EQUAL MEASURES AND FAIR BURDENS: NEGOTIATING ENVIRONMENTAL TREATIES IN AN UNEQUAL WORLD

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93-03 **MAY 1993**

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This paper may be cited as: Edward A. Parson and Richard J. Zeckhauser, "Equal measures and Fair Burdens: negotiating environmental treaties in an unequal world." CSIA Discussion Paper 93-03, Kennedy School, of Government, Harvard University, May 1993.

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1. Introduction

In negotiations of the Framework Convention on Climate Change, concluded in May 1992 and signed in June at Rio's "Earth Summit", the most contentious issue was whether the treaty would include "targets and timetables", quantitative limits on national emissions of carbon dioxide (CO_2).[2] This dispute represented a substantial departure from most recent experience in environmental negotiations, where discussions have routinely focused on allocating quantitative national limits on polluting activities. In the climate negotiations most industrial nations, led by the European Community, argued that CO_2 targets and timetables are a necessary first step to a more comprehensive and flexible set of obligations. The United States opposed targets and timetables on three grounds: that they are premature, given present scientific knowledge of climate change; that early enactment of narrow CO_2 targets would bind nations to costly measures that might be hard to reverse even if later found to be unnecessary; and that such targets would obstruct negotiation of a comprehensive long-term management system.[3] The treaty could be signed in Rio because a last-minute compromise characterized national emission goals in highly

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[2] Carbon dioxide (CO_2) emitted from fossil-fuel combustion and land-use change is the largest anthropogenic contribution to climate change, representing about half the total radiative forcing. Other major contributions include methane, nitrous oxide, chlorofluorocarbons and related chemicals, and troposphere ozone.

[3] Detailed summaries of the negotiations are available in ECO, a daily newsletter published electronically be journalists and environmental organizations observing the negotiating sessions, and available electronically on the electronic bulletin-board service Econet.

ambiguous language, allowing disputing governments to assert both that the treaty did, and did not, represent a commitment to specific CO_2 targets.[4]

After Rio, the debate over targets and timetables continued. At a December 1992 meeting in Geneva, some environmental groups and governments argued that parties should begin negotiations immediately on a "CO_2 Protocol" under the Convention, whose core would be CO_2 targets and timetables.[5]

In this essay we are concerned with the negotiation of national emission targets, and other forms of quantitative national obligations. Who will do or give how much, and how will they decide? Other contributions to this volume focus on institutional questions of monitoring, verification, compliance, enforcement, capacity-building, research, and training that precede or accompany the negotiation of control obligations. While acknowledging that these measures are of key importance in achieving and sustaining effective international agreements, we contend that the negotiation, assessment, and comparison of quantitative measures of national performance - emission targets or equivalent measures - will remain the central problem in negotiations on climate, indeed on any multilateral environmental issue.

In examining these measures we have a particular focus: the symmetry of obligations, and of interests. We argue that most multilateral environmental treaties

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[4]The text of the Framework Convention is available as United Nations document A/AC.237/18 (Part II)/Add.1,15 May, 1992. In addition to the ambiguous language on emission targets, the Treaty contains extensive institutional measures. It requires nations to prepare consistent inventories of national emissions, develop and repost on national plans to limit emissions, and support and coordinate relevant research. The treaty creates a Secretariat and two subsidiary bodies, one to support implementation of the treaty and one to bring relevant new scientific information into future negotiations.

[5] International Environment Reporter; Curtis et al (1993)

impose *symmetric* obligations on all signatory nations; they require all signatories to do "the same thing", in a sense that we make more precise in the next section. But in most cases, the nations joining a treaty are highly *asymmetric* in their interests on the environmental issue being negotiated - how strongly they want to improve it, and how much it costs them to make any particular level of contribution to the effort. While treaties with simple, symmetric obligations have important negotiating advantages, symmetric deals among asymmetric parties can create both serious inefficiencies and inequities. For environmental issues with high stakes, such as climate change, comprehensive agreements based on simple, symmetric distribution of obligations may be impossible to negotiate. In the concluding sections of the paper we examine the functions that symmetry performs in promoting negotiated agreement. On that basis, we develop some preliminary suggestions of other approaches to multilateral environmental negotiation that may provide these functions while more flexibly admitting the disparate interests of asymmetric parties.

Much of our argument is based on a rather abstract, stylized treatment of international environmental issues, their costs, and measures for their mitigation. We treat international environmental protection as a problem of *public good* provision among unitary nations, and environmental negotiations as negotiations over what level of the public good is to be provided, and by whom. Each nation negotiating is assumed to have a well-defined overall national interest. Each prefers that *global* contributions to the environmental problem be reduced, but each prefers that the bulk of the reduction be done by others.

2. Symmetric Obligations in International Treaties

Most international environmental treaties impose symmetric obligations on all parties; they require all nations signing to do the same thing. That "same thing" may take several forms. It may involve establishing common administrative procedures to regulate some activity. The Basel Convention on Transboundary Movement of Hazardous Wastes, for example, requires that national authorities only permit the export of such wastes under certain circumstances and after the importing State has given written notice of its consent to the shipment.[6] Alternatively, treaties may impose common technical standards in some activity, such as loading and ballasting procedures in oil shipping,[7] or ban some activity entirely, such as hunting blue whales or importing ivory.

The most significant recent environmental treaties, though, have imposed quantitative national limits on specified emissions or other forms of environmentally damaging activity. In these treaties, the "same thing" normally means equal percentage emission reductions from a fixed-year baseline, effective for all countries in the same year. Table 1 below shows several examples, from recent treaties and major proposals and declarations.

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[6] Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal, Article 4.

[7] Mitchell (1993).

TABLE 1.

SYMMETRICAL OBLIGATIONS IN SELECTED ENVIRONMENTAL TREATIES AND DECLARATIONS

Treaty	Date	Countries Bound	Measures
Montreal Protocol on the Ozone Layer	1987	92	Cut CFCs 50% from 1986 levels; Freeze Halons at 1986 levels.
London Amendments	1990	20	Eliminate CFCs, Halons, Carbon Tetrachloride by 2000, Methyl Chloroform by 2005.
Copenhagen Amendments	1992	(74 signed, not yet in force)	Advance phaseout dates to 1996 (CFCs, MC, CT) and 1994 (Halons); Freeze HCFCs and Methyl Bromide at 1991 levels.
Convention on Long-Range Transboundary Air Pollution			
Sulfur Protocol	1985	20	Cut Sulfur emissions by 30%
NOx Protocol	1988	23	Freeze NOx at 1987 levels
"NOx Club"	1988	12	Cut NOx emissions by 30%
VOC Protocol	1991	21	Cut emissions of all Volatile Organic Compounds by 30%[8]
North Sea (Third Ministerial Conference)	1990	8	50% cuts in 37 chemicals; 70% cuts in dioxin, Hg, Cd, Pb
Baltic Sea (Ministerial Conference)	1988	6	50% cuts in nutrients, heavy metals, organic toxins, by 1995.
Toronto Declaration	1988	(non-binding declaration)	20% CO_2 cuts by industrial countries

[8] The VOC Convention was slightly more flexible than this suggests. While most countries advocated 30% cuts on all emissions, a few sought to limit those cuts to regions contributing to trans-boundary cuts, and a few were only willing to accept *a freeze*. The treaty language permitted signatories to select which of these three sets of obligations they were committing to. Three nations chose a freeze (Bulgaria, Greece, Hungary); Two chose 30% cuts in specified regions contributing to trans-border fluxes (Canada and Norway); the remaining 15 chose overall 30% cuts.

In those cases where treaty obligations do not treat all participants identically, the differences tend to be of a highly constrained kind. For example, the 1987 Montreal Protocol imposed a schedule of phased CFC reductions leading to 50% cuts in 1999 for the industrial countries, while developing countries were to meet each reduction target 10 years later. This "10-year grace period" for developing countries has been retained in both subsequent amendments of the Treaty, such that the requirement is now for industrial countries to eliminate CFCs in 1996, and developing countries in 2006.

Among multilateral environmental treaties, there is but one striking counter-example to the tendency toward symmetric obligations: the European Community's Large Combustion Plant Directive. This agreement specifies national limits on sulfur and nitrogen emissions that range from 70 per cent reductions in Germany, France, Netherlands, and Belgium, through various smaller reductions in Denmark, Luxembourg, UK, Italy, and Spain, to *increases* in Greece, Ireland, and Portugal.[9]

3. Asymmetries of Interest: origins and consequences [10]

The prevalence of symmetric measures in environmental treaties is puzzling, because the nations participating are often highly asymmetric in their relevant interests. Nations can differ both in the benefits they derive from the environment being

[9] Commission of the European Communities (1988), Annex 1 and 2.

[10] Parson and Zeckhauser (1993) provide a more formal development of the consequences of bargaining among agents with asymmetric interests, using simple two-agent and ten-agent models.

improved, and in the costs they incur from undertaking measures themselves to improve it.[11] This section first considers the kinds of differences among nations that yield such variations in costs and benefits for a particular environmental good, and their consequences for symmetric environmental agreements.

One nation might value an environmental good more highly than another for several reasons. The first nation's citizens might be wealthier, giving a higher valuation of environmental goods except in the unlikely case of inferior environmental goods.[12] It might be more vulnerable to the consequences of this particular form of environmental harm. For example, its soil might be more easily acidified; its coastal regions more extensive and low-lying, hence more sensitive to sea level rise; its economy more dependent on the environmental resource; or its people more sensitive to related health harms. It might be larger or more populous, and so subsume within its borders a larger fraction of global damage. Alternatively, its citizens or political groups may simply care more about the environment and so be willing to pay more to protect it, perhaps for historical or cultural reasons. These differences may change over time, and may be endogenously determined. People may learn to value a good environment by having one, and may learn to value many kinds of environmental quality, including those not directly observable, by having certain

[11] While this section argues in terms of one nation's benefits or costs being simply higher or lower than another's, each nation's benefits and costs are of course functions of the level of provision of the environmental good and of their own contribution.

[12] Higher values for environmental harm are most likely to be positively correlated with wealth if the harm manifests principally as health risk or loss of consumption. If the dominant effect is loss of productivity, though, the relationship to wealth will depend on relative effects on marginal productivities of different factors of production.

observable kinds. Alternatively, people may grow to accept lower environmental quality by having to endure it.

One nation might also find it more costly than another to restrain its activities contributing to a particular form of environmental harm. Its economy may be more dependent on a particular harmful activity in aggregate, or may have more limited opportunities to substitute away from it at low cost. This difference may reflect different structures of capital stock, natural resource endowments, or levels of technological development.

The transmission of harm between countries is asymmetric for some environmental issues, when one country's emissions blow or flow principally into another country. Downstream riparian states receive pollution from upstream states but not vice versa, while downwind states import more air pollution from their upwind neighbors than they export to them. This form of asymmetry does not arise for global-scale environmental issues such as climate change and ozone depletion, but can dominate negotiations over such regional issues as acid deposition, smog, and international river pollution.

Finally, the *means available* to control an environmental harm may impose asymmetries even if the harm itself is borne symmetrically. For example, if the way chosen to reduce emissions is to create property rights in the emissions, then those granted the rights may appropriate the rents that in another regime would have gone to other, former, or potential emitters. If property rights are originally undefined, as is typical for pollution, then any particular way of defining them is likely to represent

a transfer relative to the status quo. Examples include the historical fencing of medieval commons, and the parallel modern demarcation of ocean fisheries into exclusive economic zones.[13] Contemporary discussions over the use of tradable emissions permits to solve environmental problems, both domestically and internationally, thus focus on the problem of how to define an acceptable distribution of the property rights so created.[14]

These forms of asymmetric interests are based on our simple model of a well-defined national interest yielding national cost and benefit functions for the international environmental issue. A more realistic political description of state interests could yield further sources of asymmetric interests. Since the environmental harms, and the costs of reducing national contributions to it, fall on different people within each nation, we would also expect nations to be stronger opponents of international environmental protection to the extent that those bearing the emission mitigation costs within a nation are more concentrated, more known to each other, and more represented in relevant political bodies relative to those bearing the costs of the environmental harm that is to be mitigated.

While we find the *existence* of these forms of asymmetries of interest persuasive, some of them are easy to observe and measure and others hard. There are a few examples of agreements adopted when asymmetries of cost were obvious and very

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[13] The resultant transfers can be large. The transfer to American fishermen of the enclosure of the 200mile Exclusive Economic Zone has been estimated at 5 billion dollars. (Christy 1977, cited in Dasgupta 1982, p.28)

[14] Joskow (1991); Grubb (1989)

large. For example, the 50% CFC cuts in the 1987 Montreal Protocol applied both to those signatories who had *already made 50% cuts* by eliminating CFCs in aerosol sprays, and to those who had done nothing. The compliance costs of the latter group were close to zero, while those of the former were substantial. The 1986 moratorium on commercial whaling, while universal in its application, imposed costs only on those nine nations that were still catching whales.[15] Among those nations who pledged in 1988 to make 30% cuts in their NOx emissions, one study found that the marginal costs of the agreed cuts ranged from less than 300 DM per tonne to more than 8000.[16] Seventeen European nations agreed in 1985 to make uniform 30% cuts in sulfur emissions, but subsequent modeling has shown that trans-border emission transport is so asymmetric that an optimal pattern of reductions would have some countries reducing by as little as 2%, while others reduce by more than 80%.[17]

When nations' interests are highly asymmetric, simple symmetric control measures can bring two kinds of consequences. First, they can yield greatly different marginal costs of control among participating nations, leading to large economic inefficiencies. Consequently, costs of compliance can be much higher than under a more flexible agreement yielding the same aggregate level of environmental protection.[18] Moreover, the *total* cost burden imposed by equal-measure treaties can

[15] Mitchell (1993)

[16] Amann (1989), derived from graphs in Appendix 1.

[17] Maler (1991), Table 2.

[18] Economists have widely attacked equal-measure deals for these inefficiencies. For example, a recent World Sank Working Paper criticizes the 1987 Montreal Protocol on the grounds that equal proportional reductions are inefficient given different control costs, and that the developing countries'

also be highly unequal, so such agreements may violate plausible standards of fairness.

4. Advantages of Symmetrical Agreements

If equal-measure treaties are so bad, why are they so widespread? First, it is important to note that international bargaining is qualitatively different from domestic bargaining. How significant the benefits of symmetric deals are, depends on the degree of supervening authority available. In negotiations over domestic provision of environmental public goods - e.g., in regulatory negotiations to set environmental standards or emission limits in different regions within a federal state - domestic authorities have some power to impose solutions and enforce trades across issues and over time. The existence of such authority can overcome the obstacles to agreement that asymmetric interests pose, since national authorities (at least in principle) can impose solutions even over the objections of some affected agents. The solutions imposed can range from benign to malign. For example, with unrestricted side payments, or an ideal distribution of property rights, the authorities can impose a range of solutions that make all agents better off.[19] Other, less ideal

ten-year grace period represents an in-kind transfer and is hence inefficient relative to a cash transfer. (Bohm, 1990). Of course, given that direct side payments among nations are often infeasible, such agreements may not be Pareto inefficient; it may be impossible to redistribute emissions so as to make somebody better off and nobody worse off.

[19] Representative arguments are developed in Wirth and Heinz (1988).

forms of control might leave some or all agents worse off, but can still be imposed. [20] With such supervening authority available, it is not surprising that complex, asymmetric regulatory solutions are far more common domestically than internationally. It is also unsurprising that the Large Combustion Plants Agreement, the most complex and asymmetric extant international environmental agreement, was negotiated within the European Community, with its extensive institutional linkages and community-level authorities. Even so, reaching this agreement was difficult and slow, requiring five years of intensive twice-weekly negotiating meetings. [21]

For international commons problems, sovereign states must bargain to an agreement in the absence of supervening authority. Requirements inherent in the process of multilateral bargaining imply several strong advantages to simple equal-measure deals, even when agents' interests differ sharply.

On some issues asymmetries of prior measures and of concern may partly cancel, making equal-measure deals more reasonable than they seem at first glance. For example, if some parties face higher marginal abatement costs because they have taken prior unilateral measures, perhaps hoping to advance the international process by their example, they may in fact be the most concerned and hence the most willing to bear higher costs in a negotiated agreement. Equal-measure treaties from this unequal starting point may then be a reasonable basis for an agreement, roughly

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[20] Sometimes controlling exploitation of a commons is accompanied by its expropriation. If former users are excluded without compensation, clearly their lot is worsened. So also if exploitation is controlled through a tax whose proceeds are not re-distributed (Weitzman 1974; Rolph, cited in Ostrom 1990, p. 215.)

[21] Grubb (1989), p.14.

reflecting parties' differing degrees of concern. This argument can be made, for example, of the uniform 50% CFC reductions in the 1987 Montreal Protocol.

We cannot expect such happy coincidence of asymmetries to be typical. But even when they are absent, equal-measure deals still enjoy important advantages. The first is that they are simple, and so limit the informational burden on negotiators. Considerations of simplicity grow in importance as the number of participants in a negotiation increase. With N nations participating, an unstructured negotiation over emissions of even one pollutant would require agreement on a point in N- dimensional bargaining space. The number of candidate agreements to consider, and the time required, would grow exponentially with the number of participants. Consequently, while two or three nations could negotiate with detailed attention to the particular measures each will undertake, as the number of participants increase such a negotiation would quickly become impossible. Multiple negotiators need some prior rule, or constraint, to limit the number of candidate negotiated agreements under consideration. The presumption that negotiations will concern equal proportional emission reductions accomplishes this limitation by reducing the bargaining space to a single dimension, requiring agreement only on the common level of reduction that all will undertake.

The second advantage of equal-measure deals is that they restrain the most extreme value-claiming behavior by negotiators. A prior presumption of equal measures ties reductions in each nation's contribution to reductions in all others', so any measure that a participant might advocate brings him both benefits (others'

contributions) and costs (his own). While in an unconstrained negotiation among highly asymmetric parties, anyone could likely find a plausible pretext for his contributing very little and others very much, the prior presumption of equal measures restrains such fruitless advocacy of extreme positions. All parties may prefer this collective renunciation of opportunistic negotiating.

Third, a principle of equal measures restrains another form of opportunism, the type that arises when a party holds an already negotiated deal for ransom to get a slight improvement in his position. Equal measures accomplish this by virtue of being a conspicuous, or *salient way* of tying together the contributions of different parties. Among principles that reduce the size of the bargaining space and couple various parties' contributions, equal-cuts represents a *focal point,* in the sense of Schelling (1960): an element from a choice set that commands attention by virtue of uniqueness, discreteness, or salience. A focal point is defined by negotiators' perceptions, not by objective reality; it need have no particular scientific or economic merit.[22] But because it stands out in negotiators' perceptions, an incremental departure from it, as would be obtained by slightly shading a negotiated deal to one party's advantage, looks like a big change. Consequently, focal-point solutions in negotiations enjoy a stability that comes from the convergence of negotiators' expectations: each expects others not to try to shade the deal to their advantage, because each expects that to try to shade it to his own advantage risks widespread

[22] Typical kinds of focal point solutions could include setting some salient quantity equal for all parties, setting some salient quantity to zero or another round number (uniform reductions are most often by 10%, 30%, 50%, or 90%), or keeping some salient quantity at its status quo value.

imitation, effectively re-opening the entire negotiation.

Finally, equal-measure deals are easier to ratify, for reasons related to the above three advantages and others. Simplicity is an advantage at the ratification stage too, as are salience and its deterrence of attempts to shade the deal. Equal-measures deals also have a prima facie appearance of fairness, making it harder for domestic opponents to mount persuasive argument against them. The persuasive force of the seeming fairness of equal measures is of course strongest when the knowledge of other parties' costs and benefits is highly uncertain. Paradoxically, an unequal measures deal may be harder to ratify than an equal-measures one, even for those parties making the smaller of the unequal contributions. Domestic opponents or principals can more easily argue that the negotiators should have done better still, and the agent negotiating, anticipating this criticism, may be more hesitant to reach agreement.

All these advantages of equal-measures deals apply to any particular multilateral negotiation. The same advantages may be magnified when the same set of parties expect to negotiate many deals. Even the parties most aggrieved by equal measures in any particular negotiation may be willing to endure them rather than break the norm of equal measures for other negotiations. The presumption of equal measures buys a predictability of negotiations that everyone wants, and in return for which may be willing to bear higher costs in some, perhaps even in most deals. The immediate benefit of breaking the precedent might not be worth the resultant effort or the ill-will, for the consequence would be to risk occasional terrible deals, and to endure

the high friction and transaction cost of negotiating distributions of obligations from scratch each time.

5. Climate Negotiations: asymmetries of interest

We turn now to international negotiations on global climate change, with a particular focus on negotiating limits on carbon emissions. This section presents information relevant to negotiating nations' asymmetries of interest in emissions, abatement costs, and sensitivities; the sections that follow argue against the viability of a climate treaty based on equal proportional emission reductions and propose alternative approaches to negotiations.

As discussed above, nations may show arbitrary differences in their cost and benefit functions for emission abatement, reflecting differences in such characteristics as size, wealth, income, tastes, economic structure, and capital stock. The full economic cost a nation bears from abating emissions depends on the particular time-path of emissions constraint imposed, the policies used to achieve it, and a host of characteristics of the national economy - rates of productivity growth and how these respond to energy constraints, ease of substitution between fossil and non-fossil energy and between energy and other factors, and so on. To model these characteristics fully would require a dynamic general-equilibrium framework, and a great deal of nation-specific data. Such a model yields a time-path of economic effects of the emissions constraint - GNP losses, implicit carbon tax levels, and so

on.

Fully characterizing nations' asymmetries of interest in emission abatement would require consistent application of such a model to many countries. This work has not yet been done, though several sophisticated energy-economic models have been used to study carbon abatement costs nationally, and in a few aggregated world regions.[23] Consistent comparisons of abatement costs between particular nations are only presently available from bottom-up cost estimates that compare technical substitution opportunities available. These do not permit comparisons of aggregate economic effects, but only of direct marginal costs of substitution. The results of one such estimate for EC countries is shown below in Figure 1, which shows marginal costs per ton of carbon abated by each country, relative to a 1988 emissions baseline.[24] The zero-points of the curves differ because national emissions are projected to grow at different rates between 1988 and 2010. The variation among countries is very large, and there are both high and low marginal costs among both high and low-income countries. The highest-cost countries include Italy, Netherlands, Spain, and Belgium, while the lowest-cost countries are Denmark and Portugal.

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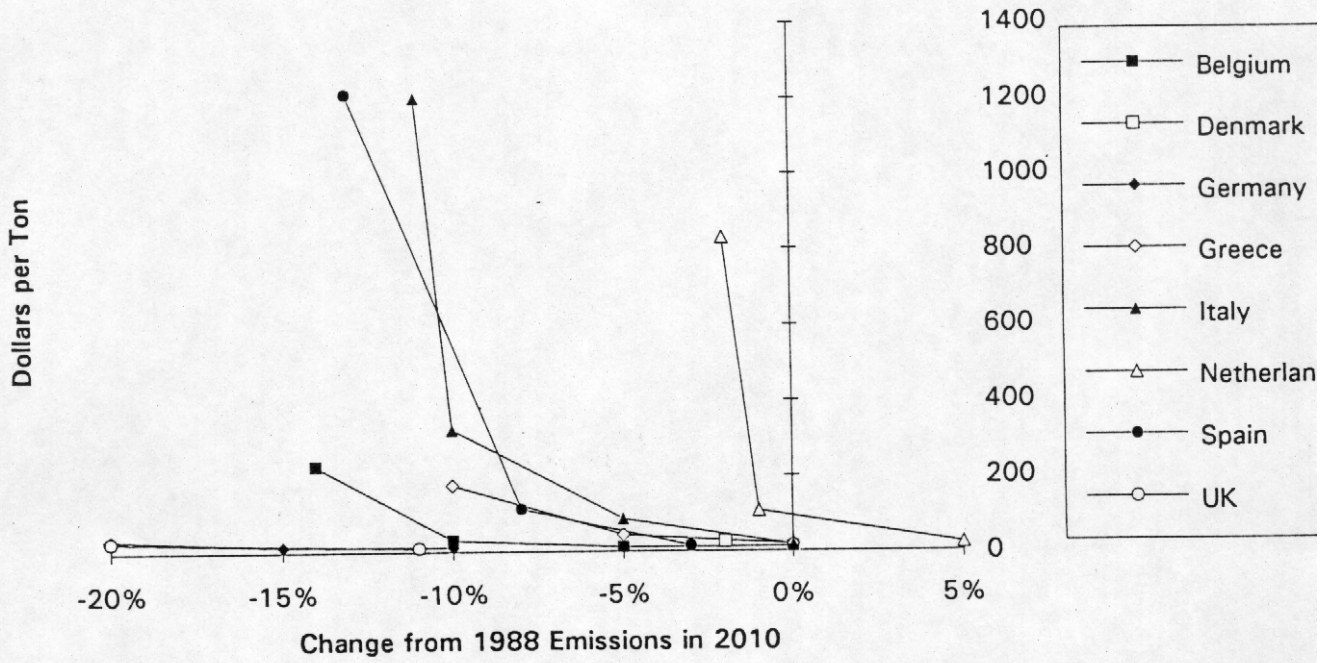
[23] For example, Jorgenson and Wilcoxen (1991) use a dynamic general-equilibrium model of the US economy to model the impacts of a carbon-emissions freeze, and a 20% cut, and show annual GNP losses ranging from 0.3% to 1.6% and required carbon taxes from $9 to S60 per ton. Manne and Richels (1990, *1992)* apply a somewhat simpler model, linking a moderately detailed energy-sector sub-model to a macroeconomic model, to the United States and to a five-region world, and find substantially larger GNP losses and required carbon taxes - up to 3% for the United States, and $250 per ton, respectively. Edmonds, Barns and Ton (1992) have initiated work modeling the impacts of several forms of carbon emission limits on a nine-region world.

[24] These are calculated from Barrett (1991), after Coherence (1991).

Figure 1: National Marginal Cost Curves for Carbon Abatement, 2010



Less formally, a nation's position in international climate negotiations is also likely to be associated with measures of its aggregate emissions. Many different measures of aggregate emissions are liable to be used in support of negotiating positions, and as Subak and Clark (1990) showed, what measure you use - current or cumulative, and national totals or per capita, per hectare of land area, or per dollar of GDP - drastically alters the rank-ordering of the largest contributors. Whether all gases or just carbon are counted, and whether sinks are counted as well as sources, also make for marked shifts in relative accountability, as recent controversy over the accounting system used in the 1990-91 World Resources report attests.[25] There is large variation in aggregate emissions indicators not just between industrial and developing nations, but also among relatively homogenous industrialized nations. Table 2 shows ranges of variation for two aggregate emission measures among countries of the European Community, the OECD, and the world.

[25] World Resources Institute (1991); Agarwal and Narain (1991).

TABLE 2

Variation of Greenhouse Emission Indicators Among Specified Nations, 1987.

	Carbon Emissions (metric tons per capita)	**Total Greenhouse Emissions** (Kg Carbon equivalent per $ GDP)
EC	0.8 – 3.6	.17 - .62
OECD	0.8 – 5.4	.11 - .62
World	0.0008 – 22.4	.10 – 5.6

Sources: World Bank 1991; WRI 1990; Subak and Clark (1990).

Notes on entries: The EC carbon range excludes Luxembourg, which emits 6.8 tonnes/cap; Germany is otherwise highest at 3.6; USA is highest in OECD at 5.4 tonnes/cap; lowest in EC and OECD is Portugal. Highest world per capita carbon is Laos, almost entirely due to deforestation; the other highest emitters include Brazil and several small OPEC states, all around 9 tonnes/cap.

There are not yet any comparative national estimates of damages from climate change, principally because there are no reliable biophysical models of regional impacts. The one exception is that estimates are available of costs of protecting against specified sea level rises. Still, casual inspection of ranges of wealth, climate, and economic structure among nations suggests that they can differ strongly in their susceptibilities to harm., The first two columns of Table 3 show ranges of variation on two measures plausibly associated with national sensitivity to climate change. It seems plausible that countries with much of their economy in agriculture will be more sensitive, and those with higher incomes better able to adapt to any changes.[26] The third column shows results from one study on relative costs of protecting against a 1-meter rise in sea level.

[26] The few existing analyses of projected climate-change impacts place agriculture among the most climate-sensitive sectors, e.g., Nordhaus (1990). Ausubel (1991) argues that rich industrial societies already control their effective climates, suggesting that sensitivity declines with increasing national income. A rich country may, though, be less sensitive in relation to GNP but still willing to pay more in absolute terms to avoid a change.

TABLE 3

Variation of Climate Sensitivity Indicators Among Nations

	Percent of GNP in agriculture	GNP per capita	Costs per capita of 1-meter sea level rise
EC	2% - 17%	$4,900 - $22,320	$190 - $429
OECD	2% - 17%	$4,900 - $32,680	$38 - $1,550
World	0 – 67%	$80 - $32,680	$38 - $1,800

Sources: World Bank 1992; CIA 1992; IPCC 1990.

Nordhaus has made systematic, order-of-magnitude estimates of the sensitivity of the American economy to the climate change resulting from steady-state doubled atmospheric carbon dioxide. He estimated production losses by dividing the economy into sectors deemed more and less climate-sensitive, and derived a best guess of .25% steady-state GNP loss (with a subjective upper bound of 2%), implying a marginal damage from emissions of $0.57 to $13 (upper bound $4.50 to $106). We have found no comparable analysis for other countries.

The problem of finding plausible quantitative estimates for national sensitivity to climate change is so hard that other studies have inferred damage functions from abatement costs, by making some assumption of optimal behavior. For example, Barrett's recent EC work assumes that the Community's pledge to freeze carbon represents the optimal emissions level, and hence derives marginal damage of $75 per ton of carbon emitted.[27] This approach follows Maler's (1991) study of European acid rain, which assumed that countries' 1984 emissions represented a Nash equilibrium, and thereby derived marginal damages from known marginal abatement costs.

Though cross-national comparison estimates of costs and benefits relevant to climate change are weak - weak on the abatement side, and even weaker on the sensitivity side - there are plausible grounds to suspect that international variation in these costs are large.

[27] Barrett (1991), p.8

6. Climate Negotiations: equal cuts and other focal points

Many multilateral environmental treaties have settled on equal emission cuts despite substantial asymmetries of interest among the negotiating nations. In addition to the general factors favoring negotiations to equal reductions discussed above, these may have been also supported by the perceived need to get agreement quickly. Many observers of climate negotiations argue that a similar deal should be made soon on this issue as well. a freeze or equal percentage reductions in national carbon or greenhouse emissions for the industrial countries, plus a set of later, or smaller emission-control obligations for the developing countries and a fund to support them. They cite the Montreal Protocol in particular as a precedent for an equal-measures treaty on carbon emissions.

So why fuss about symmetric reduction obligations? If international environmental diplomacy has always happily pounded asymmetrical pegs into symmetrical holes and accepted the resultant inefficiency and inequity, why not continue to do so? We contend that for climate change, this traditional approach is unlikely to work. A climate treaty based on equal measures is likely to be impossible to negotiate, or unsustainable once negotiated. The principal reason is that the costs on both sides of the ledger - the abatement costs of a serious attempt to slow the rate of climate change, and the impacts of plausible rates of change if we fail to restrict - may be much larger. The inefficiencies and inequities inherent in across-the-board reductions, which can reasonably be expected to vary with the total costs,

are consequently also likely to be much larger. It is our view that they are liable to be sufficiently large to obstruct agreement on the kinds of simple formulas that have been pursued so far.

We particularly dispute the relevance of the successful negotiation of across-the-board CFC cuts in the Montreal Protocol. In addition to the fact that total abatement costs for CFCs were orders of magnitude smaller than for serious carbon-emission reductions,[28] agreement on this simple formula was facilitated by four factors not present in climate. First, CFC negotiators worked under a high level of perceived urgency, because there was substantial evidence that the environmental threat was worsening as they negotiated. With such great perceived need for rapid agreement, the simplicity and salience benefits of equal-cuts took on even greater importance. For climate, while surprises are of course possible, most observers expect the system to evolve on a scale of decades to centuries, and so never reach the same perceived urgency for action *this year*. Second, the costs of abatement were narrowly borne by a few internationally traded industrial sectors, so the concerns of potential opponents focused more on the competitiveness effects of relative cost burdens than on absolute costs. Third, because the number of parties whose agreement was required to strike a viable deal was so much smaller, it was possible to accommodate the most serious concerns of a few parties by minor variation in the form of controls. And finally, it became clear by the time of the 1990 amendments that the desirable action on

[28] CFC reduction cost estimates also dropped sharply over time. Large cost reductions normally arise in abating any pollutant - you find cheaper ways to control once you begin to look for them - but it is highly unlikely that future reductions in greenhouse abatement cost estimates will reduce them to the magnitude of CFC control costs.

ozone-depleting chemicals was the most simple, salient solution of all: a. complete phaseout.

If we are correct that climate negotiations based on across-the-board emission reductions are infeasible, what approach do we propose instead? We argued above that a presumption of equal reductions facilitates negotiations in three ways: simplifying the set of proposed solutions to be considered, by reducing the dimensionality of the bargaining space; restraining extremes of opportunism, by coupling increases in each nation's contribution to increases in all others; and resisting incremental attempts to shade the agreement, by being a focal point - standing out conspicuously and discretely from other nearby solutions. But equal reductions are not the only way to realize these advantages; many other principles to tie together contributions of various parties to a bargain could serve the same functions. The following is a partial, illustrative list of principles that meet these conditions. It is by no means exhaustive.

- fixed equal targets for emission reductions (proportional or absolute)
- equal reductions per person (proportional or absolute)
- equal reductions per dollar of GNP (proportional or absolute)

- equal annual incremental changes, with review (in emissions per person, emissions per dollar of GNP, energy intensity, or other measures)

- equal entitlements to emit per person .
- equal entitlements to emit per dollar of GNP.
- equal entitlements to emit per unit of land area.

- reduce emissions to incur equal abatement cost per person
- reduce emissions to incur equal abatement cost per dollar of GNP
- allocate equal fractions of government budgets to emissions abatement programs
- tax emissions at equal rates
- tax specified activities related to emissions at equal rates (specific, or ad valorem)
- equalize marginal abatement costs (proximate or economy-wide) through non-tax measures

- adopt equivalent specific technical regulations or goals (e.g., all new power-plant investment to meet specified efficiency goals, or auto fuel-efficiency standards)

- revise any of these principles to reflect cumulative emissions history (a simple integral, or a discounted integral).

The observation that many principles can serve the same functions as equal percentage reductions could improve the prospects for reaching agreement. In any particular negotiation, some of the plausible candidate principles will be less severe in their inefficiencies and inequities, and hence less obstructed, than others. But even such an expanded set of candidate principles still leaves two serious obstacles to negotiating an agreement; one a consequence of the expanded set of candidate principles, the other a difficulty the expanded set shares with equal cuts. First, how will one principle to guide negotiations be chosen from many candidates? In some past negotiations it seems that cutting by equal percentages was the only approach ever considered. But when negotiators realize they must choose among plausible competing principles, this very recognition that a choice must be made ensures that no principle can enjoy the same prominence that equal-reductions does when it is alone on the bargaining table.

Moreover, in any particular negotiation, some of the candidate principles will naturally and visibly favor certain parties. With both principled and interested differences over what rule should be followed, there will be ample opportunity for each negotiator's cognitive biases to make the most advantageous rule seem coincidentally to be the fairest and most reasonable. When evaluating any particular proposed deal, negotiators are likely to perceive most vividly principles according to which this deal leaves their nation overburdened and others under-burdened. This is not merely to assert that negotiators will be disingenuous, though they will be. Rather, it is to assert that sincere and opportunistic disagreement are liable to mingle

in the space that cognitive biases allow, making the negotiation far more contentious and difficult than it would be under either simple principled disagreement or pure conflict of interest.[29] With many discrete, plausible principles available to distribute obligations, choosing one will require a negotiation of great subtlety and difficulty.

Second, any one of these principles is liable to suffer from one of the same difficulties as equal cuts. In informational terms, the essential characteristic of a proposed principle is the number of degrees of freedom it leaves open for negotiation. An appropriate principle for any particular negotiation will leave enough to allow the negotiations to accommodate the relevant range of interests and special cases, but few enough to be manageable. Much of the difficulty of equal-cuts is that it leaves just one degree of freedom to negotiate, but this is also the case for most of the principles on the list above, *if they are applied strictly*. And if they are not applied strictly, but nuanced with special exceptions and interpretations, particularly in negotiations among a large number of parties, the advantages of simplicity and salience are liable to be at least partly lost.

Several simple criteria for desirable principles suggest themselves. They should not imply too grievous a departure from efficiency. They should be anonymous, in that a nation's treatment should not depend directly on its identity. They should not leave any nation much worse off than with no agreement; collective pressure to join

[29] Messick and Sentis (1983) present relevant experimental data from individual behavior. People were presented with choices (dividing a sum of money between themselves and another, absent person) in which they could act completely opportunistically with no penalty (keep all the money), but to which several obvious principles of fairness could also be applied (equal division, division according to hours worked, etc.). They tended strongly to choose according to those principles that most favored them, but rarely to keep all the money.

an agreement may overcome some disadvantage to a particular nation, but it would have to be modest. Finally, principles should have a logically defensible claim to fairness. In a negotiation on a complex set of policies, though, claims of fairness may be difficult to establish, and may bear differently on different aspects of the policy. For example, if some activity (e.g., burning coal) is agreed to be strongly identified with the environmental harm to be controlled, there may be quick agreement that, say, a tax on coal is a fair component of a solution. But the question of what ways are fair to distribute the resultant surplus is likely to be much more difficult.

7. Other Approaches to Climate Negotiation

The foregoing sets up a problem. When the stakes are potentially enormous and parties are asymmetrically situated, equal-cut deals are likely blocked. Other principles can meet the same negotiating needs, but any one is also likely to be highly limited and choosing any single principle explicitly is liable to be contentious, difficult, and time-consuming. This section presents some tentative ideas for ways of structuring negotiations that offer the potential of moving beyond these difficulties.

7.1. Nested negotiations.

Many of the difficulties to negotiation posed by equal cuts and other simple principles are consequences of the large number of nations participating in

negotiations. To the extent that the number of effective participants in a negotiation can be reduced, the difficulties are mitigated. While one writer has proposed climate negotiations restricted to those twenty or so nations who are big, rich, or influential enough to matter,[30] other approaches could achieve the same simplification without excluding nations.

The most widely used of these approaches is to group participating nations into a few classes whose members are similarly situated, agree that all members of a class will do the same thing, and negotiate over what that "same thing" will be for each class. If the set of all negotiating nations is too diverse for all to take the same measures, but they fall into a few clear, politically salient, internally homogeneous categories, then this approach can yield easily negotiable and efficient agreements. The most commonly used categories, of course, are industrialized and developing countries; separate obligations for these groups have been enshrined in the Montreal Protocol, as well as the recent negotiations on climate change and biodiversity. Even this simple division into two, classes of obligations has been surprisingly limited in application, though; the most detailed application so far has been to grant the developing countries a grace period and financial assistance in meeting precisely the same obligations as industrial countries, rather than negotiating a separate set of obligations.

Even if pursued more aggressively, the approach of grouping countries into classes has two limitations. The first is that even nations within seemingly

[30] Brenton (1992).

homogeneous classes may be sufficiently dissimilar that imposing uniform measures on them is excessively costly or unfair. The cost data presented above suggests that even within the European Community the gains from relaxing a constraint of equal reductions are great. The second is that criteria defining classes may be sufficiently unclear that it is difficult and contentious to decide where to assign border cases, and to resist pressure to increase the number of categories. There is, for example, a legitimate case for separate treatment of "economies in transition from central planning to markets", as has been proposed in both CFC and climate negotiations. In the climate negotiations both "low-lying coastal and island nations" and "African nations subject to desertification" also claimed special status because of their high climatic vulnerability. The difficulty of defining agreed categories and who belongs within them can he partly mitigated by using ranges of relevant numerical measures of responsibility, ability to contribute, or sensitivity. The Montreal Protocol, for example, applies the criterion for developing-country treatment that national CFC consumption be less than 0.2 Kilograms per capita.[31]

One way of enlarging the number of classes of countries receiving different treatment is for informal groups of activists to self-select to stronger measures. On two occasions, such informal "clubs" of like-minded countries have announced themselves at the conclusion of a negotiation that has failed to yield broader action as strong as they had advocated: at the 1988 NOx protocol, and the 1990

[31] This objective criterion has not spared the parties contention over who gets the status. The 1991 meeting of the parties had to deal with attempts by Turkey to be added to the list, and by Jordan and Malaysia to remain on it despite apparent large increases in their CFC consumption.

amendments of the Montreal Protocol. On one other occasion a club formed before a treaty was negotiated to increase the pressure for a treaty, the "30% Club" on sulfur emission controls. One proposal would enshrine this practice by agreeing that reduction programs undertaken after a fixed date would count toward a nation's obligations in future treaties.[32] In terms of promoting future actions, though, such a proposal cuts both ways. It would make unilateral leadership easier, since early leaders would collect later benefits; but it would reduce the effectiveness of such leadership, since early leaders would be in a weaker position to induce others to follow their lead.

A distinct approach to reducing the number of effective negotiating parties would be to structure global negotiations as negotiations among a few large regional blocs to take on regional emission-control obligations. One can imagine a negotiation among the EC, an expanded NAFTA, an East-Asian trading bloc, a coalition of Eastern European and former Soviet nations, and perhaps a couple of major developing countries, over the distribution of *regional total* emission-control obligations. Each bloc would then face a subsequent internal negotiation over how to meet its aggregate obligation. Unlike the approach based on distinct *national* obligations for nations within each class, this approach permits the efficiency gains available from distributing obligations within each bloc. It would also permit diversity of implementation approaches between blocs. This approach is of course highly speculative, and would depend on the continued development of strong regional

[32] Moomaw, "A Modest Proposal to Encourage Unilateral Reductions in Greenhouse Gases", Tufts University, 1990.

economic organizations with increasingly rich institutional capacity to facilitate intra-regional trades and redistribution. The experience of the EC, in its Large Combustion Plants directive and its community-wide carbon target, provides a modestly hopeful example, though, for such major institutional innovations over a period of decades.

7.2. Formulas.

A second broad approach, which may help to overcome the difficulties in a multiplicity of plausible principles, would be to negotiate a formula that defines national emission entitlements, or changes from the status quo, on the basis of national characteristics such as population, GNP, current emissions, or factors plausibly associated with national responsibility, sensitivity, or need for various emitting activities. In negotiating the factors to be included in a formula and their coefficients, parties would in effect negotiate a weighted-average of several plausible principles for allocating contributions, implicitly blending considerations of efficiency with various conceptions of equity.[33]

A similar proposal was advanced in CFC negotiations in 1986, under which national CFC quotas would be linear functions of population and GNP, with the relative shares to be negotiated.[34] Instructively, the proposal was dropped in favor

[33] In principle the factors in a formula need not appear linearly, though each departure from linearity would of course sacrifice further the advantages of simplicity.

[34] Environment Canada (1986).

of equal cuts because its quotas departed too far from the status quo. Any significant weighting of population would have granted vast over-entitlements to developing countries, while even the GNP factor failed to track variation in use among industrial countries closely enough.[35] Such a scheme may be more feasible for climate, though, at least relative to the alternatives. While Nitze and Cline's proposal for carbon emission quotas distributed 50% according to population and 50% according to present emissions is no doubt too simplistic, a negotiated formula using three to five factors may be more viable. Such an approach may be particularly viable as the basis for initial distribution of allocations within an emissions-trading system, since subsequent trading would likely reduce remaining inefficiencies in the allocation. The strongest precedent for this approach is the system of defining quotas in the IMF, which employs a formula based on national income, reserves, exports, imports, and the variability of exports. The coefficients of this formula have been re-negotiated twice in the IMF's history.[36] An approach to negotiations based on a formula could be combined with the division of countries into classes, with different formulas for each class.

In complex negotiations that seek to include many forms of national policy and action, formulas can play a second role. They can be used to express equivalence between different forms of national action, reducing many distinct obligations to a single aggregate obligation. For example, common metrics can be used to express the

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[35] Distribution of quotas according to GNP, for example, would have bestowed large surpluses on the Scandinavian countries and the USSR. Parson (1993).

[36] Lister (1984)

relevant environmental equivalence of different kinds of emissions. This has been accomplished with the adoption of Ozone-Depletion Potentials to express the effect of different CFCs in a common, environmentally relevant metric. The pursuit of an equivalent "Global Warming Potential" to weight emissions of various greenhouse gases, has proved problematic so far.[37] A comprehensive approach to emissions of all gases, as advocated strongly by American negotiators among others, will require some such scheme for trading off emissions of various gases.

This approach could be extended to include negotiated tradeoffs between other forms of treaty-relevant action. Relationships could be negotiated between emission reductions achieved sooner and later (equivalent to a negotiated discount rate); between reductions achieved through domestic action and through funding of action abroad (akin to the offset factor employed in domestic emissions-trading, and allowing a balancing of the views of trading advocates and those who contend that each party must accomplish some of its own reductions); or between the limitation of emissions and the management of sinks.

7.3. Trend Obligations

[37] Adoption of the ODP standard has been credited with breaking a crucial deadlock in the CFC negotiations, in that it allowed Japan to increase use of CFC-113 by crediting against it reductions achieved in 11 and 12. (Benedick 1991) The search for a consensus Global Warming Potential remains problematic, though, because the contributions of different gases depends strongly on the time-horizon used. Selecting a particular time-horizon, which is equivalent to deciding on the relative valuation of present and future effects, inevitably weights the relative assessed contributions of different source gases, and consequently the total contribution of different countries. Short horizons stress the contribution of short-lived gases such as methane, while long horizons stress C02. There is no scientific basis for establishing one time horizon or another as the correct one. IPCC (1990, 1992); Watson (1991); US Task Force (1991).

An alternative approach to defining obligations as fixed endpoints to be reached by a specified date, is to define them as trends -- rates of change from status quo, or past trend-lines, that must be achieved each year. Progressive obligations could most obviously be defined in terms of targets such as trend lines in national emissions, or energy or carbon intensity of the economy. Alternatively, they could be defined in terms of policy inputs - progressively increased tax levels or expenditures on emissions control. Since energy sources contributing to greenhouse emissions are subsidized in many nations, negotiators could do as GATT has done with tariffs: announce and bind all their fossil fuel subsidies, then agree to progressively phase them out over time. A schedule of constant absolute reduction or constant proportional reduction would be feasible, [38] perhaps modified by provisions to calibrate the phaseout in proportion to the carbon intensity of the fuels subsidized. Unlike tariff reductions, such schemes need not stop at zero, but could continue toward progressive taxation of formerly subsidized activities. Such an agreement would of course have a finite lifetime and be subject to successive rounds of renegotiation as the policies phase in.

This is simply a shift in focus from fixed-year goals, to annual incremental ones. But from a negotiating standpoint, this change in view has several important advantages. First, it integrates the observation that we do not know how tight emission limits should be, and hence respects nations' concerns about setting a precedent that will be wrong; and also observation that we know little about the

[38] Finger (1987)

effectiveness of emission control programs, so are unable truly to pledge a fixed target. By avoiding fixed targets (for good reasons), this approach also denies parties the obstructive rhetorical device of criticizing a proposed form of obligations as if they will extend unchanged forever.

Since attainment of targets over a period as short as a year is significantly a consequence of random fluctuations, this approach basically amounts to establishing a continuing negotiation over the appropriateness and effectiveness of national emission-reduction programs. The essence of this approach is its review process - both periodic negotiated review of the appropriateness of the annual incremental targets, and review of national measures, which should strive both to give national policy-makers the right incentives (try hard, be flexible, and report progress honestly) and to maximize learning through international comparison of experiences.[39] Such a system presupposes a very different forum from broad, comprehensive, diplomatic negotiations; rather, it would seem to require a small, functional, professional group developing good working relations as they continually negotiate, developing skill at knowing what works, and able to consult effectively enough with national officials to apply the pressure needed to keep plans effective and targets honest.

7.4. Side Payments

[39] This approach has points in common with the "pledge and review' scheme advanced by Japan and the UK, though that system did not include any specific targets; with Schelling's 1992 discussion of the procedures used to oversee disbursement of Marshall Plan money; with one element of the present EC position; and with Victor's (1991) proposal for a "General Agreement on Climate Change".

It is a common, and correct, observation that one of the most effective ways of improving the negotiation of environmental agreements would be to decouple the decisions of where and how emissions are reduced from decisions of who pays for the reductions. This decoupling is necessary to approach minimum-cost allocations of reductions, which require that marginal costs of abatement be equalized across different sources, nations, and regions. Achieving efficient solutions based on marginal cost of abatement does not depend on precise damage estimates; even if such estimates remain elusive, any agreed world limit on emissions can be achieved at least cost by equalizing marginal abatement costs. Depending on the state of knowledge of abatement costs, and how costs change over time, the principle of equalizing marginal abatement costs can come close to specifying a unique desirable configuration of national emission targets.

The principle of equalizing marginal abatement costs has, though, had essentially no influence in any environmental negotiation to date. While this may partly reflect dispute and ignorance about how large marginal costs are and how to measure them, it is more likely a consequence of the severe distributive implications of the principle. Most observers agree that abatement costs are generally lower in developing countries than in industrial countries, because present capital stock is so inefficient and because much of the impact on future emissions can be realized in new investment rather than retrofits. The principle of equalizing marginal abatement costs would consequently specify larger abatement in developing than in industrial countries. As argued above, there are also likely to he large disparities in marginal

abatement cost among seemingly similar industrial countries, and among developing countries. The consequence is that absent other policy measures to re-distribute costs, the costs of a system based on equalizing marginal costs will be borne highly unequally, and are liable to include a large implicit transfer from developing countries to industrial ones.

Since these distributional implications are viewed by many as morally objectionable, and are certainly liable to block negotiated agreement, an allocation of emission reductions that even approaches efficiency is only possible if accompanied by parallel measures to re-distribute the burden of costs. This is the side-payment debate. An efficient, or nearly efficient solution requires allocating emissions on the basis of marginal abatement costs, and a completely separate negotiation to allocate costs.

The reality of environmental negotiations is far from this ideal. First, international side payments are seemingly hard to negotiate and hard to deliver. In 1990, reaching agreement on an American obligation of only $13 million per year for three years to fund CFC reductions was surprisingly difficult. And the US has chronic difficulty meeting its long-established obligations to the UN and the development banks, even for such a widely supported activity as UN peacekeeping operations. Even more difficult than international payments to developing countries, for which some domestic constituency exists, may be side payments to other industrial countries - say, to European countries or the former Soviet Union. Moreover, it seems that explicit exchange of money among nations is even harder politically than mutual

accommodation on substantive issues intended to achieve the same result. It is ironic that the strongest example of a complex, asymmetric international environmental agreement, the European Large Combustion Plants directive described above, appears to use asymmetric emission targets to achieve distributive goals at the cost of efficiency losses, rather than distributing targets to reduce costs with compensating financial transfers. The largest reductions are required of the countries whose marginal costs are probably the highest. [40]

The question of compensation seems to have been effectively solved in the Montreal Protocol negotiations. In the 1990 amendments, the first negotiation with forceful developing-country participation, major developing countries agreed to join the industrial countries in CFC phaseouts if their full marginal costs of doing so were compensated. This was realized by raising a multilateral fund from the industrial-country parties, and creating a small Executive Committee to administer expenditures from the fund according to specific negotiated criteria.[41]

Climate change negotiations, though, will pose the question of transfer payments, in particular the question of how large they should be, in a far more difficult form. An agreement such as the Montreal Protocol, which pays precisely the developing countries' marginal costs of compliance, leaves the recipients no better off. In

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[40] (private communications with officials and analysts)

[41] Once the principle of funding incremental cost was negotiated, the detailed work was delegated to a committee of 14 countries (7 industrial, 7 developing), who work with multilateral development agencies to develop specific investment plans for each developing-country party. The process shows promise because the relatively small group of national representatives involved have built good working relationships; and because their fairly specific mandate and fixed budget have made it an unsuitable forum for the large and contentious distributive questions.

principle, it leaves them indifferent between joining and not joining the treaty (neglecting for the moment that the treaty's penalties against non-parties make not joining worse than the status quo). But if the negotiated level of controls is even roughly right, the emission controls to be realized in any country should be worth more to the rest of the world than they cost the country to implement, possibly much more. Unless the investment or project to control emissions brings domestic external benefits to the country undertaking it (which may be the case), for the donors to pay only incremental cost is for them to claim the entire surplus realized in the transaction.

There is substantial evidence in the recent negotiating record that developing-country representatives perceive their bargaining position as much stronger than ought to warrant such a disadvantageous outcome. If the industrial world's concern about greenhouse emissions remains at present levels or grows substantially, then the range of different development plans of such nations as China, India, and Brazil may include some that impose substantial harm on the rest of the world. For them, this possibility can represent a threat, which can be used to extract transfers larger than the costs they would incur in changing paths (and which can be characterized morally in various terms: compensation for historical inequity and exploitation, or blackmail). [42]

The redistributive negotiations related to climate change have not yet been seriously engaged. While financial negotiations represented the most divisive item on

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[42] LDC leverage in the climate issue is discussed in MacNeill et al (1991).

the Earth Summit agenda, the resolution was a standoff: developing countries accepted minimal new substantive environmental obligations, and industrial countries accepted minimal new financial obligations. [43]

As this negotiation is more seriously engaged, it is likely to be more divisive the more explicit is its distributive component. Consequently, there may be substantial negotiating benefits to schemes that blend the negotiation of emission obligations with the negotiation of transfers, in particular systems that make use of marketable emission permits or that distribute emission obligations to multi-nation regional blocs, leaving a subsequent internal distributive negotiation. The example of the European Community suggests that a general increase in the tightness of institutional linkages among nations would also facilitate such negotiations, allowing an increasingly flexible system of compensation through trading across issues without cash changing hands. The example of the Montreal Protocol also suggests there may be a benefit to systems that partly rely on delegating distributive decisions to small, professional institutions.

8. Conclusion

We are confident that international negotiations over climate change will span years or decades, with many successive generations of agreements. The scope of the job to

[43] The language on development assistance was artfully crafted to avoid representing any new commitments. The climate and biodiversity conventions did, though, include provision for industrial countries to fund the cost of those monitoring and reporting responsibilities that the developing countries accepted. Haas, Levy, and Parson (1992).

be achieved, and the time span, both suggest that the ultimate international management of the issue will involve major institutional innovations. Whatever pattern of obligations is adopted, with whatever review provisions and accompanying institutional measures, will have to function in a world of huge changes. The number and character of the states making it up will vary, as will the intensity of inter-state linkages and conflicts. The most confident prediction we can make is that the outcome is highly unpredictable.

We had three goals in this essay: first, to understand the nature of past environmental agreements, and in particular their extraordinary focus on equal contributions; second, to appreciate fully the salience and appeal of the equal-proportional reductions approach to climate negotiations, in order to analyze its pitfalls and weaknesses; and third, to initiate the search for principles for designing effective and efficient agreements for controlling climate change. Any agreement, we believe, must rely basically on some formula -possibly an amalgam of considerations - that dramatically limits the dimensionality of the problem. The equal-reduction formula, the standard of the past, will not work. However, potential signatory nations, we conjecture, will be willing to abandon this precedent when that facilitates reaching more and significantly better agreements.

Even prodigious efforts by scholars and negotiators to identify the principles that must underlie workable treaties on climate-change control would surely be merited, since the stakes involved are potentially enormous.

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