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Double CO_2 and beyond: benefits, costs and compensation

Clive L. Spash

Department of Economics, University of Stirling, Stirling, FK9 4LA, UK

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Abstract

Economic decisions over what action, if any, to take concerning the greenhouse effect tend to revolve around the social discount rate. Implicitly the debate concerns how to attribute intertemporal weights to welfare and implies a moral stance that is rarely given explicit recognition. Refocusing on the outcomes of current actions emphasises the role of "compensation". A conflict is apparent between the view that the current generation need be unconcerned over the loss or injury caused to future generations because they will benefit from advances in technology, investments in both man-made and natural capital, and direct bequests; and the requirement to avoid harming the innocent. Changes in units of welfare cannot be viewed as equivalent regardless of their direction. In general, doing harm is not cancelled out by doing good. The result is a rejection of the potential compensation principle which underlies the current economic stance, and a reconsideration of the acceptability of "compensation" altogether. The concept of human rights and a non-utilitarian perspective are used to show how cost–benefit analysis denies the existence of inalienable rights, and economics limits the moral considerability of harm.

Key words: Carbon dioxide; Cost–benefit analysis; Greenhouse effect

1. Introduction

During the expansion of literature on global warming over the last five years, little attention has been paid to the implications of going beyond a doubling of CO_2-equivalent. Part of the reason has been the expense and time needed to run global circulation models (GCMs). While concentrating on the double CO_2-equivalent scenario aids comparisons across GCMs, a myopic view has also been encouraged. As a CO_2-equivalent has been estimated to occur by 2028 under a business as usual scenario (DOE, 1991), this suggests a time horizon of around 35 years. Such a short-term view is familiar to economists who invoke discount rates of 10% and calculate net present values. However, the implications of acting in this way are extremely serious for future generations and the results imply a particularly undesirable moral stance.

In this paper the long-term picture of global climate change is painted concentrating on intertemporal impacts. This shows how the greenhouse effect can be regarded as the creation of an intergenerational externality which results in the asymmetry of costs and benefits – the imposition of costs and risks on the unborn. Inaction on the part of the current generation then becomes acceptable if "suitable" discount rates are chosen. That is, concern over the well-being of future

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individuals is inadequately expressed under the cost–benefit approach to global warming (as exemplified by Ayres and Walter, 1991; Nordhaus, 1991a,b). However, the discount rate alone is only a symptom of the deeper problem of realising the boundaries of utilitarianism. The arguments for ignoring responsibilities for the future effects of global warming are shown to reveal a fundamental flaw in economic reasoning. Harm cannot be treated in the same way as good, and the deliberate imposition of harm on the defenceless contrasts with the morality of modern democracies. As a result, the use of compensation as a justification for taking actions that create harm is brought into question.

2. Intertemporal impacts of global warming

Mean global temperature has in the past been much warmer than at present; 1°C higher during the Holocene climatic optimum (5000 to 6000 years ago), 2°C higher during the last interglacial warming (125 000 years ago), and 3°C to 4°C higher during the Pliocene (3 to 4 million years ago) (MacDonald, 1988). However, over the last 10 000 years, from the Holocene to the Little Ice Age, the mean temperature of the northern hemisphere varied by no more than about 2°C (Gates, 1983). The earth's mean surface temperature has increased between 0.5°C and 0.7°C since 1860 (Abrahamson, 1989, p. 10), coinciding with the increased combustion of fossil fuels due to industrialisation. The evidence from more than 100 independent studies gives estimates of average global warming within the 1.5°C to 4.5°C range for a double CO_2-equivalent scenario (Jamieson, 1988).

An average global warming of 0.5°C is expected to produce net benefits in terms of heating, agriculture, and water use (d'Arge, 1975). Research suggests that Great Lakes fish may benefit with walleye yields in Lake Michigan increasing 29–33%, although trout may simultaneously decrease by 2–6% (Mlot, 1989). Idso (1983) maintains that increased levels of atmospheric CO_2 will increase future well-being via crop fertilization. The projected yield increases range from 16% for corn, to 60% for cotton under a CO_2 doubling (Seneft, 1990). In the past an argument has been put forward in favour of deliberately increasing mean global temperature to reap the benefits of delayed glaciation and increased agricultural range (Callendar, 1938, p. 236). More recently a similar line of reasoning can be found in Crosson (1989) where the costs of stopping warming are to be weighed against the potential loss from doing so too soon.

As temperature continues to increase, such gains are likely to diminish and costs rise. The positive CO_2-fertilization effect will only prove beneficial while CO_2 remains a dominant gas in climate forcing. As other gases become relatively more important, yields will fall while negative impacts of global warming increase. Agriculture and, particularly, forestry are more susceptible to serious declines if climate change occurs rapidly. For example, in North America each 1°C rise in temperature translates into a range shift of about 100 to 150 km (Roberts, 1989). The rate of northward dispersal of trees due to historical warming, shown by fossil records, is 10 to 45 km a century, with spruce the fastest at 200 km. Abrahamson (1989) estimates, given current gas emissions, global warming is proceeding at between 0.15°C and 0.5°C per decade. That is, greenhouse-induced range shift is 150–750 km per century, which is 3.75 times faster than the fastest trees are capable of migrating. No thorough analysis of adaptive capacity has yet been conducted for the agricultural sector (Parry, 1990).

Costs will also escalate as the ability to adapt is restricted by the absolute size and increasing *rate* of sea level rise. Studies suggest the rate of change of sea level will be relatively small in the first quarter of the next century compared to the last quarter, and this is true for a variety of underlying emissions scenarios (Titus, 1989). The absolute rise is estimated at between two-thirds of a meter to over three and a half meters by 2100 (Thomas, 1986; Titus, 1989). Cost estimates for protecting against a one meter rise include $4.4 billion for the Netherlands (Goemans, 1986); up to $100 billion for the east coast of the United States (Jaeger, 1989); and the loss of around one-tenth of the land area in both Bangladesh

and Egypt, resulting in the dislocation of over 16 million people (Broadus et al., 1986). Meanwhile, other expectations are that low-lying islands, such as the Maldives, would disappear completely.

There is, as Crosson (1989) has noted, no reason to believe global warming will stop at double CO_2-equivalent. The lifetime of CO_2 in the atmosphere, biosphere, and upper ocean combined is approximately 500 years (Wuebbles et al., 1989). Emissions of greenhouse gases prior to 1985 have already committed the earth to a warming of 0.9°C to 2.4°C, of which about 0.5°C has been experienced. The warming yet to be experienced is unrealized warming, 0.3°C to 1.9°C, and is unavoidable (Ciborowski, 1989). Emissions of the principal greenhouse gases are increasing at rates between 0.3 and 5% per year (Wuebbles et al., 1989). Within 50 years we are likely to create an irreversible increase of 1.5°C to 5°C, and in the 40 years following that a further 1.5°C to 5°C increase (Ciborowski, 1989). As Cline (1991) reports, a six-fold increase in CO_2 has been estimated by 2250 and an eight-fold increase by 2275 associated with central estimates of 7.5°C and 10°C respectively. Beyond this point ocean uptake is hoped to be our saviour with CO_2 levelling out at 3.5 times preindustrial levels in 750 years time (assuming the system is not chaotic). The implication is of continually rising temperatures and associated damages for at least the next 250 years, followed by 500 years of stabilization.

While the results of perturbing the global system in this way are highly uncertain, a fairly optimistic view would appear to show that the current generation is benefiting although others may suffer. Even net gains from slight warming would lead to disruption and economic losses to some, e.g., via changes in trade. There are many uncertain impacts, for example, increased pest and weed problems (Daily et al., 1991). The picture given above abstracts from the intratemporal issues (for an overview, see d'Arge and Spash, 1991), but does so in order to adopt the standard approach of aggregating generations found in economics, e.g, assuming generations are equivalent to individuals (Norgaard and Howarth, 1991). The important point as far as the following sections are concerned is that we today are consciously creating an array of future damages.

3. Discounting future generations

The standard application of cost–benefit analysis to the greenhouse effect, even if all costs and benefits could be calculated, would give the impression that the future is almost valueless. As Nordhaus (1991b, p. 936) has stated,

> 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 close to one-third of GHG emissions.

The distribution of net costs in the future and net benefits now makes the emission of greenhouse gases appear falsely attractive. The process of discounting the future, at almost any positive rate, creates insignificant present values for even catastrophic losses in the further future (d'Arge et al., 1982). A 10% discount rate results in benefits and costs occurring in 50 years time to be weighted at less than 1%. [1] That is, future values asymptotically tend to zero relatively quickly.

The acceptance of discounting as the proper approach to intertemporal distribution requires an unavoidable moral judgement (Page, 1977). Thus strong supporters of discounting must consider how employing this tool can violate the rights of future generations. Justifications for discriminating against future generations have been discussed in the literature (for a review, see Spash, 1993), but are quite different from those given in economics. Economists assume the rationale for discounting is that individuals express a positive time preference and that capital is productive (Pearce, 1983). That is, both consumers, via a

[1] Quirk and Terasawa (1991) have recently argued in favour of a government discount rate of 10% or more. Recognising the potential for discrimination against future generations, they suggest compensation for any costs imposed to be achieved by "investment set-asides".

positive rate of time preference, and producers, via the social opportunity cost of capital, are observed to treat the future as less important than the present. [2] The debate on discounting has concentrated upon the appropriate rate to choose and differences between private and social time preferences as if the question were in some sense "objective". Rarely are any obligations we may violate by adopting the procedure of discounting discussed.

The main implication of discounting is to choose the weight given to the welfare of members of a community on the basis of their temporal position. The question then becomes, how do we aggregate individual views? Including future generations in decision making could be considered to widen the concept of democratic voting in an unacceptable way, providing a justification for ignoring their welfare. That is, those who are alive today constitute the proper electorate and the government's social welfare function should reflect only the preferences of present individuals (Marglin, 1963). An altruistic counter argument recognises that individuals identify with a community extending over time. In this way future generations gain a voice in the decision making process and an implicit vote (Boulding, 1966). The concept of a vote for all generations might be considered from the perspective of the original position behind a veil of ignorance as advanced by Rawls (1971). That is, what rules of justice would you wish to adopt if your identity is unknown, i.e., you might be any individual living at any time. The choice of a discount rate can then be seen as the acceptance or rejection of certain rights for future individuals, and the use of cost–benefit analysis as determining how we discharge our obligations when employing that rate.

Norton (1982) has contended that the current generation is at best weakly obligated to future generations because the individuals concerned are only potential beings and contingent upon previous events. Under this line of reasoning, individuals cannot claim they have been harmed by global warming as long as they are contented to live because they would have been non-existent without global warming, i.e., their lives are contingent upon the events that created global warming. Howarth (1992) has put forward the counter argument that obligations to maintain welfare exist via a duty to one's children, and this then sets up a chain of obligations from generation to generation. More generally, we can recognise certain actions will harm future persons despite indeterminacy concerning their identities and our ignorance of their special needs (Baier, 1984). Whoever exists can reasonably be expected to have the same biological needs as those now existing. Thus obligations might be maintained on the basis of basic human rights. In this way, the consideration of the consequences of our actions for future generations implies concern for the harm caused and not merely the aggregate level of benefits addressed by the debate over which discount rate is the "right" one.

4. Equity and injury

There is a persistent view that the current generation should be unconcerned over the loss or injury caused to future generations because they will benefit from advances in technology, investments in both man-made and natural capital, and direct bequests. Adams (1989, p. 1274) has raised this exact issue in terms of alleviating our responsibilities for global warming. While fossil fuel combustion implies foregone opportunities for future generations, they "typically benefit (in the form of higher material standards of living) from current investments in technology, capital stocks, and other infrastructure."

If society has, in fact, been undertaking investments with the express purpose of compensating future generations for global warming, the lack of publicity has been conspicuous by its absence. More seriously, this would imply that if the future is better off, the extent to which it is better off has in some sense been balanced against *all* the long-term environmental problems. That is, soci-

[2] Some behaviour suggests societies have held negative rates, e.g., the Russians under Stalin, and that individuals do hold such marginal rates of time preference. See Loewenstein and Thaler (1989).

ety cannot take global warming and see the future as better off, and then ignore global warming and take ozone depletion as compensated, and then ignore ozone and balance nuclear waste against supposed future well-being. A society which is concerned that future generations be compensated for damages imposed upon them must take each case into account.

Compensation has also been suggested as recompense for non-renewable resource depletion, e.g., Hartwick (1977). If all things remain unchanged while non-renewable resources are depleted, the future will have fewer options. That is, for a given technology and capital stock output will be lower and environmental degradation higher. Thus compensation, via improved technology and increased capital investment, has been suggested (Barry, 1983). Compensation in this context concerns the maintenance of a basic opportunity set and is, therefore, properly regarded as welfare distribution. However, there is no particular reason to limit compensation for damages to criteria being used to determine distributional transfers. The appropriate reference point when considering compensation for injury is the level of damages caused to an individual. The reference point for distributional transfers is the welfare level, difference in welfare, or opportunity set of others.

Reducing the stocks of non-renewable resources affects future generations in a different manner from the creation of long-term environmental damages. The concern in the case of resource depletion is for the maintenance of a basic standard of living. The concern in the case of environmental damages is for reparations for the violation of the right to remain unharmed. Those holding the view that the future is typically better off due to our actions imply that the goal of development has been to achieve ever increasing standards of living. Thus there has been an intention to improve welfare over time. Compensating individuals for the loss and harm they are to suffer has nothing to do with this undertaking.

Two distinct types of transfer across generations are, therefore, relevant in the context of global warming. First, there is a set of basic distributional transfers which will be defined by the ethical rule used in a society. Different ethical rules have been applied by environmental economists (Schulze et al., 1981; d'Arge et al., 1982; Kneese and Schulze, 1985). The Pareto Criterion is the rule commonly employed by economists. This rule states that society should undertake actions that allow at least one person to be made better off and none worse off. A common alternative is the egalitarian rule where actions are undertaken to improve the welfare of those who are worst off. Basic transfers may be considered as achieving the ethically required basic welfare or living standard which such rules imply. That is, actions are undertaken to ensure the rule is met for a society defined into the future. This category of transfers would then be concerned with concepts such as the "compensation" for non-renewables, opportunity maintenance, and the inadequacy of the Hartwick rule.

Second, there are compensatory transfers, which are made because injury or loss is inflicted upon a later generation by the actions of the current generation, such as the combustion of fossil fuels. The distinct nature of such compensatory transfers has been neglected. This has been partly because they are assumed to be identical to basic transfers, and partly due to the principle of "potential compensation". The argument put forward is that, if the current greenhouse gas emitters could compensate the future climate change losers, continued emissions would be an improvement regardless of whether compensation is actually paid. If compensation were undertaken, the principle merely reverts to the Pareto Criterion.

This leads to an interesting paradox. According to Freeman (1986) the Pareto Criterion is neither widely accepted by economists nor plays any role in mainstream environmental economics. Yet the basis of cost–benefit analysis is the potential compensation principle which Freeman believes "...is justified on ethical grounds by observing that if the gains outweigh the losses, it would be possible for the gainers to compensate fully the losers with money payments and still themselves be better off with the policy." Thus, the results of cost–benefit analysis are justified if they are potential Pareto improvements, but Pareto improvements themselves are rejected.

In this way, use is made of the potential compensation principle to deny compensation. The other reason for invoking the principle is to separate efficiency and equity. Discussions of actual compensation have been avoided on grounds that equity issues are outside of the economist's realm. The failure to distinguish compensation for injury from basic transfers can be seen as a symptom of focusing on the one normative concept of efficiency.

The greenhouse effect as characterised earlier creates an asymmetric distribution of losses and gains over time. Intergenerational compensation would counterbalance the negative outcomes of global warming by positive transfers while not interfering with basic transfers. For example, assuming egalitarianism, the maintenance of the same welfare level fails to compensate for global warming. If aggregate welfare were the only concern, then spreading the costs of global warming equitably across generations would be an equally acceptable solution, as suggested by Crosson (1989).

The stumbling block here is in recognising that compensation for injury is a separate moral issue from the concern over distribution. Government transfer payments to the poor cannot be taken as allowing the government to inflict injury on the poor while claiming the transfers as compensation. Similarly, receiving unemployment benefits is unconnected to a claim for damages when the government is responsible for negligence which, for example, paralyses an unemployed individual.

5. Limits to compensation for global warming

The extent to which compensating future generations for damages is acceptable is smaller than might be suggested by economists who view changes in units of welfare as equivalent regardless of their direction. [3] The standard approach of economists can be traced at least as far back as Bentham (1843, p. 438):

> ...To the individual in question, an evil is reparable, and exactly repaired, when after having sustained the evil and received the compensation, it would be a matter of indifference whether to receive the like evil, coupled with the like compensation, or not.

Unfortunately, this approach treats harm as reversible by good. In general, doing harm is not cancelled out by doing good. If an individual pays to have a road straightened and saves two lives a year, they cannot shoot one motorist a year and simply calculate an improvement (Barry, 1983). This argument is most apparent where the right to life is involved, but can be extended to other areas where rights are accepted to exist. For example, assume individuals of a nation are accepted to have a right to live in their own homeland. Sea level rise due to global warming floods the Maldives and violates this right. Of course the Maldavians can be relocated and compensated, but this approach is unacceptable given the previously stated right.

The objection free-market economists might raise to the imposition of such rights is that freely contracting parties are prevented from entering into agreements of their own free will. As Bentham went on to point out:

> What is manifest is --- that to no person, other than the individual himself, can it be known whether, in this instance, between an evil sustained, and a benefit received on account of it, any compensation have place or not.

That is, the individual is their own best judge of welfare changes. If the Maldavians believe they are better off in their new homeland, then who is to deny the acceptability of this exchange. The difficulty in the intergenerational context is that

[3] Standard objective functions in economics make the relative merits of social states depend upon the welfare characteristics of those states. Intergenerational efficiency allows for the violation of human rights because any two states generating the same welfare values must be treated in exactly the same way. Even if a future generation is richer, enjoys a higher welfare level, and the marginal utility from a consumption loss is greater for the present generation than its marginal welfare gain, intergenerational transfers may be required to avoid uncompensated effects of pollution (Sen, 1982).

the individuals who will be impacted are unavailable for comment. In order to protect these individuals from unjustified harm, rights could be used so that what appeared to be a problem for the use of rights can be viewed as an argument in their favour. In fact, this approach would define harm as a violation of the rights adopted by society.

The appeal to the "safe minimum standard" can be viewed as an example of constraining economic trade-offs by introducing rights. This standard advocates the protection of species, habitats, and ecosystems unless the costs of doing so are "unacceptably large". In the case of global warming Batie and Shugart (1989) argue that the safe minimum standard would support emission reductions despite apparently high costs. However, the withdrawal of the right of, say, a species to exist at some cost implies a basis of the right within utilitarian morality. This view contrasts with rights in the context of a deontological philosophy. [4]

More generally, the economic process of exchange can be viewed as the transfer of goods and services within a framework of established rights. In this case rights are only valid in as far as the institutional setting allows them to exist. This position was expounded by Bentham (for a more recent argument along these lines, see Bromley, 1991). Yet the question being probed here is one of the existence of a right of future generations in the sense of a natural right, not merely the recognition by a piece of legislation in a particular society at a particular time that such a right is valid. A natural right can be defined as a right based upon intrinsic value (for a comprehensive discussion of natural rights, see Nash, 1989).

There are many instances where intrinsic human values are recognised by "free-market economies" and such rights are protected from violation by contractual agreement. Examples of these rights include the right to freedom of speech, to freedom from torture, to sue another party, and to be free from slavery. Freely contracting children are protected from working in coal mines despite the potential economic gains. These rights are maintained despite the fact that there are those who would accept the loss of their rights given enough money, or societies in which these rights are denied.

The question is, given that they will exist, do future generations have inalienable rights? The UN charter of human rights represents an internationally accepted set of goals to which the world aspires. The fact that these rights are violated does not reduce their importance. Yet within these rules there is little comfort for future generations. A generous reading would only protect the future indirectly under articles intended to protect the current generation. Public concern is starting to be expressed regarding this oversight and this has reached the extent of a global petition to the United Nations (Cousteau Society, 1991).

If rights that protect future individuals from the results of our greenhouse gas emissions are accepted to exist, the scope for trade-offs commonly assumed in economics will be drastically reduced. Compensation payments are no longer licences for society to pollute, provided the damages created are less than the amount of compensation. In which case compensation cannot be used to excuse the continuation of greenhouse gas emissions. Irreversible damages which will occur regardless of greenhouse gas emissions reductions would require compensation. In order to protect the future from potential infringements upon this right, actions with uncertain intertemporal consequences would have to be avoided and environmentally benign production and consumption processes encouraged.

6. Conclusions

Stopping the build up of greenhouse gas emissions in the stratosphere is complicated by the delay in transportation. That is, in the event that

[4] Deontology sees certain features in a moral act itself as having intrinsic value, e.g., lying is wrong regardless of the consequences. Teleological systems see the ultimate criterion of morality in some non-moral value that results from actions. See Pojman (1989). Economists operate with a teleological outlook, disregarding individuals who hold deontological beliefs, e.g., protest voting in contingent valuation studies.

anthropogenic greenhouse gas emissions were halted today, stratospheric concentrations would continue to increase for over one hundred years. For example, in the case of chlorofluorocarbons total emissions in the world would have to be reduced by approximately 85% immediately in order to stabilize the concentration of CFC12 immediately (Hoffman, 1986). Due to the cost of enforcing the rights of future generations to remain unharmed, the current generation has a vested interest in denying those rights. Continuing to emit greenhouse gases at current rates denies the future the right to remain undamaged and asserts the dominance of the current generation. The current generation is then being asked to change the present rights structure, as found within society, in a manner detrimental to its own interest. The dictatorship of the current generation allows the imposition of damages regardless of the gain now and the extent of future damages. Yet the abolition of slavery is an example of just such a change within society.

The economists' appeal to cost–benefit analysis attempts to take losses and gains of controlling harmful activities directly into account. In doing so the rights of future generations are violated when the costs of controlling the greenhouse effect are deemed to exceed the benefits of that control. The use of cost–benefit analysis, therefore, denies the existence of inalienable rights. Reliance upon the potential compensation principle prevents compensation while the welfare of a subgroup of individuals is reduced. Even the Pareto Criterion allows harm to be inflicted, but at least this harm must then be compensated for by resource reallocation. That is, harm and good are seen as equivalent. However, harm is recognisably different from good and the deliberate infliction of harm is morally objectionable, as recognised in modern democracies. If remaining unharmed is defined as a set of rights given to future individuals, actual compensation is required if these rights are violated. If at all possible, these rights should not be violated and people should be freed from actions that deliberately externalise the risk of damages by imposing it upon others. This can be viewed as a stricter definition of the Pareto Criterion, preventing harm rather than allowing harm and actual compensation.

The task of defining harms will be difficult, but as suggested earlier the UN charter of human rights provides guidance. A further difficulty arises from the uncertainty as to when an action might result in the violation of such rights. In terms of the greenhouse effect there is a strong case for believing numerous contraventions of these basic rights will occur. The point here is to emphasise a fundamental basis for human action in morality.

The slippery slope of externalising the harm created by our actions can be viewed as having led us to the dramatic risks of damages faced by the world under global warming. Whether this issue materialises in the devastating form some predict or not, the moral implications go to the heart of the modern industrial society. Immoral actions can be justified if society or individuals can potentially (but not actually) transfer resources to those harmed. Of course, hopefully the consequences of such actions will be felt by those on the other side of the world and living in the distant future so even the potential need for such considerations can be discounted. Restricting the current global warming debate to a double CO_2-equivalent world is endemic of how closed our minds are to the potential results of our actions.

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