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PRICES, QUANTITIES, TIMING AND PARTICIPATION IN GREENHOUSE GAS CONTROL POLICY

Michael Toman, Resources for the Future*

Introduction

Following a decade of international meetings and negotiations, more than 160 nations signaled their commitment to address the problem of climate change by initialing the Kyoto Protocol in December 1997. The Protocol requires industrialized "Annex I" countries to reduce their total greenhouse gas emissions by an average of roughly five percent compared to 1990 levels; developing countries are not required to meet quantitative emission goals, though all signatories to the 1992 Climate Convention have certain obligations to measure and report emissions and to encourage more climate-friendly activities. Implementation of the Kyoto targets was discussed at the November 1998 meetings in Buenos Aires. However, questions remain in the US and other countries about whether and when the Kyoto Protocol will be ratified and meaningfully implemented.

Ratification and implementation have now become a race against the clock. Failure to ratify and implement concrete and effective policy measures within the next few years means delays in making the critical investments needed to comply with the tough Annex I Kyoto targets. Yet, the costs of meeting the targets on a compressed schedule will be higher, making the politics of Senate approval and the politics of implementation in many countries all the more difficult. Moreover, even if the Kyoto Protocol does move toward ratification and implementation in a timely way – which is by no means a sure bet – the world's governments will need to consider other strategies to deal with the prospect of climate change over the longer term. These strategies will have to be as cost-effective as possible to encourage participation generally, and they will have to find ways to incorporate expanded developing country participation in a credible and equitable way.

Over the past decade, climate negotiators made a series of key policy decisions with far-reaching consequences not fully appreciated at the time. In each case, negotiators passed up options that might have lowered the costs of achieving the long-term objectives of the Framework Convention. We believe that (re)consideration of these options in the international negotiations will be crucial for long-term success in limiting greenhouse gases.

The Protocol focuses on year-to-year emissions of greenhouse gases the targets in this treaty, rather than the concentration of those gases in the atmosphere which actually affects the climate over the longer term. The Protocol further emphasizes a short-term timetable, 2008-20012, rather than the century-long schedule that this treaty will require if it is to be fully effective. These characteristics are important because there are many paths by which a specific long-term concentration can be reached. Those with greater

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when flexibility will be less costly than others. Specifically, approaches with a more gradual beginning and increasing in momentum over time will cost less, whereas the more front loaded the targets, the more it will cost to reach them.

Another choice in the Kyoto approach is the decision to state goals in terms of the quantities of gases emitted, rather than the level of effort, or costs, of reducing those emissions. Under the Kyoto policy the emissions reduction would be predictable, but the costs of achieving it would not. Under an alternative policy with greater *how flexibility*, the costs could be predictable but the size of the emissions reduction would not. This is important since fears of high and unpredictable costs currently are contributing to the opposition to the treaty, and there are also substantive efficiency arguments favoring a price-based approach.

Certain flexibilities were introduced in the Protocol,.e.g., the *where flexibility* of trading in carbon rights and the *what flexibility* of trading in multiple gases. Where flexibility is linked in turn to the participation of developing countries through the Clean Development Mechanism. But important questions linger about the effectiveness of this mechanism, and the fact that the Kyoto negotiators found no agreement on more specific policy targets for developing countries simply postponed an inevitable day of reckoning on how these countries are to be incorporated in global emissions limitation. Just as Kyoto's quantitative targets for Annex I countries in themselves only delay by a few years the inexorable growth of global GHG concentrations, so the omission of developing countries from quantitative emissions limits implies only a modest slowing down of GHG growth, no matter how draconian the long-term policies in Annex I (for critical discussion of the Protocol on this issue see Jacoby, Prinn, and Schmalensee 1998).

Before discussing these policy questions in more detail, it is useful to briefly explore the roots of the ideas in the Kyoto Protocol. This international agreement was heavily influences by its very successful predecessor, the Montreal Protocol for limiting stratospheric ozone-depleting substances (ODS) like CFCs. However, there are several reasons to think that Montreal was in fact a poor model for Kyoto.

The Montreal Model

The talks on climate change were just getting under way in 1987 when an international conference completed the Montreal Protocol to protect the stratospheric ozone layer. The Montreal Protocol and the subsequent London revision in 1990 first subjected ozone-depleting chemicals to tight regulation and then, as more worrisome scientific findings came along, flatly banned most of them. The Protocol was unprecedented in the scope and effectiveness of international cooperation in engendered.

Inevitably, the Montreal approach became the model for negotiators as they approached another environmental threat, climate change. The same institutions, and many of the same people, were involved in both cases. The resounding success of the Montreal negotiations created philosophies and preconceptions that negotiators applied in the climate change talks. But there are substantial differences between ozone depletion and global warming that make this problematic. (For further retrospective discussion of the Montreal Protocol see Morrisette et al. 1991 and Benedick 1998.)

The politics of the ozone treaties was driven in large part by the public fear of cancer. Although the science was uncertain at first, a series of research reports rapidly made it evident that this fear was well founded. In contrast the consequences of global warming for human health and economic well-being are not fully understood and remain controversial.

The chemical compounds implicated in the disappearance of the ozone layer were produced by a few very large corporations, and nearly all of their production was in the industrial countries. Although questions about the rights and responsibilities of the developing countries arose in the Montreal talks, as a practical matter they amounted to little. In contrast production of CO_2, the most important of the global warming gases generated by human activity, is ubiquitous and emissions of CO_2 are growing rapidly in developing countries. Thus questions of governance and international cooperation have a very different weight in the Kyoto process.

The United States was the leader in pressing for the Montreal restrictions, especially on a family of compounds known as chlorofluorocarbons (CFCs). The American chemical industry was unwilling to risk consumer boycotts and damage to their reputations in behalf of a line of products that were a relatively small part of their business. In addition, early in the Montreal talks the American companies apparently concluded that they were well ahead of their European rivals in developing substitutes for the CFCs. Thus they supported the Montreal Protocol. But every economy on earth depends on fossil fuel for energy. While there are ways to produce energy without CO_2 – nuclear power, hydropower, wind and several other kinds of renewable sources -- none of them currently is a cost-effective substitute for a substantial proportion of the immense volumes of fossil fuel that the world currently consumes.

The economics of the ozone treaties was pretty simple. The projections of the death rates from cancer, multiplied by a standard estimate of value of avoided deaths ($3 million per case), produced huge estimates of the economic benefits of curbing the CFCs. The costs, because of the appearance of relatively low-cost substitutes, were relatively small. For many applications the shift to new products was pushed as much by commercial competition as by the treaties. The economics of global warming is another story altogether. The costs and benefits of reducing CO_2 emissions are difficult to calculate and, at the present stage of knowledge, amount to hardly more than guesses. In the ozone case, the cost-benefit balance was conclusive. In the climate case, it is anything but.

Questions about targeting concentrations of CFCs versus emissions came up in the ozone negotiators, but early in their talks many governments began to press for an ultimate goal of banning CFCs altogether. That mooted the distinction between concentrations and emissions. Similarly, economists brought up the question whether it would be more efficient to impose CFC consumption cuts early and severely or more gradually. While the theoretical argument was interesting, it had little relevance to a case in which the industry was pushing to move rapidly away from CFCs to substitutes.

(It is interesting also to note that these issues are far more contentious in the case of methyl bromide, the last major ozone-depleting gas whose regulation is still being crafted. Agricultural interests have expressed concerns about the costs of substitutes and

the competitive effects of partial bans that exclude developing countries. Some economists have argued that a gradual phasing out of methyl bromide with a cumulative emissions target would be more effective than an abrupt phaseout. These arguments are strongly similar to climate debates.)

As for the choice between price and quantity as the instrument of regulation, it too was meaningless in a case in which it was both possible and inexpensive to seek a flat ban within a few years. There was no need to get into messy questions about the allocation of rights to produce, or the costs to society of the phase-out.

In June 1988, nine months after the Montreal Protocol was signed, the Canadian government convened in Toronto a conference to address global warming. It proved extremely influential. Although it was nominally unofficial, it attracted politicians and diplomats from many governments and UN agencies, as well as scientists and representatives of environmental organizations. It drew great attention with its recommendation for a global agreement to reduce CO_2 emissions 20 per cent below the 1988 level by the year 2005.

The Toronto target was not based on extensive scientific analysis, since not that much had appeared at that time. Instead, it reflected a desire by the conference to choose a number large enough to signal a decisive change from business-as-usual, but not so large that governments would dismiss it as unrealistic. Tracking the sources of this kind of judgment is never easy. But it is notable that the first cutback in CFC production mandated by the Montreal Protocol was 20 per cent.

With this recommendation, the focus was fixed on emissions targets placed in a short-term timetable. From that point forward, in the American and European environmental movements and in politics generally, a government's position on short-term emissions targets has been taken quite generally as the key indicator of its seriousness of purpose in addressing climate change.

In the spring of 1992 negotiators completed the Framework Convention on Climate Change which, like the first treaty on the ozone layer seven years earlier, stated a goal for emissions reduction but did not legally commit any countries to it. This Framework Convention was signed with great ceremony at the United Nations Conference on Environment and Development, in Rio de Janeiro. In 1995, at the first conference of parties (COP-1) to the Framework Convention, these governments acknowledged that voluntary cooperation was not producing reductions in emissions and they agreed to proceed, as in the ozone case, to a further protocol that would establish mandatory and binding commitments among the industrial countries. That started the process leading to the Kyoto Protocol to the Framework Convention at the December 1997 COP-3 in Japan. The Kyoto treaty was to put teeth in the promise to cut emissions of the greenhouse gases, just as the Montreal Protocol a decade earlier had imposed mandatory and binding commitments to cut consumption of CFCs and the other gases attacking the ozone layer.

But because the issues were much more complex, the Kyoto conference did not go as smoothly as its predecessor at Montreal. The United States, which had been the leader in the ozone case, was a skeptic at Kyoto. Several months before the conference the U. S. Senate, by a vote of 95 to 0, had passed a resolution warning President Clinton

not to accept any treaty that did not also commit developing countries to "meaningful participation" in any control regime, understood to mean actions that would not allow developing countries to take advantage of a partial agreement. To be ratified by the United States, any treaty would require a two-thirds vote in the Senate. But to be negotiatied in the first place, developing countries would have to agree to whatever provisions the Protocol contained. Those countries vociferously opposed any binding obligations, even those of a putatively no-regret nature, and the final text of the Protocol essentially obliges developing countries only to pursue with renewed vigor the monitoring and analysis of their GHG sources. (Note that the FCCC itself obliges all countries to act in ways that simultaneously promote sustainable economic development and climate protection. However, there is no way to translate this into concrete leverage over developing or developed countries' actions.)

The Clinton administration also made it clear that it wanted a system of international trading in emissions permits, to enable the United States and other industrial countries to meet part of their required cuts by buying permits from other countries -- presumably Russia and developing countries. As the Kyoto text emerged, however, it left the trading rules conspicuously vague. Moreover, as it dawned on other countries that the Americans meant to comply mainly by buying permits abroad, rather than by reducing emissions at home, many negotiators -- particularly among the Europeans -- began demanding limits on the amounts that any country could buy. That has generated a further dispute, still unresolved.

In their efforts to end the conference with a successful consensus, its managers also set aside several other issues. The text does not address the questions about who is to verify the countries' emissions, and what is to be done about countries that fail to meet their obligations. The text acknowledges a promise to give the poor countries financial and technical aid but is altogether vague on the amounts and terms. While this promise of aid is not much discussed in the United States, in the developing countries it is considered central to the whole subject of Kyoto and emissions control. The negotiators continued to work on these issues at COP-4 in Buenos Aires and to the present, but progress remains limited. Meanwhile a substantial body of recent analysis has raised other kinds of questions about the economics of the Kyoto treaty.

The Issue of Timing

The Framework Convention declares, in its section on principles, that "policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost" (Article 3, section 3). A number of papers published in the past several years conclude that the lowest-cost path to any targeted concentration of greenhouse gases in the atmosphere would begin gradually and leave the more drastic reductions in emissions until the later decades of the program. For example, a recent study by Manne and Richels (1997) finds that the Kyoto Protocol followed by subsequent least-cost policies designed to reach a long term concentration level of 550 ppm is 40 percent more expensive than a strategy that embraces least-cost policies from the outset. (See also Richels and Edmonds 1995 and Wigley et al. 1996.) The sharp reductions in emissions by the period 2008-2012 under the Kyoto treaty provide little when flexibility

and thus do not lie on the lowest-cost path to any plausible long-term GHG concentration target.

Four reasons for back-loading the heaviest cuts in emissions are generally offered in the literature. First, the world's investments in fuel-burning equipment are vast, and to replace that equipment before its normal life has ended would be extremely expensive. It's quite true that technologies are available to use energy more efficiently, with lower emissions of greenhouse gases, than much of the present equipment does. But an electric power generating plant, for example, is often built with an expected life of 40 years. To replace it after only 20 imposes a cost on society.

Under the Kyoto treaty, if it is ratified and put into force, the United States would be obligated to reduce its greenhouse gas emissions during the period 2008 to 2012 to a level equal to 7 per cent below the 1990 emissions. But with economic expansion the country's emissions are already 10 percent above the 1990 level, and U. S. Energy Information Administration projections indicate that under present policy, by the year 2010, US emissions would be more than one-third above 1990. Meeting this target provides a time frame hardly longer than the life of an automobile, let alone heavy industrial equipment.

Second, technology steadily finds ways to use energy more efficiently, with fewer emissions. By postponing drastic cuts in emissions for several decades, the world's economy could take advantage of technology that is not yet available. Third, the discount rate argues in favor of delaying the heavy expenditures. A dollar invested in 1998 at a real (after inflation) interest rate of 2 per cent a year would be worth $1.88 in the year 2030 and could buy almost twice as much then as now. More generally, if a dollar is saved today and invested in science, or education, or any of the other contributors to economic development, it will result in a richer society. Each dollar spent on emissions control two or three decades from now would represent a smaller proportion of society's wealth, and would be a smaller burden on society.

Fourth and finally, CO_2 in the atmosphere is constantly absorbed by the oceans, the forests, soil and other sinks. Not all of the CO_2 that human activity throws into the air is absorbed, of course, and that is why concentrations in the atmosphere are rising. But something over half disappears that way. If the sharp cuts in emissions are postponed, some of the CO_2 emitted to the atmosphere in the meantime will have disappeared naturally before the concentration reaches the target. This is relevant since it is the concentration of greenhouse gases, not the annual emissions, that influences climate change.

Each of these four points has generated controversy. (Perhaps it's worth observing that, in the professional literature, most of the papers supporting a gradual approach postponing severe cuts have been written by American economists, and most of the rebuttal has come from Europe – see, for example, Grubb et al. 1995 and Ha-Duong et al. 1997.) To many questions, the present state of economic knowledge cannot provide a categorical answer. First, will research and development, for example, produce significant advances in energy technology in the absence of the pressure exerted by mandatory emissions cuts? What exactly are the incentives that will produce the

technology the world would need to reduce emissions substantially without crippling industrial production?

Debates rage in the literature on the importance of this induced or endogenous technological change. A recent paper by Goulder and Mathai (1998) considers two channels for knowledge accumulation: R&D activity and so-called learning by doing. Goulder and Mathai find that the inclusion of endogeneous technological change in their model lowers the size of the carbon taxes required to obtain alternative concentration targets. The impact of the endogenous technological change on the optimal abatement path varies. When knowledge is gained through R&D investments, some abatement is shifted from the present to the future, thereby supporting the notion of backloading. However, when knowledge is gained through learning by doing, the impact on the timing of abatement is ambiguous. Nordhaus (1997) concludes that induced innovation in itself is not likely to rationalize a rapid and major cut in GHGs unless the returns are at least an order of magnitude larger than the "already supernormal" returns to R&D assumed in the model.

A central related argument against the option of beginning gradually is that, in the absence of dramatic and forceful change, people will not take seriously the need to curb emissions. Companies' management and private consumers alike, the argument goes, will not change their habits and begin to make the investments necessary to carry them into the era of low emissions. Postponing severe action will merely mean that, a generation from now, the world will face the same need to cut but from a much higher level.

One response is that the argument about credibility cuts both ways. If a program turns out to be too expensive and disruptive, it will collapse and discredit the whole idea of controlling emissions. Politicians are left to struggle with the same question with which the Toronto conference tried to deal a decade ago: What's the size and shape of an emissions cut big enough to persuade people that profound change is coming, but not so big that they dismiss the whole idea as unrealistic? But in so doing, they must take into account the large potential cost savings from increased when flexibility.

Price Versus Quantity

The Clinton administration's analyses indicate that under the right circumstances, the cost of Kyoto to the American economy would be small. The analysis indicates that a "shadow price" on emissions somewhere around $14 to $23 per ton of carbon equivalent would bring the country into compliance with the treaty's target. That would be 0.1 per cent of GDP in the year 2010, or an increase of $70 to $110 per year in the average household's cost of energy.

Estimates by other analysts run higher, in some cases substantially so. Some analyses calculate that emissions fees as high as $300 a ton would, under some circumstances, be required. (A forthcoming special issue of *Energy Journal* edited by John Weyant provides an excellent review of the cost literature.) That would be well over 1 per cent of GDP, or an increase in the average household's energy costs as high as $1500.

Many of the disparities among these figures arise from the differing assumptions on which they are based. The most important is the assumption regarding trading of permits. The Clinton administration analysis assumes that there will be full worldwide trading, enabling the United States to buy from other countries as much as 85 per cent of the permits it would need to comply with the treaty. The cost and penetration of more energy-efficient technology is another important factor (see Interlaboratory Working Group 1997).

Since the rules for trading under the Kyoto treaty have yet to be worked out, nad there is no prior experience with broad and substantial GHG cuts, it is not possible to know what assumptions and projections are more accurate or realistic. It is hard to say more than to note that various sets of numbers are defensible results of the assumptions on which it is built. Nevertheless, fears of inordinate cost to reach the Kyoto targets are widespread in Congress.

One way to resolve the issue of cost uncertainty, at least within and among the Annex I industrial countries, would be to impose a low fee on emissions and see how much of an emissions reduction the world's economies get at that price. A low initial fee could be raised over time to move gradually toward a longer-term GHG concentration goal. One variation on this theme, known as the safety-valve option, would require tradable permits for emissions but with an agreement to sell unlimited amounts of them for, say, $25 per ton of carbon equivalent (see Pizer 1997 and Kopp et al. 1999). These approaches would create greater incentives for emission reductions (compared to the present zero value of carbon) while assuring that nations would not face extremely high economic costs. They would permit governments to calibrate the relationship between cost and reduction, using real data from actual experience. And they could be combined with international cooperation with developing countires through the Clean Development Mechanism.

The chief objection is to this approach, which is very much in the spirit of Weitzman (1974), is that it would not promise to produce a specific reduction on an agreed timetable. One then returns to the question of guaranteed emission reductions compared to what. If the Kyoto Protocol is not ratified in a timely way, few if any emission reductions will materialize. Hard quantity targets also could be justified to safeguard against catastrophic climate change. Such catastrophes cannot be ruled out, though they are highly uncertain. More to the point, they are highly uncertain over a short-to-medium time frame. By starting with more modest price-based policy targets and gaining experience with GHG control while also providing more time for scientific knowledge to accumulate, the world gives up little in the way of options to act more decisively in the future as warranted (Kolstad 1996).

Another concern is the difficulty of implementing carbon charges or a safety valve on an international scale, even among the Annex I countries. There is no precedent for international policies of this type and scale, nor would it be easy to devise a system that imposed burdens on very different economies in a way acceptable to those countries. This leads to broader questions related to incentives for international participation in the Protocol and the Framework Convention.

Policy Design and International Participation

The discussion to this point has been concerned with policy design and target flexibility at the domestic level. Yet, a key to the success of any GHG control program is broad international participation. And at the international level, the arguments are less clear-cut.

Recently, Cooper (1998) has authored a stinging attack on the Kyoto Protocol because of its reliance on national emissions targets and its failure to embrace mutually agreed-on policy measures. Specifically, he argues that the control of GHGs, unique among international environmental challenges, will involve behavior changes by billions of people, not merely the fiat of 180 or so governments.

To accomplish this, Cooper supports an international regime of carbon-based energy taxes over quantity targets and tradable permits. Cooper's argument rests heavily on the observation that the key to GHG reductions lies not in government exhortations or in international treaties per se, but in the incentives governments provide to their citizens and the exercise of their own economic self-interest. While taxes and tradable permits induce cost-effective private sector responses, Cooper sees the primary advantage of taxes as being the generation of revenue for governments whose usual revenue sources reduce productivity. Although Cooper raises the possibility of using some of the revenues for the direct benefit of developing countries, he posits that most of the new tax revenues would be used to reduce other taxes, notably those with the largest adverse effects on productivity. Cooper also argues that monitoring national compliance with a carbon tax would be relatively easy through the International Monetary Fund's ongoing national consultations.

In contrast, the Kyoto agreement requires the allocation of national rights to GHG emissions. Yet, Cooper argues, "there is unlikely to be any generally acceptable principle for allocating valuable emission rights between rich and poor countries" (Cooper 1998, page 68). Finally, he appeals to history in arguing that "international cooperation in other fields has progressed most successfully when there was agreement not only on the objective but also on how best to achieve it….[T]he absence of scientific consensus on how [GHGs] translate into global warming and how these temperature changes in turn affect the human condition will make it difficult to agree on how to share the costly actions….But taxes, like death, are inevitable as well as universal, and they can more profitably be imposed on harmful activities than on socially valuable ones" (Cooper 1998, page 79).

Eizenstat (1998) notes the widespread public opposition to new taxes and cites history to argue that "no international agreement has ever imposed an obligation on countries to tax their citizens" (Eizenstat 1998, page 120). Unlike Cooper, he believes that the required level of international scrutiny on domestic tax decisions would prove to be extraordinarily difficult to implement. But neither Cooper nor Eizenstat satisfactorily addresses the long-term problem of broadening participation to include developing countries. Would the US accept a recycling of carbon tax revenues internationally to favor developing countries? Would it accept a lopsided allocation of future GHG permits to developing countries?

Wiener (1998) adopts a somewhat different tack in support of tradable permits and against either a tax or a hybrid approach. He examines whether the legal frameworks in force at the national level imply particular choices for regulatory instruments to be used at the global level. He suggests that the presumption favoring environmental taxes derives from a standard analysis of instrument choice in which it is assumed that the regulator can compel polluters to comply by fiat, and that the regulator can impose the instrument directly on polluters without any intermediate level of government in the way. Yet, he argues that neither coercion nor direct regulation applies to international treaties. Rather, such treaties depend on countries' voluntary assent, and on implementation through national governments.

Wiener examines the impact on regulatory instrument choice of two basic legal parameters that differ between the national and global settings: voting rules and implementation structures. He concludes that "the jurisdictional obstacles to taxes…[are] quite serious." Like Eizenstat he believes that it will be much harder to monitor national agents' internal fiscal manipulation under a global tax regime than to monitor their agents' actual emissions under a global quantity-based regime.

Last, but not least, Wiener argues that international transfers to developing countries are crucial for expanding participation in GHG control and stabilizing the atmosphere, and that such transfers are much more effectively accomplished by the international allocation of GHG rights and their sale through market channels than through intergovernmental redistribution of carbon tax revenues. Wiener would characterize Cooper's objections to quantity policies as relating more to the limited degree of commitment developed countries actually feel to reduce GHGs over time than to an advantage of taxes over quantity policies. In Cooper's scheme the degree of quantitative policy coordination would be limited (developing countries are unlikely to accept tax rates as high as the OECD would need to meet their environmental and fiscal goals), and the degree of international resource transfer to poorer countries also would be limited, implying low GHG tax rates internationally and relatively little GHG reduction.

Even if one accepted Wiener's basic premise, many questions remain before a practical near-term international approach to climate change can be crafted. Cooper is right in underscoring the enormous difficulty in establishing international agreement on how to divide up rights to emit GHGs over the longer term. This difficulty is reflected in the real-world controversies surrounding international equity in the climate negotiations, where one finds vehement opposition by spokespeople of developing countries to US and other developed-country proposals for a flexible approach to GHG mitigation on the grounds that it may create economic or environmental disadvantages for the developing world. Proponents of GHG allocation formulas from developing countries have proposed a variety of formulas reflecting the basic notion of an equal per-capita right to emit GHGs and the developed world's responsibility for its historic GHG emissions. Developed countries in turn have staunchly resisted such proposals as involving politically unacceptable ex post liability and income redistributions along with inadequate

provisions that resources transferred would actually generate international environmental benefits.

Even a cursory review of the growing literature on international equity in GHG policy casts grave doubt on the notion that some simple formula will resolve this dilemma. (Burtraw and Toman 1992, Rose et al. 1998). While it is possible to find convex combinations of allocation rules that generate less lopsided distributional consequences than simple approaches like equal GHG allocations per capita or per unit of GDP, it is still questionable whether such ad hoc approaches can command broad political support. More to the point, it is questionable whether the climate negotiations most need a formula right now. Instead, it may be more useful to look for a *process* that can gradually increase the engagement of developing countries in GHG control, while increasing understanding of the options available and building international confidence in international mechanisms as they evolve. This gradualistic approach with an emphasis on learning by doing is akin to the industrial organization idea of "relational contracting" in the face of manifold uncertainties, in which an agreement to a longer-term relationship is espoused and maintained but ythe terms of the relationship evolve as needed rather than being firm in advance. It also is a logical extension of our earlier arguments concerning the value of gradual and flexible domestic policies of Annex I countries.

The Clean Development Mechanism provides one means for pursuing this approach. Even the most ardent proponents of the CDM concede that it will have higher transactions costs, greater monitoring difficulties, and lower overall efficiency than other options like a full-blown permit trading system. But it is a place to start.

CDM projects can provide concrete information on GHG control opportunities and costs in developing countries as well as more or less tangible GHG reductions, cost-saving benefits in developed countries, and economic benefits in developing countries. Specific institutional measures, like a liability system that holds international investors at least partly responsible for project shortfalls, can improve credibility. The "leakage" problem with a project-based approach is vexing, but it can be addressed by defining rules of thumb for different project categories that can be updated over time and, equally important, by encouraging the voluntary adoption of growth baselines in developing countries. To protect the longer-term bargaining positions of developing countries, it must be absolutely clear that such baselines are for defined periods and for the reckoning of CDM credits only, with no prejudice as to future divisions of GHG responsibilities.

Developing countries have expressed a concerns about an uneven playing field for negotiation of CDM deals. A proposed solution to this problem has been the embedding of CDM in a multilateral institution, such as an expanded GEF, in which developing countries individually and collectively can exert influence on what CDM projects are undertaken and how. The problem with this approach is that it risks drowning an imperfect but potentially valuable international market mechanism in a transactions-cost-intensive international bureaucracy. Developed countries should stand fast to the idea of promoting the CDM as a market mechanism with maximum operational participation by the private sector, while also acknowledging the right of host developing countries to veto projects they find unacceptable.

Another developing country concern has been the risk of "giving up the low fruit" – having low-cost CDM projects undertaken early with international partners and then not having these options available later when or if binding commitments are undertaken by developing countries. While it is important to understand this concern from a political perspective, it is also important to note that developing countries with the capacity to act in their own self-interest can negotiate terms and conditions for CDM projects that reflect the best tradeoff for them between short-term economic and environmental benefits, and the longer-term value of retaining low-cost options for GHG domestic control. Given the high opportunity cost of capital in many developing countries, the prospects for local environmental benefits from CDM projects, the uncertain prospects for when binding GHG targets would be undertaken, and the possibility that today's low-cost GHG abatement opportunities may be tomorrow's "lost fruit" because of technical progress, it seems clear a priori that CDM projects could yield substantial benefits to developing countries as well as Annex I partners.

While the CDM can help start international climate cooperation, it is not a substitute for broadening formal international commitments and developing more cost-effective mechanisms. As noted, Wiener asserts the need for some kind of broad-based international GHG trading system in the long term, with clearly established national GHG emission budgets. If one pursues this line of thought, while also acknowledging the difficulty of once-and-for-all bargaining over the distribution of national budgets, one is drawn to the "graduation" idea that is receiving increased attention in the literature (see, for example, Richels and Edmonds 1995 and Brandt and Stevens 1998). The essence of this idea is that developing countries gradually assume more responsibility, in a relatively predictable way, as their economic circumstances and thus their ability to pay improves.

The strategy is by no means a panacea. For example, once-and-for-all negotiation of a graduation formula is likely to be difficult, though perhaps less than one-shot negotiation of national GHG budgets in that the formula allows feedback between economic performance and developing country commitments. One might attempt to allow periodic renegotiation of the formula, but this could create incentives for holding out. And balancing environmental and economic concerns in the formula will be difficult, though no more so than in any other approach (and less so compared to approaches that require excessive fixity of commitments in the face of uncertainty). Despite these challenges, graduation seems to be one of the most promising ways to operationalize the FCCC's concept of "common but differentiated responsibilities," and it should receive considerable further attention.

Conclusions: If the Kyoto Treaty Stalls

It is a gigantic undertaking to organize a cooperative worldwide program limiting the emissions of greenhouse gases. Some 180 governments are now involved, and all now realize that any useful attempt must affect their economies deeply. But amidst all the gaping uncertainties of this subject, there is one thing that can be stated with assurance: A program that offers great flexibility and relatively low economic costs will have a better chance of actually being adopted than an inflexible and expensive one. In the range of all

possible approaches, the Kyoto Treaty lacks significant elements of when and how flexibility.

At first glance, the present process of post-Kyoto negotiations looks like nothing more than a tedious process of jockeying over minor technical points. The more accurate explanation of the delays is, however, that many governments have begun to realize the extent to which the treaty opens difficult questions requiring further thought. They are now grappling, not with final details, but with the enormous economic implications of the treaty itself. That is why the progress toward completing it is turning out to be very slow.

If this slow progress continues, governments will eventually have to consider whether Kyoto was not a false start. As this paper has suggested, there are alternative policies that, in economic terms, offer a more promising start. For Annex I countries these include active embrace of when and how flexibility through less ambitious but accelerating emission control targets with price-based policies to limit compliance cost shocks. For developed and developing countries alike, the challenge is to find ways to use the concept of the Clean Development Mechanism to the best possible effect and to continue discussions on how all Parties' interests can be served by a gradual broadening of GHG control commitments consistent with a still-evolving science of climate change risks and the legitimate aspirations of poor countries for sustainable development.

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