

9. International agreements and the struggle to tame carbon

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1 INTRODUCTION

My task is to comment on the role of international agreements for controlling carbon. I undertake this effort at a time, summer 2001, when the attempt to build an international regime to manage carbon is in disarray. The US government has abandoned any pretense of ratifying and implementing the Kyoto Protocol while most nations in Europe are leading a coalition that will attempt to bring the Protocol into legal force even without US participation. The US is leading an effort to think about alternatives to (or radical reform of) the Kyoto Protocol, perhaps even scrapping the idea of a new treaty altogether. The European Union is leading an effort to finalize agreement on the many detailed issues, such as accounting rules, that are necessary if the Kyoto Protocol is to serve as the architecture for international efforts to slow global warming. These nations are establishing two separate paths with potentially two competing architectures and conflicting rules. Now is an opportune time to step back and explore the fundamentals – what are we trying to achieve with an international agreement on carbon, and what are the architectural options? This chapter offers some answers.

First, a brief review of the main findings from the previous chapters in this book suggests some attributes of the climate change problem that must be taken into account when attempting to design an effective international agreement to combat the problem. Chapter 2 by Schlesinger and Chapter 3 by North underscore that there is little direct, immediate relationship between carbon emissions over a particular period in time and the climate of that period. Rather, human-caused changes in climate are a function of the growing concentrations of carbon dioxide and other greenhouse gases that accumulate in the atmosphere over long periods of time. Yet many of the proposals under discussion in the international diplomatic efforts to address global warming, including the Kyoto Protocol, envisage imposing high costs from controlling emissions over the short term and do not set long-term goals (see Edmonds and Sands, Chapter 7). This approach contrasts sharply with

the results from the economic model presented by Manne in Chapter 8, which suggests that a more efficient strategy would involve much more modest control policies in the first few decades, which would send long-term signals to the economy and, over long periods of time (five decades and beyond) have a significant impact on atmospheric concentrations of greenhouse gases.

Over the long term, the benefits of controlling emissions could be substantial since it could prove especially difficult to adapt to large, unchecked changes in climate (see Mendelsohn, Chapter 5). The studies in this book also underscore the tremendous uncertainty in the shape of the marginal damage function from this growing concentration of CO₂ and other greenhouse gases. The uncertainties stem, in part, from incomplete knowledge about the relationship between CO₂ concentrations and climate (see North, Chapter 3) and particularly from the difficulties in linking changes in climate to particular damages (see Mendelsohn, Chapter 5 and Smith et al., Chapter 6).

Taken together, these findings suggest the need for an international strategy based on long-term goals and commitments as well as one that is adaptive to new information. Those two criteria – adaptive to new information and long term – are not completely compatible. The international system is highly adaptive because treaties, the main instruments of international governance, require the consent of governments to have force. Thus treaties are relatively easy to adjust in response to changing interests and information. Indeed, every major international environmental agreement is explicitly designed for change – in some cases, changes in commitments occur through conferences at which governmental representatives agree to adjust rules, and in other cases the treaties themselves are rewritten or amended and then subjected to re-ratification by their members.

While it is relatively easy to design agreements that can adapt to changing circumstances, the very flexibility of international law makes it much harder to create agreements that send credible long-term commitments. It is hard for states to bind themselves, collectively, to long-term commitments when international law allows those very states to change or abandon their commitments. This fact can lead to particularly unstable agreements when addressing problems, such as climate change, that require interdependent commitments. The level at which one state is willing to control its emissions depends on the level of others' efforts, in part because costly emission controls affect economic competitiveness. The defection of a single large player alters the calculus for all others, leading to a much less ambitious equilibrium in level of control that governments are willing to codify into international treaties.

Much of the controversy today about the Kyoto Protocol between economists and activists is, in part, a controversy about the best solution to this difficult task of setting credible long-term commitments. Economists have

been particularly mindful of the long-term nature of the climate-change problem and the short-term costs of controlling emissions. Activists have been more concerned about the need to get some short-term commitment, even if it is inefficient, that sends a credible signal for the longer term. For economists, the troubles with the Kyoto Protocol offer an opportunity to rethink the architecture for the collective effort to slow global warming. For activists, rethinking the architecture is particularly threatening because it is the source of still further delays in sending a credible signal.

Thus we are dealing with a problem that is particularly ill suited for the instruments available under international law because it spans long time periods and is marked by short-term costs with benefits that accrue only over long time periods. To examine the types of agreements that will be stable and effective, we must look closely at the interests of each potential member of the treaty since each must ratify the deal. Thus Section 2 starts by focusing on the advanced industrialized nations because they are the only ones willing to pay for any significant abatement in greenhouse gases. Any viable framework for controlling carbon dioxide and the other greenhouse gases must start with them. I am mindful that Mendelsohn in Chapter 5 suggests that some of those nations may actually benefit from some global warming. Thus even with these nations, it may be hard to gain agreement on an effective emission control program. I examine four options and dismiss all but one. What is left is known as the 'hybrid' approach to regulating pollution, and I explore why it is superior to the others in delivering an agreement that will be economically efficient as well as matched to the interests of the major participants.

In Section 3, I examine the incentives at work in the developing world and conclude that the current efforts to force developing countries to undertake emission targets will lead either to deadlock or to an agreement that does little to slow global warming. Finally, in Section 4, I comment on the prospects for solving the problem of greenhouse gas emissions directly – through massive investment in new technology. Section 5 concludes.

Throughout, my treatment is sparse and focused on the political and institutional issues that arise, especially, in the international system. That system operates in ways that are very different from national law, but the differences are often not well appreciated. The key difference, as will become clear, is the voluntary nature of international law and the weakness of enforcement mechanisms – those twin problems are severe, and they lead to some unusual advice. For simplicity, I also focus on carbon dioxide emitted from fossil fuels. Other gases, in particular methane, also contribute to global warming; but fluxes of methane are hard to measure accurately and have much shorter lifetime in the atmosphere and are much less important to the long-term global warming problem than the accumulation of carbon dioxide in the atmosphere.

2 A FRAMEWORK FOR CONTROLLING CARBON: THE INDUSTRIALIZED COUNTRIES

The centerpiece of any international strategy for addressing global warming over the long term must be a system that puts a price on carbon. So long as it costs nothing to emit carbon, there will be only weak incentives to innovate and apply technologies to reduce carbon.

The core of that effort must begin with countries that have the highest willingness to pay for carbon controls – the advanced industrialized nations. Some argue that these nations must lead because they are responsible for most of the problem – only if they lead will an agreement be 'fair', and fair international agreements (it is assumed) are more effective than those that are unjust.¹ The evidence that fairness leads to more effective agreements is actually pretty weak, especially when commitments require governments to implement costly actions.² In the past, governments have adopted many agreements that appear to be 'fair' and appear to work. For example, the Montreal Protocol, adopted in 1987 and amended several times since, which requires the industrialized countries to phase out their use of chlorofluorocarbons and other ozone-depleting substances rapidly while giving the less wealthy developing countries a longer timetable for compliance. This treaty also requires the industrialized countries to pay for the 'agreed incremental cost' of compliance by the developing countries. This treaty appears to be the quintessential 'fair' bargain. In reality, this and all the other examples of effective treaties are actually examples of a different principle at work: willingness to pay. It so happens, that for most of the international environmental problems on the world agenda – including global warming – willingness to pay is highly correlated with income and liberalism. The advanced industrialized democracies contribute most to the problem at hand, but they also have the highest willingness to pay. In contrast, treaties such as the 1994 Convention on Desertification have been largely symbolic, because the countries that have the resources to address the problem at hand are not willing to pay much for a solution. Most of the variation in the ability of international law to influence behavior is explained by this phenomenon.

The cause of this phenomenon will become a familiar refrain in this chapter: it is difficult to impose an obligation on a reluctant country. One can compensate (bribe) another state to participate, as in the Montreal Protocol's arrangement for paying the 'agreed incremental costs' of compliance. Exactly that is done today under the Framework Convention on Climate Change, the only multilateral treaty on global warming that is in force under international law. But compensation can probably go only so far before the industrialized countries will want the developing nations to shoulder some of the burden. Or, one can coerce reluctant countries to join. One can lean on

allies, threaten retaliation, and generally be nasty in international politics to force the reluctant to play, but those efforts only go so far. Studies on the influence of economic sanctions, for example, show that they are often blunt and ineffective (Hufbauer et al., 1990). I see only one way to coerce reluctant countries into participation in a climate-change regime and that is by coupling participation in the regime to the benefits of membership in the World Trade Organization (WTO). Yet integrating global warming and trade is fraught with danger – it could severely upset the world trading system, it poses novel legal and technical problems, and it is politically impossible in the foreseeable future. Today, the WTO membership is large and the majority of nations are developing countries, nearly all of which have been hostile to linking trade with environmental protection.

Thus any effective global warming treaty must be largely in the interest of the signatory country – either because it wants to undertake controls on carbon or because it is paid to do so. That is a hard test to satisfy, and it is why the Kyoto Protocol is in such trouble today. The treaty imposes costs on economies that far exceed what they are willing to pay. What would a viable treaty look like? In this section, I examine that question from the vantage point of the industrialized countries – those nations that have a non-zero willingness to pay. In the next section I examine the developing countries – those where willingness to pay is approximately zero. These two groups have different incentives and they must be examined separately. For the former, the question is, ‘How to put a price on carbon?’; for the latter, the question is, ‘How to control carbon while avoiding a price?’.

The Kyoto Protocol

Of course, there is already an international agreement that seeks to control carbon – the Kyoto Protocol. It requires 38 industrialized countries to control their emissions, on average, 5 percent below 1990 levels by the years 2008–2012. Each country has its own emission target, set forth in Annex B of the Protocol. The Protocol envisages creation of an emission trading system that would let countries trade portions of their targets, which would give them flexibility. The model for this system is the sulfur dioxide emission trading system under the 1990 Clean Air Act in the United States. The theory of emission trading is well established, although in practice the many countries emission trading have delivered uneven results because markets are often poorly designed (Tietenberg, 1985; Hahn and Hester, 1989).

At the time of writing (March 2001), the Kyoto Protocol is in the midst of a slow motion meltdown. The proximate cause of its troubles is the Bush administration’s announcement that it would not control carbon dioxide emissions at the levels mandated in the Kyoto Protocol.³ With the world’s largest

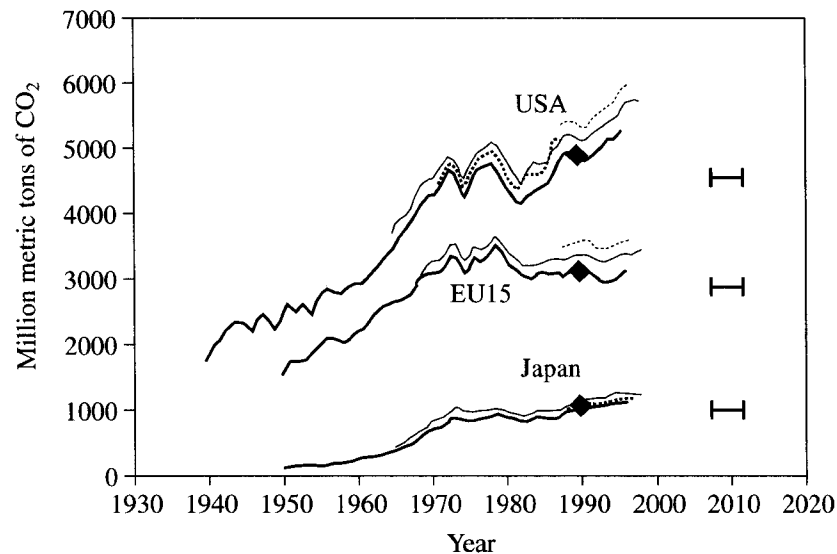
emitter not limiting its effluent (about 25 percent of the world’s total emissions), other countries will find it hard to justify subjecting their economies to costly emission controls when the US does not. The need to preserve a ‘level playing field’ in the world economic competition will make that scenario hard to swallow.

The intermediate cause of Kyoto’s troubles is that the targets set in Kyoto were too ambitious. They envisaged achieving significant reductions in emissions below the level at which the world’s major economies would otherwise grow, over a short period of time (barely a decade after the ink was dry on the Kyoto accord). Yet the lifetime for technologies that are responsible for most emissions – such as electric power plants, houses and factories, and automobiles – is relatively long. The time set for the Kyoto emission caps is not commensurate with the time scale for technological change. I shall return to technology at the end of the chapter, since that offers one way forward.

The troubles are immediately evident in Figure 9.1, which shows historical emissions of carbon dioxide for the three most important political units among the countries that have some willingness to pay for slowing global warming – the United States, the European Union, and Japan. None is on track to comply with the Kyoto targets; yet the clock is ticking. When President George W. Bush announced that the US would not implement the targets, he was merely stating a position that reflects the situation in most other advanced industrialized nations. It is just that no other nation dares publicly declare that it will not comply with the target for fear of political crucifixion. The Kyoto Protocol has become a symbol for efforts to slow global warming, and one crosses the symbol only at peril.

There are at least three scenarios by which the advanced industrialized nations could comply with the targets, but none is attractive. First, diplomats might make it easier to comply with the Kyoto caps on emissions by playing accounting tricks. Notably, the Protocol includes language that allows countries to take credit for ‘sinks’ that remove CO₂ from the atmosphere. When plants grow they accumulate carbon in their trunks, stems, roots and leaves, as well as in surrounding soils. Agricultural soils are important sinks. In the United States, for example, starting in about 1910, when tractors made it easier for farmers to plow deeper, intensive tilling has reduced the carbon content of soils. Since the 1950s, farmers have shifted to ‘no till’ techniques that have helped slow soil erosion while also fortuitously increasing the carbon content of soils. Trees are especially important. Forests are growing larger and denser in all the advanced industrialized countries, in part because efficient farming is reducing the need for cropland and some of the abandoned land reverts to forest.⁴

Luck and clever accounting could deliver large credits for these sinks. One data set suggests that the US could offset about 14 percent of its current



Note: The figure shows historical data from four semi-independent data sources and thus indicates the low uncertainty in the data. The large diamonds show the official data reported by countries for 1990, the base year for determining compliance with the Kyoto targets, which are shown as bars from 2008–12. US emissions have continued to rise steeply since the early 1990s, but emissions in Europe and Japan are more flat. Data exclude carbon sinks (for example, forests and soils) as well as non-CO₂ greenhouse gases.

Sources: Oak Ridge National Laboratory (solid heavy lines), IIASA/WEC (International Institute for Applied Systems Analysis/World Energy Council) (dashed heavy lines), BPA/moco (solid light lines), EIA (Energy Information Administration) (dashed light lines).

Figure 9.1 Trends in CO₂ emissions from combustion of fossil fuels

emissions if it were awarded full credit for 'land-use change and forestry' – a significant downpayment that could amount to nearly half of the required reduction during 2008–2012.⁵ The more credit awarded for CO₂ that plants and trees are already absorbing, the easier it is for nations to comply with the Kyoto Protocol targets without actually changing behavior.

But this strategy founders on the lack of widely accepted methods and data for counting sinks.⁶ Even if nations could agree on the necessary procedures, there would still be enormous potential for cooking the books. Only a monitoring program larger and more intrusive than anything ever attempted under international law could settle the inevitable disputes. In temperate and boreal regions, where all the advanced industrialized nations are located, most carbon in forests and in the soils varies naturally. Decades of monitoring would be needed to be certain that a 'sink' was not merely transient and deserved

full credit.⁷ Yet the commitment periods under international law are typically much shorter, such as the five-year 'budget period' of the Kyoto Protocol.

A second dead end is for nations in deficit to earn credits overseas in developing countries through the Clean Development Mechanism. Diplomats still have not been able to agree on the rules that would govern the Clean Development Mechanism. Thus investors are still not sure whether and how they could earn credits through these mechanisms. Years of preparation, testing, and learning will be required to build a pipeline of sensible projects. Time has run out for firms and governments to earn large quantities of credits by investing in emission-reducing projects through the project-by-project, Clean Development Mechanism.

Emission trading is a third way to ease compliance, but it also leads to a dead end. At the time of writing, negotiations on the rules to govern emission trading had broken down in The Hague in November 2000 and were patched together in the summer and fall of 2001. Even if governments solve considerable technical and political problems, such as how to enforce compliance, emission trading under the Kyoto Protocol still poses a significant political problem. Russia and Ukraine are by far the cheapest source of emission credits – not because the Russians and Ukrainians have had an epiphany about the risks of global warming, but rather because their negotiators got an emission target in Kyoto that far exceeds their likely level of emissions. Russia and Ukraine agreed in Kyoto to freeze emissions at 1990 levels, but the collapse of the Soviet economy in the early 1990s means that their emissions are already far below that target and unlikely to recover fully by 2008. Selling the windfall to nations in emissions deficit – notably the US – could earn Russia and Ukraine about \$100 billion.⁸ About four-fifths of that windfall would flow to Russia. Since the windfall is free – completely an artifact of the luck and skill of the diplomats in Kyoto rather than the result of any effort to control emissions – these extra credits would squeeze out bona fide efforts to control emissions. That buys paper compliance, but no reduction in global warming. No Western legislature will ratify a deal that merely enriches Russia and Ukraine while doing nothing to control emissions and slow global warming.

My interpretation of these events – that the advanced industrialized world is not on track to comply with the Kyoto Protocol and there is no attractive scenario for fixing the problem – is that the Kyoto Protocol will collapse. What next?

After Kyoto

One option 'after Kyoto' is to do nothing to create additional international law and institutions. The Framework Convention on Climate Change will still

be in place, requiring all countries to report data and requiring industrialized countries to make some effort to control emissions. Such a 'best-efforts' regime could promote experimentation with different policies for controlling emissions (Hahn, 1998), and as nations learn which systems work, they might codify them into stricter treaties later on. Indeed, one problem with the Kyoto framework is that governments attempted to codify specific, stringent commitments into international law before they had much shared knowledge about how to implement such commitments.

Whether the best-efforts approach makes sense depends on how much one is willing to pay today to slow global warming. The troubles with the Kyoto Protocol may lead the world to a best-efforts policy for a few years, perhaps longer, as nations figure out what to do next. However, there are two reasons why the analysis should not stop here. First, it would be unwise to let a best-efforts approach flourish without some vision for how more stringent controls on emissions might be codified in the future. As Jacoby and Reiner (2001) warn, there are great dangers that as each nation goes its own way it will be hard to stitch their efforts back together into a coherent, rigorous international system for limiting emissions of greenhouse gases. Second, a best-efforts approach will not be adequate for those who feel that global warming is a severe problem that merits stringent action. The concerns over economic competitiveness require a tighter coordination between countries to ensure that each does its proper share – that coordination requires negotiation over the *allocation* of the effort among nations and also requires mechanisms for *enforcement* to ensure that each does its agreed part. The best-efforts system is poor on both those criteria because, by design, it does not require quantifying and codifying exactly what each country will do; nor does it envisage holding a country's feet to the fire if it fails to comply. Indeed, the chief benefit of 'best efforts' is that it allows flexibility for learning – including failure. My sense is that, especially in Europe, the willingness to pay for policies that will help slow global warming is greater than can be justified by a best-efforts approach alone.

What are the options for a regulatory system that moves beyond Kyoto and beyond 'best efforts?'. When thinking about the options it is useful to return to Weitzman's (1974) insight. Broadly, we can control the quantity of emissions and let the market determine price. That, more or less, is the approach in the Kyoto Protocol, which sets a cap on total emissions. Or, we can control the price (for example, a coordinated carbon tax) and let the quantity fluctuate with the market. Without perfect information, the architects of an international treaty cannot do both. I evaluate both – quantities and prices – with an eye to the three criteria that have already been suggested. First, which approach makes the most economic sense? Second, can nations find a way to allocate commitments under international law? Third, which is easier to enforce?

On the economic attractiveness, the choice is easy. Carbon dioxide, the main cause of global warming, is a 'stock' pollutant. The processes that remove carbon dioxide from the atmosphere operate mainly on long time-scales (five decades and longer), and thus the concentration of carbon accumulates slowly in the atmosphere. Thus the benefits from controls on this growing stock in the form of less global warming also rise slowly and steadily. Short-term variations in the quantity emitted, such as over a few years or a decade, do not have much effect on the total stock of carbon dioxide that is accumulating in the atmosphere. Although the benefits of emission control only emerge gradually, the cost of efforts to limit emissions could be very sensitive to their exact timing. If governments commit to regulate emission quantities but misjudge future costs they could force early premature retirement of carbon-intensive equipment (for example, coal-fired power plants) – a waste of resources that could be invested elsewhere in the economy. By that logic, outlined by Weitzman (1974) and applied by Pizer (1999) to the global warming problem, prices are the best instrument. They send a signal to firms to control carbon dioxide, but they do not require compliance with specific emission targets during specific timetables.

Under international law, a 'price' approach could take the form of an international tax on emissions that would funnel into an international fund. That option is politically impossible for the simple reason that few nations would agree to send 'their' money to a huge international fund. Thus most visions for a price instrument imagine a coordinated carbon tax (Cooper, 1998, 1999). Each country would set and enforce the tax on its own and collect and spend the revenues. The tax might be set at a common level (\$ per ton of emissions) to reflect a common willingness to pay to control carbon. However, it is conceivable that nations could negotiate on an allocation of effort that was not uniform – some that have a higher willingness to pay might impose stiffer taxes. To offset the effects on competitiveness – known as 'leakage' because carbon-intensive production would migrate from high-tax to low-tax jurisdictions – nations might also impose border tariffs to offset the effect of different tax levels. Such border measures would probably run foul of the WTO today, but perhaps they could be permitted in the future. The tax scheme might also allow countries to claim a credit for projects that they fund outside their borders.

Thus the tax approach does well on two criteria – it makes economic sense, and it makes it relatively easy for nations to allocate the effort by negotiating over tax rates. Allocation would not be a trivial process, just as it was not trivial for nations to agree how to allocate tariff reductions and other rules that are the mainstay of international trade rounds. But the tax approach makes the level of effort transparent, and nations may be willing to agree on

differential tax rates even without offsetting border tariffs if only because the worries about 'leakage' will not be severe except at high tax levels.

Unfortunately, the tax approach fails on the count of enforcement. There is no way to know the effective tax level in an economy because governments will impose carbon taxes on top of existing distortions. Also, they may use revenues from carbon taxes to create new subsidies that blunt the effect of the tax. It would be easy to spot the nominal level of the tax, but the real level would be quite hard. This problem is not completely novel to international law; for example, in WTO disputes, complex economic models are used to estimate the effect of illegal trade measures and to quantify the level of retaliation that is allowed when a nation persistently violates its commitments. But the state of economic modeling on energy taxes is far from where it must be to allow such calculations for a carbon tax. Moreover, even if nations could agree on a procedure for enforcement, how could judgments be imposed? In the WTO, which has the most effective enforcement system in international economic law,⁹ retaliation is available because trade is inherently a bilateral activity and in relatively open international markets, there are numerous opportunities for retaliation. No such lever sits ready and available in a system of coordinated carbon taxes – unless, of course, that system is integrated with the WTO, which is an option I have already suggested is highly unlikely.

The score for 'quantity' measures – notably the 'cap and trade' approach that is the hallmark of the Kyoto Protocol – is exactly the reverse. Its economic logic is dubious, unless one posits that certain dangerous thresholds of climate change must not be crossed and one should 'cap' emissions to avoid those thresholds. I note that scholars have argued that such thresholds may exist (for example, Broecker, 1987; Stocker and Schmittner, 1998; Still et al., 1999), but nobody knows where the thresholds lie or even whether they exist. Rather, there is a whole series of long-tailed distribution functions around poorly characterized risks. In that situation, even though thresholds may objectively exist in the real world, the economic logic for abatement is more or less the same as for a simple 'stock' problem. The benefit of lowering the risk that the world will slip across some (unknown) dangerous threshold rises gradually as the accumulation of the stock of greenhouse gases in the atmosphere is slowed. The existence of non-linear threshold effects is what worries me most about global warming, but since we do not know which thresholds and effects will be most dangerous, we are still dealing with a stock problem. A quantity instrument is not the best way to address such a problem.

I note that there is a particular danger in the use of quantity instruments in international environmental law. The political dynamic in negotiating international environmental treaties often rewards bold but symbolic promises. In a negotiation such as the one leading to the Kyoto Protocol, the political

benefits of bold promises are immediate, and the costs are a decade or more distant in the future. That leads to ambitious caps that cause one of two outcomes – neither of which leads to sensible policy. One outcome, now evident, is that as the elixir of symbolism wears off, countries find that they cannot meet their caps and they simply refuse to join the treaty. That, more or less, is the problem of the Kyoto Protocol today. A different outcome is that governments ratify the agreement and then find that they have imposed the quantity nightmare on their economies. They are forcing their firms to meet emission targets during specific time periods that cannot be met except at extreme cost. For evidence of the cost of such constrained markets one need look no further than the electric power exchange in California, where prices periodically skyrocket because demand is rising and supply is constrained. Similarly, if the supply of carbon credits is constrained because technologies in the energy sector are long-lived and the pace of technological change is relatively slow and the demand growth is robust, then prices (and costs) will skyrocket. That should be a real worry for those nations that are still contemplating imposing the Kyoto limits on their economies. What will they do in 2012 if the books do not balance?

The cap and trade approach also scores poorly on the criterion of allocation. Schelling (1997) and Cooper (1998) have argued, correctly in my view, that they do not see any viable way to allocate enormously valuable emission credits under international law. I agree. Elsewhere (Victor, 2001), I estimate that the implied value of the permits issued in Kyoto was over \$2 trillion. One could imagine creating such assets within a system of strong law, such as exists inside nation states and now exists, more or less, across the European Union (EU). Indeed, we do that already. For example, states auction licenses for the wireless spectrum (\$100 billion worth in the EU alone in 2000, thanks to the auction of the 'third generation' of wireless licenses). But under international law it is especially hard to create secure assets because countries can refuse to join (or withdraw from) the treaties that are the instruments of international law.

Allocation of emission permits is particularly difficult not only because the assets at stake are extremely valuable but also because the future demand for permits is highly uncertain. Countries are often risk averse when they contemplate whether to join treaties (Stein and Pauly, 1993). In the case of global warming, they will focus on the downside danger that future emissions and abatement costs will be higher than anticipated, and they will demand additional permits accordingly. Uncertainty exists because governments try to make allocations for a decade or more into the future (as in Kyoto, which in 1997 sought to set targets for 2008–12) and techniques for projecting emissions and costs are contested. Governments could attempt to shorten the lag by negotiating targets for only a few years in the future, but they cannot

shorten by much because of the long delays in ratifying and implementing international agreements. Uncertainty also exists, fundamentally, because the cap and trade system is a quantity instrument. It offers no surety about cost.

This uncertainty creates a destructive dynamic that, in my view, is fatal for the pure quantity approach. When governments attempt to allocate permits they create, in essence, a *negative sum* negotiating dynamic. Each new country brought into the negotiation over allocating emission permits will, like the others, demand additional permits as compensation just in case costs are higher than expected. Yet the countries cannot simply issue additional permits because, like inflation, the extra permits dilute value and lead to additional emissions. This problem is especially severe for countries that are reluctant to undertake any costly emission controls at all and is best seen in the behavior of Russia and Ukraine at Kyoto. Neither country had any willingness to pay for carbon control because, understandably, they had other economic priorities and (with very few exceptions) scientists from the Soviet Academy of Sciences have concluded that some warming would actually be good for these cold countries. It is not surprising, then, that the emission targets allowed for Russia and Ukraine almost exactly equal the highest credible projections for emissions from those countries during the years 2008–12 (Nakićenović et al., 1998; Victor et al., 2001).

One may wonder why, with these fatal weaknesses, the cap and trade approach is today's anointed king. Part of the reason is that alternatives – 'best efforts' or a coordinated carbon tax – are even worse. And part of the reason is political. For the environmental community, emission caps are superior because they are easy to explain and ensure a particular environmental outcome – a particular level of emissions that will not be exceeded.¹⁰

The one area where the cap and trade approach does very well, in principle, is enforcement. If buyers are liable for the integrity of the permits then they will be sure that they purchase from sellers that comply. More accurately, the concept might be termed 'issuer liability' since the burden of compliance is on the government that issues tradeable emission permits, not necessarily the particular firm that sells the permit in the market. This approach forces the market to price the risk of default and creates a built-in incentive for compliance. That is an important advantage for emission trading since enforcement is the Achilles' heel of international law. I note, in passing, that a strange thing has happened on the road from Kyoto – the countries that are most enthusiastic about emission trading have become equally enthusiastic about 'seller liability', which would seem to undercut the chief advantage of their favorite instrument. In the negotiations at The Hague in November 2000, which were slated to tie up the loose ends of the Kyoto Protocol (but ended famously in deadlock), slightly different terms were used. The idea there was to create a 'Commitment Period Reserve', which would require

countries to hold a certain fraction of the emission permits ('allowances') allocated in Kyoto in their national registers, untraded, until the end of the 2008–12 commitment period. When the books are balanced after 2012, the true excess in each country's register can be sold or banked. If the Commitment Period Reserve is set at a high level (for example, 100 percent) then the system functions almost identically to a buyer liability regime – a country will have valuable tradeable credits only if it remains inside the system and beats its target. If the Commitment Period Reserve is set at a lower rate then some of its permits can move under, in essence, a seller liability rule. The major advocates for emission trading – Australia, Canada, Japan, Russia and the United States – favor lower Commitment Period Reserve rates (60 to 70 percent) because that is the best way to ensure that the large quantities of excess Russian and Ukrainian permits can trade quickly and without penalty, ensuring that the buying countries can comply with their targets.¹¹ In short, the severity of the Kyoto targets has driven the countries that have the strongest long-term interest in a viable emission trading system to push for rules that would undercut one of the chief advantages of emission trading in the international legal system. We live in strange times.

A Best Option?

The message from above is unsettling. There is no presumptive best instrument for dealing with the global warming problem. The best-efforts approaches fail on the grounds that they cannot be codified in ways that allocate specific commitments and reassure all the participants that they are pulling an appropriate share; and, for that same reason, it is hard to enforce a best-efforts approach. Best efforts helps nations get started, but it is not a viable framework for the long run. The prices approach, or carbon tax, makes good economic sense but runs afoul on enforcement. Cap and trade runs significant economic risks, is hard to get started because allocation is a very difficult task, but with issuer liability is relatively easy to enforce. Table 9.1 summarizes the results.

It is worth considering a fourth alternative, also shown in Table 9.1: a 'hybrid' system that combines both the price and quantity. Countries would set emission targets and allow trading, as in the Kyoto Protocol. But governments would also be allowed to sell additional emission permits at an agreed price. In effect, that provision would put a ceiling on the price and make it much easier to estimate the cost of compliance. Economists are familiar with the mechanism from the work of Roberts and Spence (1976); work by McKibbin and Wilcoxon (1997), Kopp (1999) and his colleagues at Resources for the Future, and Victor (2001) have explored its application to the climate problem.

Table 9.1 Four regimes compared

Regime	Criterion		
	Economic logic	Allocation	Enforcement
'Best efforts'	OK for first steps only	Hard to codify	Very hard
Coordinated taxes	Excellent	Relatively easy	Very hard
Cap and trade	Poor	Very hard	Relatively easy (in principle)
Hybrid approach	Good (if price cap is set low enough)	Medium	Medium

The hybrid approach greatly reduces the worst features of the three systems examined above. It forces clear choices about allocation of commitments and prices – in contrast with the best-efforts approach, it makes each nation's effort clear and allows each nation to assess whether its competitors have agreed to undertake a comparable effort. If the trigger price is set near the level where countries expect to be trading permits anyway then the economic effects of the hybrid mechanism are similar to those of a coordinated tax, which makes the hybrid an attractive mechanism for addressing a 'stock' problem like the buildup of greenhouse gases. The hybrid approach greatly (but not fully) eases the problem of allocation because it eliminates many of the 'worst-case' scenarios that make it hard to get reluctant countries on board. (I return to this in the next section, where I address issues related to developing countries.) Finally, because the hybrid system is based, in part, on trading of emission rights it is easier to enforce than a pure tax system, for at least two reasons. First, buyer liability is available as a way to price the risk of non-compliance. Second, unlike in a pure tax system, a market inside each country is available to put a price on the 'real' marginal cost of carbon, which makes it easier (but not trivial) for outsiders to spot whether governments have adopted countervailing policies that lower the effective price of carbon.

More work is needed to flesh out how the hybrid system might operate. My top candidate for research topics in this area is to examine the problem of tax substitution that causes such trouble for the pure tax systems. Governments will have revenues from selling permits at the agreed price; what kind of rules will be needed to keep them from using those revenues (or other payments and policies) to distort the effect of the hybrid trading/tax system? We need answers to this question before the hybrid approach is ready for

prime time. My suspicion is that those rules will need to become more demanding as the stringency of the regulatory effort increases; I also suspect that two interesting findings will result. First, the rules will not be much different in their intrusiveness from rules that already exist in the WTO – on food safety, on technical regulations, on intellectual property protection, and so on. This is not a watershed for the intrusiveness of international law, as Rabkin (1998) has suggested in his critique of international efforts to slow global warming. Second, similar rules will be needed for *any* of the four systems evaluated here, and thus the hybrid approach is not much worse than the pure cap and trade or the best-efforts options. That leads to an intriguing possibility: perhaps the pure carbon tax, which is based on the most sound economic logic, is also workable with such rules in place. I suspect that the pure tax approach will remain unworkable because it delivers *all* of its incentive through the tax, whereas a well-designed hybrid system relies heavily on the permit trading market to generate prices that reflect the real marginal cost of controlling carbon. Economically, the hybrid approach and the pure tax system may be identical; administratively, the hybrid approach may be easier to monitor and enforce because price discovery occurs in a permit market rather than in the distortion-prone tax code. We need to work all this out in more detail.

The hybrid is not an ideal choice but it is probably better than all the alternatives, as suggested in Table 9.1. I close by underscoring that we are in a pivotal period today. What lesson will be learned as the Kyoto Protocol collapses? In part, the right lesson is that the targets set in Kyoto were too ambitious and the work plan of unfinished elements was too ambitious. In addition, however, the very architecture of the Kyoto Protocol is flawed. The pure cap and trade system creates an architecture in which it will be nearly impossible to allocate emission permits in the future, especially as the trading system is expanded to include additional countries that are less willing to pay for carbon controls. That is probably a bad idea since almost everyone agrees that the big political challenge for the future will be how to incorporate the developing countries, to which I turn now.

3 THE DEVELOPING COUNTRIES

I have little to say about the problem of dealing with the developing countries because I think the essential contours of the problems are fairly simple to understand. The developing countries do not want to spend much, or any, resources on dealing with this problem. I am sure that they are worried about droughts and floods in the future, but they are more worried about droughts and floods and economic development today (Schelling, 1997). Their will-

ingness to pay is low, and they will not accept commitments that require them to change behavior, unless compensated or coerced.

This simple fact leads down one (or more) of at least three pathways. One pathway would simply leave the developing countries out of any effort. That is unwise because the developing countries are the sites of many low-cost opportunities for controlling emissions. It is also unwise because these nations must be engaged in some way so that they have built up the experience needed to participate when they are willing to pay for carbon controls in the future and, in the interim, as they implement carbon controls that are paid for by others.

A second pathway is to allow these countries to opt in to emission controls on a project-by-project basis. That is more or less the system envisaged in the Kyoto Protocol under the Clean Development Mechanism, in which investors who pay for 'clean' projects that are more expensive than would have occurred anyway can earn credits for the difference between the emissions that would have occurred and those that actually result. The system is cumbersome and will have high transaction costs and that will discourage investment, just as the high transaction costs of the pollution offsets program under the 1977 Clean Air Amendments in the US discouraged investment in offsets (Hahn and Hester, 1989). But I do not see much alternative.

A third pathway is more worrisome: set emission targets for these countries and allow them to participate in an emission trading program. It seems to me that those who complain that the developing countries are 'exempt' from the Kyoto Protocol have in mind that these countries should agree to targets. But taking that argument a few steps further leads to a dead end. How will we set the targets? One approach, for example, is to set generous 'headroom' targets that more or less equal the likely emission path of the country. But it strikes me that this logic will lead to a repeat of the 'hot air' experience with Russia and Ukraine. If the developing countries are reluctant participants then they will demand permits to cover the worst-case scenario, and that will lead to demands that probably exceed their actual emission pathway – all those excess permits are a form of 'inflation' that will lead to greater emissions and lower permit prices in the emission trading program. The hybrid approach can dampen that incentive by eliminating the worst of the worst-case scenarios, but the developing countries are still willing to pay a price that, presumably, is much lower than the agreed price in the hybrid. The result, again, is inflation of permits and greater emissions.

Thus, ironically, I think we shall find upon close inspection that our interests are probably not well served by forcing developing countries to accept targets. If we do force them, then the value of our own emission permits will erode through inflation, and these new entrants to the trading system, ironically, will undermine our collective effort to control emissions (remember,

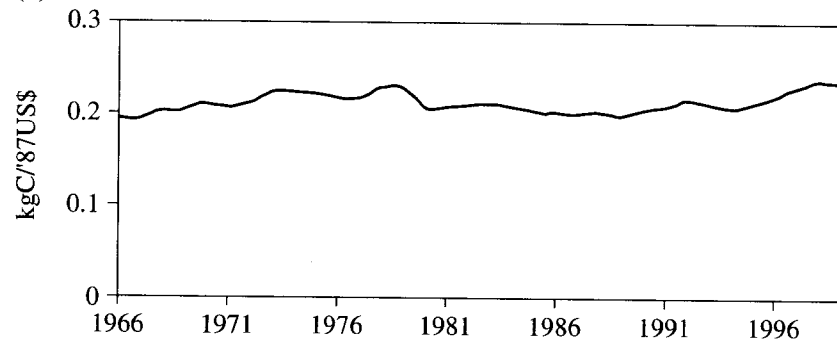
that is the goal of this whole enterprise). There is a great hope that it would be possible to create growth or index targets for emissions in these countries, perhaps using data such as shown in Figure 9.2. But I think we shall find as we look closely at these data that they are quite soft – probably too soft, for now, to be used inside an emission trading system in which the underlying assets are worth trillions and tens of billions of dollars move across borders.

So I conclude that the cumbersome Clean Development Mechanism is the only real option for developing nations. But more effort should be made to embed that option into larger programs to identify projects in developing countries that are in the host country's own interest and then back those – in part because they generate emission credits at low cost and mainly because they help the host country solve problems like urban air pollution. China's remarkable drop in carbon intensity over the last decade (Figure 9.2) is the result of such efforts, mainly driven by China itself, to solve a local problem (particulate and SO₂ emissions from coal) that is highly correlated with a global problem (CO₂ emissions from coal). Over the long run, the developing countries will probably shoulder some burden for slowing global warming – not mainly because we force them to but because rising incomes and democratization will bring value systems and interests that include protection of climate. During the short run, I would focus on self-interest – and the China case shows that a lot can be achieved that way. The other countries shown in Figure 9.2 (Brazil and India) have not seen such a decline, and efforts are needed to explore how to help them move in that direction. In Brazil, it may prove difficult to squeeze much carbon from the economy because so much of the Brazilian electric power system is based on zero-carbon hydroelectricity; in India, however, coal is king and inefficiency reigns.

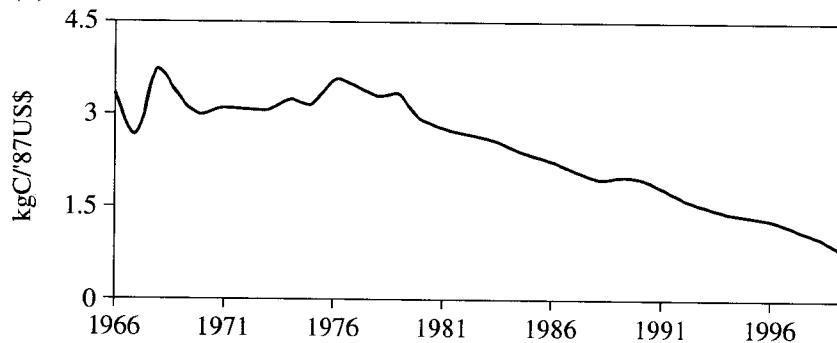
Thus I doubt that imposing binding emission targets on the developing countries is in the interest of the advanced industrialized nations, but we are hardly helpless when faced with the need to regulate emissions in the developing world. We can do a lot to find projects that correspond with their interests and also help to reduce carbon. Already, industrialized nations have funded many such projects through the Global Environment Facility and through bilateral programs. The advent of a credible Clean Development Mechanism would help to spur those efforts. We should not count on them to bend down, permanently, the trajectory of emissions from the developing countries, which will rise under every scenario for the foreseeable future. But we can help put them on a lower track. To expect more is to produce an agreement that is laden with hot air permits or totally unacceptable to the developing countries.

Finally, at some stage it will become necessary to require the developing countries to join whatever binding emission control scheme is established for the industrialized world. More thinking is needed on the provisions for 'gradu-

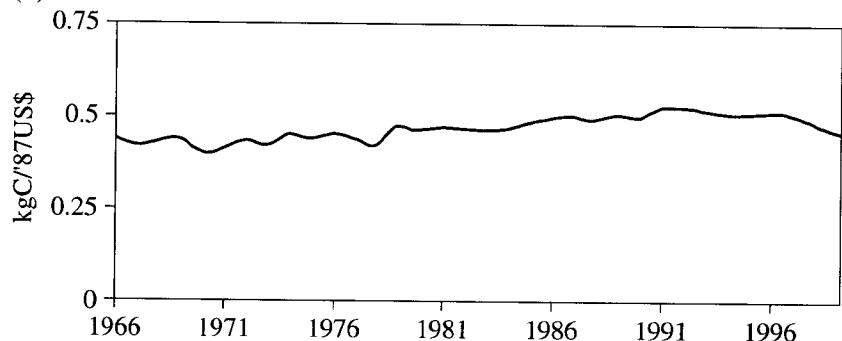
(a) Brazil



(b) China



(c) India



Note: Units: kilograms of carbon per unit GDP (constant 1987 US\$).

Sources: Carbon emissions calculated from *BP Statistical Review of World Energy* (converted with high heating values coefficients) and income from *World Bank World Development Indicators*.

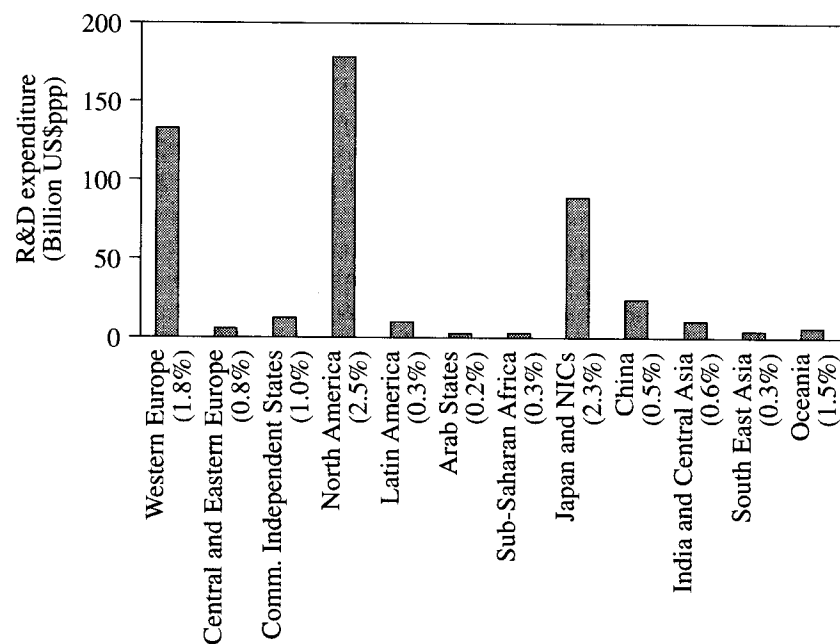
Figure 9.2 Carbon intensity for (a) Brazil, (b) China and (c) India

ation' into the tighter regulatory system. Back in 1992, when the Framework Convention on Climate Change (FCCC) was finalized, membership in the Organization for Economic Cooperation and Development (OECD) was the criterion for membership in the club of nations that had the tightest obligations to control emissions – the list of 24 members of Annex II of the FCCC was identical to the OECD membership at the time.¹² Since then, the OECD criterion has not fared well. Mexico and South Korea have joined the OECD but remain 'developing countries' for the purposes of controlling greenhouse gas emissions, and they refused to accept emission targets under the Kyoto Protocol. Turkey has remained a member of the OECD but has sought to exit Annex II of the FCCC and also refused to accept a target under the Kyoto Protocol.

One alternative approach to 'graduation' is to set a particular threshold income level. Countries would be required to impose emission controls above the threshold and to impose even more costly obligations at higher income levels, perhaps through a system of emission targets indexed to income. This approach is attractive in theory but hard to implement in practice since countries may refuse to join even as their incomes pass the threshold. In principle, one could hold other benefits of international cooperation – such as membership in the WTO – hostage to participation in the scheme to control emissions. In practice, that could be hard to implement, not least because today most members of the WTO are developing countries and are understandably wary of linking the immediate benefits from trade liberalization through the WTO to other issues about which they care much less, including long-term protection of the climate.

4 A TECHNOLOGY STRATEGY

The above will seem like a counsel of despair, and indeed many will wonder whether a robust international treaty for addressing the global warming problem is feasible at all. One alternative path, gaining currency today, is a 'technology strategy'. We owe much to Edmonds et al. (2001) for quantifying the large potential for reducing emissions of greenhouse gases through technological change. Others have also shown that assumptions about technological change are the single most important factor in driving projections for future emissions of greenhouse gases. Perhaps if we focus on technology then, eventually, controlling carbon will be cheaper (or even free). A bill is working its way through the US Senate, sponsored by Senator Frank Murkowski, that seems to envisage just that. The Global Climate Coalition, chief among the US critics of efforts to control carbon, also advocates investment in technology. Many fossil-fuel firms have lined up in support. Is this a good idea?

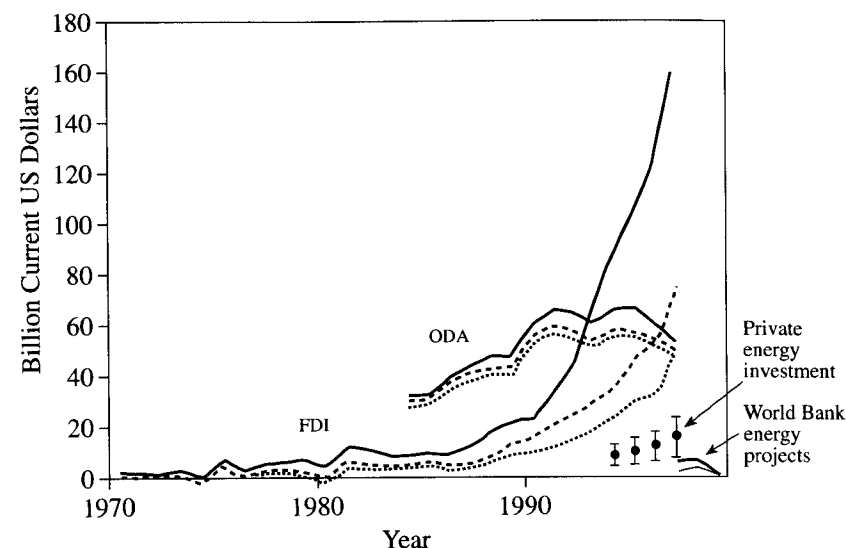


Note: NICs = newly industrialized countries.

Source: UNESCO (1999).

Figure 9.3 Geographical distribution of spending on R&D

A technology strategy has much to recommend it. A concerted effort now can make steep cuts less costly in the future. And for scholars of international relations a technology strategy requires the cooperation of many fewer nations when compared with emission controls that must, eventually, involve every nation on Earth. Most investment in research and development (R&D) occurs in a small number of countries (see Figure 9.3), and thus to increase world investment in technology it is necessary to gain the agreement of only a few countries – and those same countries are the ones whose publics care most about global warming. Moreover, the rapid rise of private investment in developing countries (Figure 9.4) means that private markets increasingly carry technologies into use throughout the world. Finally, many scholars have lamented the decline in energy R&D funding in the advanced industrialized nations (for example, Dooley, 1998; Margolis and Kammen, 1999); a technology strategy for global warming could help to reverse that problem as well. All that seems to be good news.



Note: ODA (official development assistance) includes concessional loans and official aid (grants). FDI (foreign direct investment) is net inflows. Also shown are ODA and FDI for when removing the top 5 recipients of FDI (heavy dashed lines) and top 10 recipients (light dashed lines); even when removing those countries the basic trends are the same. For comparison, estimates of energy-related FDI are shown (based on assumption that 5 to 15 percent of FDI is focused on the energy sector) and also tabulations of energy-related World Bank projects.

Source: ODA and FDI data from World Bank, *World Development Statistics* (CD-ROM series).

Figure 9.4 Official development assistance and foreign direct investment in developing countries (current dollars)

We should be cautious about a technology strategy, however. One reason for caution is that the biggest failures of technology policy have occurred when there is no market for the technology being created. Thus a technology strategy is not an alternative to putting a price on carbon – rather, such a strategy will work only if carbon is priced. The need for an international framework for limiting carbon is especially great because only then will there be incentives on large world markets to install carbon-reducing technologies. A lot of the basic upstream research can be done without a strong incentive for carbon control, but as soon as technologies reach the stage of demonstration projects and niche market deployment, the lack of any price signal will deter commercial investment. Second, we should be careful in developing a technology strategy, also, to pursue the strategy on an international level. Some of the technologies to be developed are so risky or expensive that no

nation will fund them entirely on its own; some new technologies, such as the next generation of safe and affordable nuclear power, are (partially) international public goods. This suggests the need, in parallel with the process leading from the Framework Convention, for a more active form of international collaboration on technology development. The style of that cooperation should take as its precedent not international environmental diplomacy but, rather, the cooperative technology and science programs such as those coordinated through the OECD and the International Council of Scientific Unions (ICSU). Some of this is already under way, such as through the International Energy Agency's Greenhouse Gas R&D Program, but an intensive effort will require closer coordination. The effort will require agreements and goals – in the form of non-binding, flexible memoranda of understanding rather than binding targets and timetables.

5 CONCLUSIONS

Part of the problem with efforts to slow global warming is that they have not been realistic. Most notably in the Kyoto Protocol, diplomats have set ambitious targets and timetables without a plan for implementation. And they have not given adequate attention to whether the architecture they were creating is viable. The weakness of international law poses severe challenges for any effort to develop an effective climate-change treaty. It is hard to allocate commitments under international law because countries must not feel aggrieved by their allocation – or then they can simply refuse to join the agreement. And it is hard to enforce obligations once they enter into force. Add to this the fact that developing countries – which account for most nations on Earth, most people, and most of the expected growth in emissions over the next few decades – do not care much about global warming, and we have recipe for a deadlock.

I do not offer an elegant solution to the deadlock, but I do suggest one – the hybrid approach – that is likely to work better than the alternatives. I also suggest that America's obsession with what is wrong with the Kyoto Protocol – namely that it exempts the developing countries – is misplaced. Forcing the developing countries to impose costly obligations will not be successful, and forcing targets on these nations and bringing them prematurely into an emission trading program will actually harm our interests over the long run. It so happens that on this one point – the one hated most by Kyoto's most vocal critics – the Kyoto Protocol got it right. We should exempt the developing countries, let them opt in on a project-by-project basis, and encourage technology partnerships to identify win-win opportunities.

NOTES

1. For a statement of this view, a review of the literature, and the main arguments about the importance of fairness (against which I shall argue in this chapter) see the relevant IPCC chapter: T. Banuri, K. Göran-Mäler, M. Grubb, H.K. Jacobson, and F. Yamin, 'Equity and social considerations', in James P. Bruce, Hoesung Lee and Erik F. Haites (eds), *Climate Change 1995: Economic and Social Dimensions of Climate Change* (Cambridge: Cambridge University Press), Chapter 3. My chapter is not intended necessarily as a critique of the IPCC authors – their task was to review the literature. Rather, it is a critique of the assumptions and concepts in the literature. Moreover, I shall not consider here the relevance of fairness as expressed in decisions by the International Court of Justice (ICJ) and through liability schemes, though the IPCC chapter does address those issues. In my view, neither the ICJ nor liability schemes are relevant to the adoption and implementation of international agreements to slow global warming. Liability schemes are rarely used and require proving harm, which cannot be done for global warming impacts in the foreseeable future (see the final section of this chapter). The ICJ resolves disputes, which are mainly bilateral in nature; ICJ decisions have little if any sway on multilateral environmental negotiations; and, the dispute resolution procedures of multilateral environmental agreements have never been invoked and are unlikely to be in the future.
2. See Victor (1999) for a detailed review of the evidence. I do not address so-called 'procedural fairness' concepts, such as the need for a policy-making process that is highly participatory, access to information, minority rights and so on.
3. Letter from President George W. Bush to Senators Hagel, Helms, Craig and Roberts, 13 March 2001, Washington, DC.
4. For an inventory showing that all temperate and boreal forests are increasing in size and density, see UNECE/FAO (2000).
5. That figure is based on statistics compiled by US EPA (2000); 14 percent is computed as the fraction of the most recent US emissions (1998).
6. There are also some legal problems. Article 3.3 of the Kyoto Protocol states that only sinks 'resulting from direct human-induced land use change and forestry activities' can earn credit; at the time of writing (summer 2000) there is no agreed scheme for discerning 'direct' sinks from other factors that also cause trees to grow and sequester carbon (for example, warmer climates and higher CO₂ levels). Nor is it clear if trends such as rebounding of forests on abandoned agriculture lands, which long pre-date global warming policies, would qualify. Article 3.4, which concerns other land-use sinks (for example, agriculture soils) suggests that credits could be deferred until the second budget period (that is, after 2012); no decisions have been reached on how those credits would be measured or awarded. For the best summary of the issues that surround accounting rules for land use, see Schlamadinger and Marland (2000).
7. For a theoretical treatment and some application of data see Jonas et al. (2000). To my knowledge, no other studies have quantified the 'verification times' for carbon sinks.
8. Chapter 3 describes calculations behind these numbers in more detail.
9. Arguably, the International Monetary Fund's enforcement system is even more effective since the IMF can threaten to withdraw support from deviant countries. However, the IMF system is not a relevant precedent for the global warming problem since I doubt that there will be an international climate fund whose revenues could be made conditional upon compliance by the recipient. Here I am focusing on compliance with commitments by the advanced industrialized nations; in the IMF, enforcement is most effective against vulnerable, small developing nations.
10. Some have also argued that this approach should be the presumptive favorite in international law because it allows governments to give generous caps to reluctant countries and thus compensate them for their participation (Wiener, 1999), although I do not subscribe to that view for the reasons noted above.
11. For more detail, see <http://www.cfr.org/kyoto> and my commentary on the 'Pronk text', which was the chief negotiating text for the meeting at The Hague.

12. The European Union is also a member of Annex II, bringing the total to 25 members. The OECD does not have similar provisions to allow the EU to become an OECD member, and thus but for that technical difference the lists are identical.

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