990	1990	1981	1988	1988	1995	

Data sources: Nordhaus (1991b) table 6; Cline (1992) table 5; Nordhaus (1994) table 4.1; Fankhauser (1995) table 3.15; Tol (1995) table A1; Nordhaus (1998) table 10.

Notes: a All figures rounded hence some small positive values of some studies appear as zero, e.g. hurricanes.
b Calculated as a percentage of total loss avoided.
c May not add to 100 due to rounding errors.
d Categories of 'other' and in the Nordhaus 1998 a loosely defined WTP for avoiding 'catastrophic impact'.
e Nordhaus includes biodiversity and ecosystem loss.
f Significant gains reduce net GDP reported but actual damages still occur with losers differing from gainers.
g Includes Canada, also note summation error in original corrected in these calculations.

of countries in a certain order of net GDP losses, or all fall within a few per cent of GDP, is little sign of robustness or validity. For example, consider the assessments conducted for the US, which is the most studied country. Table 7.1 shows the main assessments by categories of loss and gain. Concentration on net GDP losses ignores the wide variety of weightings being given to different categories of impacts. Thus, water supply impacts vary from zero weighting to 22 per cent of damages avoided, outdoor recreation and leisure forms 16 per cent of damages avoided or a 38 per

cent gain missed. Variation across studies by the same individual are also notable. Within these categories a range of other assumptions hide along with distributional impacts. For example, the ski industry is expected to suffer severely so the designation of large net gains masks this economic disruption and social change.

When calculations are then transferred to global studies there should be no surprise that similar inconsistencies arise, as shown in table 7.2. Loss of life here accounts for anything from 52 per cent of damages to nothing. Categories of gain appear to be a personal preference of the analysts as are the appearance or otherwise of catastrophic events. Given enough thought the categories of gains forgone might easily be shown to outweigh the losses, and while ignoring both uncertainty and distribution the lobbyist might then claim the enhanced Greenhouse Effect is good for world economic growth.

As Nordhaus (1994: 56) repeatedly informs us: 'It should be noted, again, that, because of infirmities in the underlying estimates of damage, these projections are subject to large margins of error'. In producing parameters for the DICE model a 'precautionary guess' is used to set the magnitude of surprise events (Nordhaus, 1994: 53). While the relative size of the guess categories appear large in this work the general approach is typical of how the estimates are obtained. Other researchers have been unable to obtain the data or calculations upon which Nordhaus has based these numbers and therefore they suffer irreproducibility (Demeritt and Rothman, 1999: 394).

Cline also uses a great deal of guess work and speculation in deriving his numbers, although he at least provides the details of his calculations. For example, species loss is valued by multiplying the opportunity cost estimates for forest land used to preserve the spotted owl by 25. Nordhaus (1994: 58) has criticised this on the grounds of using the spotted owl case which he regards as having been very costly. On reading Cline's reasoning behind this calculation (1992b: 36–7), some more fundamental questions are why he chose a factor of 25, what does 'measured in some intrinsic sense' mean, and on what basis are these 'conservative' estimates? Fankhauser (1995: 34) very loosely bases his own species loss estimates on some highly context-specific mean willingness to pay numbers from contingent valuation surveys on a few species and derives another highly speculative figure. Willingness to accept is the theoretically correct measure and the original studies (e.g. paying for a hunting licence in Wyoming) bear no relationship to the current question. Numbers are in fact being transferred without regard to their original content or meaning and final net estimates produced regardless.

Once numbers are produced they begin to take on their own importance regardless of any lack of rigour or meaning; they begin to grow legs. For example, the estimates of the cost of resettling environmental refugees produced by Cline (1992b: 46–7) are based upon the $3,000 per capita US local government spending on public services in 1989. He assumes this cost will only be incurred for 18 months as the refugees will by then have jobs and be taxpayers (i.e. $1.5 \times 3{,}000 = 4{,}500$). On the

Table 7.2 Author weighting of benefits in CBA studies of GHG control at the world level

	Nordhaus 1991b US/World	*Ayres and Walters 1991 World*	*Nordhaus 1994 DICE World*	*Fankhauser 1995 World*	*Tol 1995*[g] *World*	*Nordhaus 1998 RICE World*	
	%	%	%	%	%	%	*Max*
Losses avoided[a]							
Agriculture	6	0	20	15	17	7	23
Forest loss	0	0	0	1	0	0	1
Species/ ecosystem loss	0	0	0	15	6	0	15
Sea level rise	72	95[h]	23	17	11	18	95
Energy consumption	22	0	3	9	0	0	22
Human morbidity/ mortality	0	0	0	18	52	6	52
Migration	0	5	0	2	4	0	5
Hurricanes	0	0	0	1	1	0	1
Leisure	0	0	0	0	11	0	11
Water supply	0	0	0	17	0	0	17
Urban infrastructure	0	0	0	0	0	9[e]	9[e]
Tropospheric ozone	0	0	0	6	0	0	6
Miscellaneous[d]	0	0	53	0	0	60	60
Total[c]	100	100	100	100	100	100	
Gains missed[b]							
Agriculture	0	0	0	0	–13	0	
Energy consumption	–16	0	0	0	0	0	
Outdoor recreation	0	0	0	0	0	–16	
Temperature rise °C	3.0	3.0	3.0	2.5	2.5	2.5	
Measurement basis	$1,000 m	$1,000 m	GDP	$1,000 m	$1,000 m	GDP	
Net GDP loss %	0.25[f]	2.25[h]	1.34	1.40	1.90[f]	1.50[f]	
Base year	1981	1981	1988	1988	1988	1995	

Data sources: Nordhaus (1991b) table 6; Ayres (1991: 245); Nordhaus (1994) table 4.2; Fankhauser (1995) table 3.15; Tol (1995) table A1; Nordhaus (1998) table 10.

Notes: a All figures rounded hence small positive values of some studies appear as zero, e.g. hurricanes.
b Calculated as a percentage of total loss avoided.
c May not add to 100 due to rounding errors.
d Categories of 'other' and in the Nordhaus 1998 a loosely defined WTP for avoiding 'catastrophic impact'.
e Nordhaus includes biodiversity and ecosystem loss.
f Significant gains reduce net GDP reported but actual damages still occur with losers differing from gainers.
g Numerous summation errors exist in Tol and all figures were recalculated, the largest error being for morbidity/mortality given as $88 instead of $188 thousand million.
h Central estimate calculated and used here.

basis of current immigration figures he plucks 100,000 new immigrants from the air as the climate induced impact for the US. Fankhauser (1995) uses both figures, although the former is called a 'guesstimate' and the latter unconvincing. He claims the Cline dollar value is matched by that of Ayres and Walters by an alternative method which he however also notes to be unconvincing. In fact Ayres and Walters (1991: 245) mention resettlements for 1988 having cost the US $4,000 per person on the basis of a report in the *Economist*, which would be costs in additions to those of Cline. They also recommend adding to this an amount for lost output, which depends upon job and country, but which they decide as $500/yr for two years based upon 1981 income levels and use this number in their calculations for all countries. On the basis of these researchers the cost of an environmental refugee to the US around 1988 should include resettlement ($4,000), plus infrastructure costs ($4,000/unemployed year), plus loss of earnings (>$500/unemployed year, the figure requiring inflation adjustment from 1981 to 1988). Fankhauser (1995: 50–1) takes $4,500 as the OECD country cost and $1,000 as that for the rest of the world, and using Cline's 'guesstimate' of migration now applied worldwide gets 2.7 million refugees and produces a table of costs totalling $4.3 thousand million.

As if the circulation of dubious figures through economic assessments were not enough, the next layer of their use is by non-economists. For example, Houghton (1997: 134), Co-Chair of the IPCC scientific assessment group, states 'the cost of resettling 3 million displaced person [sic] per year has been estimated at between $1,000 and $5,000 per person, giving a total of about $4 thousand million per year' and cites the source; as Adger and Fankhauser (1993). Unfortunately, Houghton has referenced the wrong source; Adger and Fankhauser only give the aggregate costs of Fankhauser's work referenced therein and no per capita estimates or refugee numbers. Thus, guessed at original numbers, once in the literature, seem to achieve independent validity, passing from one source to the next and soon losing all contact with their original context or factual basis.

Economic analysis of the enhanced Greenhouse Effect shows how value judgements are presented as apparently precise and rigorous scientific numbers often with two and sometimes three decimal places being specified. Funtowicz and Ravetz (1994) have conducted a careful examination of such work using the example of Nordhaus (1991b) to show how such precision is unjustified and the numbers are swamped by the uncertainties reflected in adjustment factors based on the authors' beliefs. As they note:

> By the time that the author has admitted the manifold oversimplifications and uncertainties in his analysis, and has shown how strong are the ad hoc adjustments and hunches which are needed to bring his numbers back into the realm of plausibility, we might ask whether the statistical exercises are totally redundant except for rhetorical purposes.
>
> (Funtowicz and Ravetz, 1994: 201)

Conclusions

This and the previous chapter show how economic assessments of the enhanced Greenhouse Effect fail to address environmental and social complexity. Specific problems are the treatment of uncertainty in the estimation of benefits and cost, the value of morbidity and mortality, the distribution of costs and benefits, the moral standing of future generations and the very size of the problem (there is a point at which marginal welfare analysis loses its theoretical basis). There are many areas of uncertainty, for example, concerning regional impacts of climate change, how people and natural systems will adapt, and the character of the world's economies in the distant future. There are the standard problems of valuing non-market effects such as the displacement of wildlife, the human misery of environmental refugees and loss of life. These are areas which pose moral and political questions. Another challenge, which has received little attention, is how to treat long-term damages incurred by future generations who will suffer damages but may themselves contribute little in terms of GHG emissions.

Implicitly the regard given to future generations plays an important role in the value placed upon climate change projections, because future generations are expected to suffer the worst consequences and delaying action is largely justified by this intergenerational 'externality'. Current models tend to perpetuate the myth that the consequences of our actions will be felt by those on the other side of the world and living in the distant future and then encourage discounting any concerns. Externalising the harm created by individual actions can be viewed as having led to the dramatic potential damages faced by the world under the enhanced Greenhouse Effect. Economic analysts depending upon modern welfare economics are in the uncomfortable position of justifying any actions if society or individuals can potentially (but not actually) transfer resources to those harmed, i.e. the benefits could potentially compensate for the losses. The rising popularity of global climate change as a matter for economists to consider will either force these matters into the debate or show how strong the dominant approach to economic assessment remains by relegating them to the sidelines.

The idea that economists (or scientists) cannot, do not or should not make moral judgements in these cases is clearly false. The fact that they do so implicitly and these moral judgements may be regarded as objectionable when exposed explains much of the aggression and emotion in the debate over valuation, as exemplified here with regard to the valuation of life. The pretence persists that ethical issues can be meaningfully separated from economic analysis of the enhanced Greenhouse Effect, and that such analysis can then be performed in seclusion.

In regard to benefit assessment, the IPCC SAR of Working Group III states that:

> The level of sophistication of climate change damage analysis is comparatively low. Damage estimates are generally tentative and based on several simplifying

> and often controversial assumptions … This low level of sophistication implies that climate change damage analysis is a particularly worthwhile area for further research.
>
> (Pearce *et al*., 1996: 184)

Fankhauser and Tol (1999) have argued that the CBA studies in the 1990s were at fault largely because they were the first generation of such attempts. They suggest that the 'second generation' of models will be more sophisticated and offer superior results. While there is certainly much room for improvement the fundamental issues will remain regardless of how sophisticated the modelling.

Perhaps the meaning of 'sophisticated' modelling is worth considering. The idea that models and estimates may become more sophisticated is meant to instill faith in estimates and be a sign of scientific rigour. The roots of this word lie in the characterisation of the Greek sophists as those who were prepared to enter into debate on any matter using whatever arguments no matter how unsound. Sophistry is a method of argument that is seemingly plausible though actually invalid and misleading, using an argument known to be false to persuade. Thus, we may worry that future analysis of the enhanced Greenhouse Effect using economic models may indeed prove to be more sophisticated.

The methodology of economic investigation is failing. From a sceptical point of view the models can be seen as hiding as much as they reveal, and their growing technical jargon and detail as creating more layers of protection from casual scrutiny. The honesty of early work is self-evident because 'ad hoc' and 'hunch' estimates were actually called just that, although the guess numbers then were taken to possess far more meaning than this implied. More recently the same guess categories seem to have shifted into more technically correct language such as 'vulnerable markets' or 'willingness to pay for avoiding the risk of a catastrophic impact'. Similarly, the treatment of uncertainty in the next generation of models remains firmly within the school of converting strong uncertainty (unknowns) into weak uncertainty (probabilities). Much emphasis is placed upon applying various probability distribution functions and obtaining subjective probabilities. Credence is then given to the surveying of 'experts' as to their beliefs and these 'data' are used as key coefficients of the models.

As Fankhauser (1993: 23) has stated: 'Although there appears to be a strong tendency in the results to favour more moderate action, it seems similarly true that through the choice of appropriate parameter values almost any abatement policy can be justified'. His solution is to call for more research which should in particular focus upon the slope of the benefit function and threshold effects. However, contrary to other defenders of mainstream economic logic he recognises the need for interdisciplinary thought on the subject and the specific importance of philosophy: 'On the economic side questions of discounting and intergenerational equity in general will have to receive more prominence than they did so far, and this will naturally also

include other disciplines such as philosophy'. In the next two chapters some of these philosophical issues are explored with regard to the treatment of future generations.

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