Climate Change Negotiations: Past, Present, and Future

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1. Introduction

In the history of large scale, international negotiations, probably no issue has attracted as much attention as global climate change (the previous record holder was probably the Law of the Sea negotiations). For over 15 years, numerous negotiating sessions have been held, involving crowds of negotiators (a diplomat once told me that there were 50 members of a US negotiating team attending one of the sessions). Supporting these public efforts have been countless domestic meetings among specialized agencies and ministries, huge efforts by the Intergovernmental Panel on Climate Change to synthesize and organize the scientific evidence, and much more besides. The input into this process has been unprecedented.

And yet all this effort has made little difference. So far, two agreements have entered into force—the Framework Convention on Climate Change and the Kyoto Protocol—but neither will do much to mitigate or forestall climate change. One purpose of this case study is to explain why.

If this reasoning is right, however, then broader questions arise. First, why have the negotiations achieved so little thus far? Is the reason George W. Bush, uncertainty about the science, an unattractive economic calculus, or poorly designed legal instruments? Second, would an alternative approach work better, or is the international system, anchored by the principle of sovereignty, simply incapable of supporting any effective multilateral cooperation? Finally, from the perspective of, say, a century from now, how will this early effort be looked upon? Will it be seen as the first faltering first steps of a process that eventually succeeded? A second purpose of this case study is to suggest answers to these questions (the last, of course, being entirely speculative).

The case study begins in the next section with an analysis of the Framework Convention on Climate Change. Here I also discuss the science and economics of climate change. Section 3 analyzes the Kyoto Protocol, explaining its design and the reasons it is unlikely to reduce emissions by much if at all. The focus here is more on politics and the design of

legal instruments. Section 4 presents an alternative approach, which, though flawed, may be superior to Kyoto.

While it may be difficult for us to look back on the current period from the perspective of, say, the year 2100, we can draw from the historical archives to see whether other global environmental problems have experienced similar problems—and how their fate was eventually decided. The example of how the existing system for regulating pollution of the oceans evolved is particularly instructive, and I sketch the history of this system in Section 5. The final section of the case study summarizes the main points.

2. Framework Convention

Stripped to essentials, climate change represents a clash between two worlds, the earth's atmospheric system and its political system, a world of one atmosphere and a world of two hundred or so countries. The science of climate change draws our attention to the first world. Climate policy and negotiation require that we also look to the second. The international system created the climate change problem, and the international system will have to address it.

The first milestone in this effort—the Framework Convention on Climate Change—was adopted at the Rio Earth Summit in 1992. When I give a public lecture on this subject, and ask the audience, How many countries do you think have accepted this agreement? I get a range of answers, including "None" and "Not the United States." This perception is interesting, not least because it is wrong. As of June 2005, 188 countries have ratified this agreement, including the US. The achievement is perhaps best understood by listing the non-parties to this agreement: Andorra, Brunei, Holy See, Iraq, and Somalia. Quite plainly, this is not an agreement suffering from free riding.

To be sure, one reason for the nearly universal support is that the agreement does not require that parties reduce their emissions of greenhouse gases. And yet the consensus achieved by the agreement is impressive nonetheless. It demonstrates broad support for the goal of stabilizing atmospheric concentrations of greenhouse gases. Indeed, the only environmental agreement with as wide a following is the Vienna Convention for the Protection of the Ozone Layer. And this is encouraging, since the Vienna Convention provided the framework for the very successful ozone regime—one of the greatest achievements of international cooperation ever. If there were a problem with the existing climate regime, it would seem not to be the Framework Convention. However, as I shall now explain, the Framework Convention *is* problematic.

Dangerous interference

The Convention's main contribution is to establish a goal: "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." This would seem sensible enough. But stabilization will require a monumental effort, and identifying the concentration level that avoids "dangerous interference" with the climate system is an impossible task.

Stabilization of atmospheric concentrations cannot be achieved merely by stabilizing emissions. Stabilizing concentrations implies an atmospheric balance, with the quantity of molecules being added to the atmosphere equaling the quantity being subtracted. Today, only a fraction of the gases added to the atmosphere are removed (by ocean absorption and biomass growth), with the result that concentrations (measured in parts per million or ppm) have been rising. If emissions were stabilized at the current level (about 380 ppm), concentrations would continue to rise. Limiting concentrations to a level close to twice the pre-industrial level (about 280 ppm) would require "50 years of flat emissions, followed by a linear decline of about two thirds in the following 50 years, and a very slow decline thereafter that matches the declining ocean sink" (Pacala and Socolow 2004: 968). Current projections are that emissions will more than double over the next 50 years, in the absence of climate policy (Pacala and Socolow 2004). This means that, to stabilize concentrations in the long run to twice the pre-industrial level would require that global emissions be cut by more than half by 2050, and reduced by much more than this afterwards.

To put this into perspective, the Kyoto Protocol would only limit the emissions of about 30 of the world's 200 or so countries by only about five percent (from the 1990 level) for a period of just five years. Even if Kyoto worked as originally intended, the emissions of the countries unconstrained by the agreement would rise, making it very unlikely that Kyoto would even stabilize global emissions let alone reduce them, even over such a short period.

What level of concentrations is "dangerous?" To know this requires an understanding of the science of climate change.

The basic physics of climate change are simple.[1] There naturally exist gases in the atmosphere—primarily carbon dioxide and water vapor—that trap the sun's heat, keeping the earth about 34° C warmer than it otherwise would be: the natural greenhouse effect. It stands to reason that if more heat-trapping gases are concentrated in the atmosphere, more heat will be trapped: human-induced climate change.

Since the industrial revolution, atmospheric concentrations of greenhouse gases have increased by just over one third. As already noted, concentrations will increase even more in the future, though by how much depends on a number of things: emissions growth, which depends in turn on economic growth, technology, and policy; take up by the oceans and other carbon sinks; and the effect of CO_2 fertilization on terrestrial absorption. By 2100, concentrations are expected to be 90-350 percent above the pre-industrial level (uncertainties increase over time). Beyond 2100, concentrations are expected to keep on rising. Already, concentrations are higher than they have been in the past 420,000 years—probably in the last 20 million years.

Global mean temperature has already increased about 0.6°C. By 2100, it is expected to rise 1.4-5.8 °C. Sea level is expected to rise 0.09-0.88 meters over this same period, as a

[1] My discussion here draws from Intergovernmental Panel on Climate Change (2001).

result of thermal expansion and the melting of glaciers and ice caps. Of course, if concentrations are not stabilized, the climate will change still more beyond 2100. Even if concentrations were stabilized today, changes would continue for a very long time because of lags in the system. We are already committed to some amount of climate change. No matter what we do to mitigate climate change, adaptation will be inevitable.

Abrupt climate change

Perhaps because the basic physics of climate change are so simple, most people think of climate change as an unfolding, gradual (linear) increase in temperature everywhere. Thus the term "global warming." However, the direct changes caused by climate change may trigger yet more changes, because of a number of feedbacks (positive and negative). The difficulty in predicting such feedbacks is a main reason climate science is so uncertain.

One possible change is a weakening or even collapse of the Gulf Stream (part of the global thermohaline circulation or THC). Abrupt climate change has occurred in the past, and could be triggered by human-induced climate change. As noted in a recent report by the National Academy of Sciences (Committee on Abrupt Climate Change, 2002: 1), "future abrupt changes cannot be predicted with confidence, and climate surprises are to be expected."

That predictions about the nature of climate change are uncertain should hardly come as a surprise. The climate system is complicated. And we are conducting a huge experiment with it. We will not know its full consequences for sure until they become manifest (even then, disentangling human-induced climate change from natural climate change will be difficult). It would be imprudent to wait for uncertainties to be resolved because not all uncertainties will be resolved. Moreover, change, once it occurs, will take a very long time to reverse. Indeed, change may be irreversible.

Plainly, there is unanimous agreement that dangerous interference with the climate ought to be avoided. But do we know what level is dangerous? The expression itself implies a discontinuity, and O'Neill and Oppenheimer (2002) have identified three discontinuous changes that would be very serious indeed: the destruction of large-scale coral reef ecosystems; the disintegration of the West Antarctic Ice Sheet (WAIS); and the collapse of the THC. They then suggest that these three changes can probably be avoided by limiting long term warming to 1°C; that the last two can probably be avoided by limiting change to 2°C; and that the last can probably be avoided by limiting change to 3°C above 1990 global mean temperature. Noting that carbon dioxide stabilization at 450, 550, and 650 ppm would correspond roughly to a century's long warming of about 1.2°-2.3°C, 1.5°-2.9°C, and 1.7°-3.2°C, respectively, O'Neill and Oppenheimer conclude:

> "Full protection of coral reefs is probably not feasible for this concentration range. It is plausible that achieving stabilization at 450 ppm would forestall the disintegration of WAIS, but it is by no means certain, because additional warming

would occur beyond 2100. Avoiding the shutdown of the THC is likely for 450 ppm."

Though O'Neill and Oppenheimer aim to show how we might identify the level of atmospheric concentrations that might trigger dangerous interference, their analysis really shows how difficult the task is. Why adopt 450 ppm if this will not protect coral reefs, if this will possibly forestall but not avoid disintegration of the WAIS, if this will likely, but not for certain, avoid a shutdown of the THC? Why not aim for 400 ppm? Or 500 ppm? Or some other level? The answers are not clear from their analysis.

International Climate Challenge Task Force

This task force, established by Prime Minister Tony Blair, and jointly chaired by Stephen Byers, MP, and Senator Olympia Snowe, dared to identify the dangerous threshold, despite acknowledging the uncertainties. They concluded that global mean temperature should not be allowed to rise more than 2˚ C (3.6˚ F) above the pre-industrial level—a level "associated with a CO2 concentration of about 400 [ppm]" (International Climate Change Task Force 2005: 4).

The reasoning is familiar. "Beyond the 2˚ C level, the risks to human societies and ecosystems grow significantly. It is likely, for example, that average temperature increases larger than this will entail substantial agricultural losses, greatly increased numbers of people at risk of water shortages, and widespread adverse health impacts. Exceeding a global average increase of more than 2˚ C could also imperil a very high proportion of the world's coral reefs and cause irreversible damage to important terrestrial ecosystems, including the Amazon rainforest."

They continue: "Above the 2˚ C level the risks of abrupt, accelerated, or runaway climate change increase. The possibilities include reaching climatic tipping points leading, for example, to the loss of the West Antarctic and Greenland ice sheets (which, between them, could raise sea levels more than ten meters over the space of a few centuries), the shutdown of the thermohaline ocean circulation (and, with it, the Gulf Stream), and the transformation of the planet's forests and soils from a net sink of carbon to a net source of carbon" (International Climate Change Task Force 2005: 15-16).

Economic and moral considerations

A problem with this approach is that it ignores the consequences of mitigation. The International Climate Change Task Force (2005: 13) believes that "the cost of taking smart, effective action to meet the challenge of climate change should be entirely manageable." To this body, the risks are huge, the costs of avoiding them insignificant. Easy decision.

Unfortunately, I am aware of no evidence supporting this view. Even to stabilize concentrations at a doubling of pre-industrial levels would require a global technological revolution. To achieve the target of 400 ppm would require that emissions be cut by

much more even than in the scenario examined by Pacala and Socolow. Looked at differently, mitigation introduces different risks. For example, and as Pacala and Socolow explain and Prime Minister Blair acknowledged in his September 14th 2004 speech, stabilization requires, among other changes, an expansion in nuclear power. Globally.

To ignore or downplay the costs of mitigation is a morally empty logic. Should the rich countries reduce their emissions, even if only to help the poor countries, which will certainly be the most vulnerable to climate change? Many would answer "Yes," not least because the rich countries are responsible for the historic build up of atmospheric concentrations. But should the rich countries reduce their emissions by a huge amount, rather than by somewhat less, with the difference in costs being invested in alternative activities that could help poor countries increase life expectancy, improve the standard of living, and reduce their vulnerability to climate change? The answer to this question—which is the more important question—is morally less clear. Ask poor people in poor countries, however, and they are likely to answer "No."

Of course, the same people who would argue that we should stabilize at a level like 400 or 450 ppm would likely reply by saying that they would also want more money to be spent improving life expectancy and the standard of living, and in reducing vulnerability to climate change. But the point is that it is not possible to do everything. Money spent doing one thing cannot be spent doing another. Choices have to be made. Any approach that ignores costs ignores this unavoidable reality.[2]

Economics seeks to balance the costs and benefits (at the margin) of action. A recent review of the evidence by Pearce (2005) is illuminating. He finds that the marginal social cost of carbon is about £4-27 per ton of carbon. This is an estimate (range) of the benefit to the world of reducing carbon emissions by one ton. At current exchange rates, this is about $7-50 per ton C.

What levels of emission reductions would be realized at this damage cost? According to estimates produced by the Clinton Administration, the marginal cost to meeting the Kyoto Protocol, assuming participation by the US and full use of the flexible mechanisms incorporated within this agreement—assumptions that we know will not hold—is about $14-24 per ton (Barrett 2003). So, very roughly, the Kyoto limits would seem justified by an economic calculus, but these limits also would come nowhere near to achieving stabilization at anything like 400 ppm. Sweden's current carbon tax is about $160 per ton (though because of competitiveness concerns industry pays only about half this amount).[3] Still, even with the world's highest carbon tax, Sweden's emissions have fallen only slightly.

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[2] This same point is made in a letter to the editor of *Science*, in response to an article published in January 2004 by Sir David King, Prime Minister Blair's Chief Scientific Advisor. King's response, published in the same issue (1 October 2004), begins, "There is no real choice between action on climate change and action on poverty, disease, hunger, and other millennium development goals. These are part of the same sustainable development agenda." I agree that climate is best looked at as a sustainable development problem. After all, climate change will affect development, and development will shape the future climate. But there is no getting around the fact that choices must be made.

[3] See http://www.oecd.org/LongAbstract/0,2546,en_33873108_33873822_2108244_1_1_1_37417,00.html.

Collective versus individual limits

A goal of capping global concentrations implies a global emissions path. But there is no World Government that could ensure obedience to such a path. There are instead some 200 sovereign countries. Under the rules of international law, countries are free to participate in an international agreement as they please. Some may choose not to participate—just as the US chose not to participate in the Kyoto Protocol. If some countries fail to participate in an agreement seeking to implement a global emissions path, the others would need to pick up the slack; if they didn't the goal would be missed. But if the global goal is to be met irrespective of which countries participate, then non-participants avoid the cost of mitigation without suffering any loss in benefit. As well, the remaining participants incur yet higher costs without any increase in benefit. These incentives plainly reward nonparticipation, and so favor collapse of such an agreement.

Of course, it might be argued that an agreement needs to be structured in such a way that this will not happen. But how can this be done? Indeed, can this be done? These questions are taken up later in this case study.

An alternative goal

The stunningly successful ozone regime developed very differently. The Vienna Convention for the Protection of the Ozone Layer does not establish even a qualitative goal. Article 2 instead enjoins parties to "take appropriate measures…to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer." And take measures is exactly what the parties to this convention did, first under the Montreal Protocol and later under the adjustments and amendments to this agreement. The final result: virtually every country has done about as much as could be done to protect the ozone layer. Astonishingly, ozone levels are expected to return to their "natural" (pre-1980) levels by around 2050.

The climate regime was strongly influenced by this earlier diplomacy, but drew the wrong lessons. The "appropriate measures" taken under the Montreal Protocol were expressed as quantitative emission limits. But in Montreal these limits served as a means, not as an end. As Richard Benedick, the chief US negotiator of this agreement, explains in his insightful account of the negotiations (Benedick 1998: 105),

> "By cutting the market in half at a fixed date, the protocol was in fact tipping CFCs towards obsolescence. US negotiators had reasoned that, when substitutes were developed to such an extent, the remaining CFC market could probably not be sustained."

Kyoto established quantitative targets as an end—the idea being that certain emission limits are needed to achieve certain concentration levels. It is not clear that this was a wise choice. It was certainly not the only possible choice.

3. Kyoto Protocol

As noted previously, Kyoto asks only a small number of countries to reduce their emissions by just a little bit for a short period of time. Of course, Kyoto was only meant to be a first step. But as I shall now explain, Kyoto is unable to sustain even the little that it sets out to achieve. And if it can't sustain this effort, it certainly can't sustain a greater effort.

The essential challenge for Kyoto is enforcement—in particular, the need to enforce both participation and compliance.[4]

3.1 Compliance

Compliance is the problem of how to get parties to the agreement to do what they agreed to do. The agreement negotiated in Kyoto in 1997 did not incorporate a compliance mechanism, though it did require that parties approve "appropriate and effective procedures and mechanisms" for compliance at the first meeting of the parties. However, according to Article 18 of the agreement, "any procedures and mechanism…entailing binding consequences shall be adopted by means of an amendment to this Protocol." Under the rules of international law, an amendment is binding only on the countries that ratify it (and on the countries that accede to the original agreement after the amendment enters into law). Since any party to Kyoto could decline to ratify a subsequent compliance amendment, each can avoid being punished for failing to comply. In other words, there is nothing in the agreement that actually makes countries do what they said they would do. As matters now stand, the Kyoto emission limits are more "political" than "legal."

Does this matter? Chayes and Chayes (1995) argue that binding compliance mechanisms are not needed. Indeed, they argue that such mechanisms can be counterproductive. However, the evidence—even limiting our attention to the climate regime—fails to support this view. The industrialized parties to the Framework Convention on Climate Change pledged to stabilize their emissions at their 1990 levels, and yet very few did so. Moreover, those that did limit their emissions (primarily, Britain and Germany) did so for reasons having little to do with climate policy (Britain was helped by the "dash for gas," Germany by industrial restructuring following reunification).

Plainly, many countries believed that compliance *would* be a problem. After all, they negotiated a compliance mechanism in subsequent meetings held in Bonn in 2001. Under this agreement, a party that failed to meet its emission ceiling in the first control period (2008-2012) would have to make up for the shortfall and reduce its emissions by an additional 30 percent of this amount in the *next* control period (presumably, 2013-2017). The 30 percent value was meant to reflect "interest" earned on the shortfall (removing the

[4] See Barrett (1998, 2003), Schelling (2002), and Victor (2001) for critical assessments of the Kyoto Protocol, including discussions of the enforcement challenge.

incentive for countries to "borrow" emission reductions from the future) plus a penalty (for failing to comply).

Unfortunately, this is a defective mechanism, and not only because it cannot be binding (except by means of an amendment, as noted previously) for the first control period. First, the mechanism relies on self-punishment. That is, the mechanism is silent on the consequences for any country that fails to comply with the compliance procedure. Second, the emission limits for the second control period have yet to be negotiated. A country that worries that it may not be able to comply in the first control period may thus hold out for easy targets in the second control period—so that the punishment, if triggered, wouldn't actually bite. Finally, and perhaps most importantly, a country can always avoid the punishment by not ratifying a follow-on protocol for 2013-2017, or even by withdrawing from the Protocol at a later date. This is why participation is important.

3.2 Participation

Why do countries participate in a treaty? The answer isn't obvious, given that an effective treaty must make countries do things that they wouldn't otherwise do—reduce their greenhouse gas emissions, for example. Countries may be willing to make such a sacrifice because others are making a similar sacrifice or because doing so is simply the right thing to do. They may also be willing to make such a sacrifice because, were they not to do so, others would not do so. It turns out that this last reason is especially important. It is the main reason treaties are necessary in the first place. Cooperation in a treaty is usually sustained by a strategy of reciprocity.

In a climate agreement, reciprocity would require that, were one country not to reduce its emissions, others would not reduce *their* emissions. In a bilateral setting, reciprocity is often very effective. Indeed, this is how the multilateral trading rules are enforced under the World Trade Organization (WTO). Climate change mitigation, however, is a global public good, and when some countries punish another for failing to mitigate emissions, they harm themselves in the process. In other words, for global public goods, severe punishments are often not credible.

Intuitively, a punishment must "fit the crime." A small deviation can be deterred by means of a small punishment. A larger deviation can only be deterred by means of a larger punishment. The largest credible deviation from cooperation for any country would be for the country to emit as much as it would were it not to participate in an agreement. Hence, large punishments are needed to deter non-participation, whereas smaller punishments will normally suffice to deter non-compliance. Since small punishments are more credible, this means that if parties to a treaty can deter non-participation then they should also be able to deter non-compliance. In other words, participation should be the binding constraint on international cooperation, not compliance (Barrett 2003).

The Kyoto Protocol provides very weak incentives for participation. As of late May 2005, Kyoto has been ratified by 149 countries making up 61.6 percent of the emissions

of industrialized countries (Annex I emissions). Russia's ratification brought the Kyoto Protocol into force in February 2005.

Kyoto's entry into force, however, has come at a price. In negotiations held in Bonn and Marrakech, years after the emission limits were negotiated in Kyoto, country-specific concessions (more generous allowances for sinks) were given to Canada, Japan, and Russia, to facilitate their participation. Other modifications, such as the decision not to impose a quantitative limit on trading, also helped promote participation, by lowering the cost of compliance to countries facing net emission reduction obligations. At the same time, this relaxation in the trading rules will limit the environmental effectiveness of the treaty by releasing more "hot air."[5] In other words, Kyoto was renegotiated through the back door, as it were. If Kyoto enters into force, the reason will be that it requires that very little be done. This is not much of a victory for the environment.

Most importantly, Kyoto failed to secure participation by the United States—the world's largest emitter and only superpower. Now, to be sure, the manner in which President George W. Bush rejected Kyoto was undiplomatic. But the chances that the US would have ratified Kyoto were low in any event. Why? One reason is that the emission reduction obligations for United States are especially stringent. Most countries that have ratified Kyoto do not need to reduce their emissions at all under the agreement. Some must reduce their emissions by modest amounts. The United States was required to reduce its emissions 7 percent below the 1990 level, and it is widely believed that US emissions under a business-as-usual scenario will be at least 30 percent higher in 2008-2012 than in 1990 (in 2003, US emissions were already more than 17 percent higher than in 1990; see http://www.eia.doe.gov/oiaf/1605/ggrpt/cdemissions_tbls.html). The US would need to reduce its emissions very substantially to comply with the agreement, and this would be costly. It is also worth recalling that, in 1997, before the Kyoto Protocol was adopted, the US Senate voted 95-0 in favor of a resolution that the US should not be a party to a treaty that essentially resembled Kyoto. When Bill Clinton was president, the rhetoric was different, but Clinton did not send the Kyoto Protocol to the Senate for ratification. It is unlikely that the situation would have been any different had either Al Gore or John Kerry become president.

The failure by the US to participate is striking but it is part of a general pattern. The US failed to participate (at least in part) because the costs to the US of participating were high. Other countries agreed to participate (at least in part) because the costs to them of participating were low (as is true for some EU states), zero (as is true of all non-Annex I states) or even negative (as is true for the states given "hot air" allowances). The Annex I countries likely to have the hardest time complying (Canada and Japan) agreed to participate only on the condition that their initial reduction obligations be diluted. Russia's ratification will bring Kyoto into force, and yet, ironically, Russia's participation

[5] "Hot air" refers to the surplus of emission reductions for the former communist countries of Europe. Russia, for example is required to stabilize its emissions under the Kyoto agreement, and yet its actual emissions in 2000 were about 70 percent of the 1990 level. Trading with Russia can thus allow countries to comply with the agreement, not by reducing emissions, but by paying Russia to transfer a portion of its surplus.

ensures that Kyoto will fail to reduce emissions by much. Indeed, it may not reduce global emissions at all (Buchner, Carraro, and Cersosimo, 2001).

And what are Russia's reasons for ratifying Kyoto? Russia has certainly dragged its heals. Partly this was to gain concessions from Europe on other issues, including Russia's entry into the WTO. So, what would prevent Russia from threatening to withdraw later, to gain more concessions? And what incentive would Russia need to join any follow-on agreement? If Russia needs even more hot air or other concessions, this will only raise the cost to other countries of participating in the agreement—and so diminish *their* incentive to participate. Romano Prodi, President of the European Commission, said that, in approving Kyoto, President Vladimir Putin of Russia "sent a strong signal of his commitment and sense of responsibility." But is that really true?[6]

Even if Kyoto entered into force and succeeded in reducing the emissions of Annex I parties to this agreement, the total effect of the agreement would be diluted by trade leakage. If the Annex I countries limit their emissions, comparative advantage in the emitting industries would shift towards other countries, causing emissions by these countries to rise.

To sum up, the problem with Kyoto isn't just that it will make little difference. After all, Kyoto was never intended to make a big difference. The problem with Kyoto is that it does not provide a platform on which deeper and broader cuts in emissions can be sustained. To do that, an international agreement must sustain high compliance and participation levels even while reducing emissions substantially.

The only counter argument to this reasoning that I have heard is the rather hopeful assertion that, if some countries take the lead on this issue, others will follow. But why would they follow? Taking the lead does not by itself create incentives for change.

3.3 Reforming Kyoto?

Böhringer and Finus (2005; hereafter BF) acknowledge many of these problems but believe that Kyoto does provide a basis for significant reductions in emissions.

First, as regards developing countries, BF say that, in the short run, developing countries should be allowed "to choose, at any time and on a voluntary basis, a level of emission control that would be appropriate for their circumstances" (BF 2005: 278). The problem here is that developing countries may presumably choose not to limit their emissions. Alternatively, they might propose an emission level in excess of the existing emissions (hot air). This would reduce overall abatement costs, but it would also reduce global emission reductions—and result in a financial transfer, for no environmental benefit.

[6] Commenting on an earlier draft of this paper, Dieter Helm suggested to me that Russia's ratification is likely to weaken the climate regime. Russia, he argues, is likely to spend its revenues from permit sales on further oil and gas development, and use its position as a party to Kyoto to block more meaningful measures from being adopted in subsequent protocols.

Quite obviously, a mechanism would need to be included by which other countries would approve of these emission limits.

Second, "the shortcomings of the second punishment option under the Kyoto Protocol of additional abatement duties in the future could be partly fixed." They go on:

> "Instead of postponing punishment to the second commitment period, punishment could start immediately at low levels, with a gradual increase over time. In order to provide governments with an incentive to accept additional abatement duties as punishment, immediate action should be rewarded with generous reductions of future additional abatement obligations. Moreover, the Kyoto Protocol should include an option where parties reduce their abatement efforts as some form of reciprocal punishment (that is widely accepted in international law) if the treaty violator continuously ignores the rules of the protocol."

But there are problems with this proposal also. Since the emission limits only apply to an entire commitment period, it isn't clear how punishments could start before such a period ends. (Indeed, the delay in reporting emission levels is likely to mean that punishments are postponed well into the next commitment period.) As well, future abatement obligations have to be accepted by every party. They are not exogenous. It therefore isn't clear how "generous reductions" in such obligations could be meaningfully established. Finally, while reciprocal punishment would be desirable, there is a reason why it wasn't incorporated from the beginning: if other countries reduce their abatement to punish another country for failing to comply, then their punishment will be self-damaging. It may therefore not be credible.

Third, BF say that Kyoto could incorporate a "safety valve," a price at which each party could sell permits to its own polluters. A safety valve is a price instrument, and the combination of a price and quantity approach is generally superior to a pure quantity approach (or a pure price approach) under conditions of uncertainty. However, the problems of participation and compliance would remain.

Others have suggested that enforcement be achieved by means of trade restrictions. After all, it was by this means that the Montreal Protocol was enforced. However, Montreal was enforced without the need to restrict trade based on how a product was made—an approach that is technically almost impossible and currently WTO-illegal but that would be necessary in the case of climate change. As well, to be effective, trade restrictions must be both credible and severe. The history of environmental diplomacy shows how hard it is to meet both of these requirements (Barrett 2003). And in the case of a climate treaty, all trade would need to be affected—creating the risk that trade restrictions would strain the multilateral trading system to the breaking point. There are good reasons why trade restrictions were not a part of Kyoto from the beginning.

4. A new treaty system

Is there no alternative to Kyoto—or what might be called the Kyoto model, whereby one targets-and-time-tables agreement is succeeded by another in linear fashion? I have suggested a radically different approach.[7] It is outlined below.

This alternative consists of a number of different, mutually reinforcing protocols—agreements that would need to be adjusted and amended over time.

4.1 R&D

To make a difference to the climate, a treaty has to create incentives for long-term technical innovation. Kyoto tries to create a short-term "pull" incentive. In limiting emissions, it seeks to raise the cost of emitting carbon dioxide, creating a market for carbon-saving technologies and thus an incentive for the invention and diffusion of such technologies. This is a good way to design a domestic environmental policy (an example being the acid rain trading program in the United States), but not an international agreement. A substantial pull incentive requires robust enforcement—and as I have already explained, Kyoto fails to provide this. Indeed, since the Kyoto process began, most industrialized countries have actually scaled back their R&D funding, just the opposite of what is needed (Battelle, 2001).

As well, Kyoto provides no incentive for *long-term* technological innovation. Not only is Kyoto silent on post-2012 emission controls. It provides no incentive for investment that can lower the cost of reducing emissions in the future.

In any event, a "push" program for R&D is also needed, and yet Kyoto makes no provision for this. Basic research is in part a public good. For some problems, we can rely on individual countries to undertake the needed research unilaterally. For climate change, however, no country has a strong enough incentive to invest. Hence, a new R&D protocol is needed. Examples of "big science" collaboration include nuclear fusion research (the ITER), the new particle collider being built by CERN; the International Space Station; and the Consultative Group on International Agricultural Research (CGIAR). A climate R&D agreement, however, would have to be more ambitious than any of these.

How might such an agreement be structured? Each country's contribution to the collaborative effort should be contingent on the level of participation. That way, as more countries join, the contributions made by existing members would increase—creating an incentive for more countries to participate. Base-level contributions would need to be negotiated. They could be determined on the basis of ability and willingness to pay. Alternatively, they could be determined with reference to precedent-setting agreements (such as the United Nations scale of assessments). Either way, the agreement would fix the maximum total contribution for each country (this is in contrast to Kyoto, which fixes emission caps but not expenditures; and it differs from "price caps" by fixing total costs and not marginal costs). The existing regime asks the question: By how much should

[7] A wider range of alternatives is presented in Aldy, Barrett, and Stavins (2003) and Bodansky (2004).

concentrations be limited in the long term? This agreement asks a different question: How much are countries willing to invest in R&D so as to make it more attractive to reduce emissions in the long term? The R&D agreement thus focuses attention on the need to take appropriate measures.

Just as important as the size of the R&D budget and its financing is the way in which the money should be spent. R&D should be strategic. Technologies that capture and store CO_2, for example, may allow fossil fuels to be burned without adding to atmospheric concentrations. Such an innovation would reduce both leakage and domestic political opposition to emission reductions. It would also enhance the incentives for both participation and compliance in related agreements. However, there may also be limitations and problems with this technology, and that is why research is needed. The essential point is that the innovation undertaken under this protocol has to reinforce the efforts of related agreements.

4.2 Standards

These related agreements must create pull incentives for innovation and the diffusion of new technologies. Rather than prescribe emission limits that must be enforced, new protocols are needed that establish common standards for technologies that can be developed using the R&D (and so the R&D should also be strategic in focusing on technologies requiring standards). Economists normally reject the setting of technology standards by governments. However, market forces cannot be relied upon to be superior (Gandal 2002). Markets may fail to set a standard when standardization is welfare improving. Markets can also select a welfare-inferior standard. Committees can help market processes work better in picking standards (Farrell and Saloner 1988), and governments can also help (Funke and Methe 2001). The main reason for advocating standards, however, is different. Standards can have a strategic advantage in a world of 200 sovereign countries.

There are a number of incentives that can be created to encourage the development and diffusion of new technologies:

1. *R&D*. Current expenditure on R&D lowers the cost of developing new technologies in the future. Directed R&D would further steer development towards technologies requiring standards, technologies yielding domestic as well as global environmental benefits, and so on.
2. *Economies of scale*. With economies of scale in production, as more countries adopt a technology, the cost to others of adopting the same technology would fall. This would make it more attractive for others to adopt it.
3. *Economies of learning*. As experience in producing a technology increases, the average cost of production falls. Hence, as more countries adopt a technology, the incentive for others to adopt it in the future would increase.
4. *Network externalities*. When part of a network, the returns to every country of adopting a technology increase in the number of other countries that adopt the technology. So, as more countries adopt a network-based technology, the

incentive for others to adopt it increase. This effect is likely to be particularly strong for the transport sector (see below).

5. *Non-climate-related benefits*. Technologies that reduce local air pollution, and not only greenhouse gas emissions, increase the local benefit of adoption—and so make it more attractive for countries to adopt the technology.
6. *Trade restrictions*. Technology standards impose trade restrictions almost automatically, and these are both legal and easy to enforce.

Importantly, catalytic converters have become a global standard even though not required by any international treaty. The reason is that the adoption of this technology was influenced by all the factors listed above (Barrett 2003). But this means that a treaty that *did* require catalytic converters would not need to be enforced. In other words, the problems that plague Kyoto can potentially be avoided by a technology-centered approach.

There are, to be sure, problems with the standards approach. One problem is that standards will work better for some sectors than for others. For automobiles, network externalities are relatively important, leading to a positive feedback in the adoption of new technologies. For other sectors, like electric power generation, network externalities will be less so. Another disadvantage is that standards are not always the most cost-effective way of reducing emissions. Certain parts of the economy will not be affected by the standards protocols. And standards may "lock in" a technology, rather than promote continuous innovation and improvement. Of course, this problem can be reduced by the adjustment and amendment process. And even the Kyoto approach could create technologies subject to lock in. Nevertheless, it remains true that the standards approach is very much a second best proposal. However, the nature of this problem means that first best solutions cannot be implemented.

The standards protocols, like the cooperative R&D protocol, should be open to every country to sign. It is almost certain that the technologies needed to meet the standards will be more costly than those currently available, and this raises two problems. The first is why industrialized countries should participate in such an agreement. The second is why developing countries should participate.

For the industrialized countries, participation really needs to be based on the belief that something needs to be done to mitigate climate change. There is no getting around this, irrespective of the treaty approach taken. The difference between this proposal and Kyoto is that the latter cannot be enforced while the former would be self-enforcing. Both approaches are alike, however, in that both entail costs.

4.3 Minimum participation

Success of the standards approach also depends on establishing a threshold effect, as the positive incentives outlined above would only materialize if a critical mass of participation were achieved. Thresholds vary. The catalytic converter threshold was low (California adopted the standard first; this was then copied by the federal government and

by other countries). The threshold for a treaty spreading new technologies for ocean transport of oil had to be higher (see Section 5). My guess is that the threshold for a climate treaty would have to be higher still. At a minimum, the United States, Europe, and Japan would probably need to participate. Once the "big" industrialized countries participated, however, incentives should be created for others to participate. The minimum participation level for this treaty must thus be chosen strategically; it must ensure that participation exceeds the "tipping point" before the treaty enters into force (Barrett 2003).

Tipping would create an incentive even for developing countries to participate, but these countries should be compensated for agreeing to adopt the new technologies. A relevant model here is of the Montreal Protocol Fund, which compensates developing countries for the "agreed incremental costs" of complying with the agreement to phase out ozone-depleting substances. Note the difference between this approach and the flexible mechanisms (the Clean Development Mechanism or CDM and trading among Annex I countries) under Kyoto. With the CDM, industrialized countries must demonstrate the effect of CDM transactions on the emissions of developing countries. But the baseline level of emissions is unknown, and estimating the baseline will make transactions costly. Trading in emission entitlements can lower transactions costs but would also result in the transfer of surpluses from one country to another—possibly without emissions even being reduced. Funding technology transfer is different. Baselines need not be calculated, and the number of transactions would be fewer. Also, as under the Montreal Protocol Fund, developing countries would only be compensated for reducing emissions. And their compensation need not include surpluses. They could be compensated only for the "incremental cost" of adopting a new technology. Cutting out the transfer of surpluses has an advantage in an international setting. In reducing surpluses, the cost to the industrialized countries of financing emission reductions in developing countries is lowered—and so the incentive to offer the finance is increased. There are also political economy advantages in paying developing countries to adopt a technology likely to have been developed and produced in the industrialized countries.[8]

The need to change the technology of economic development is manifest. Poor countries like China and India are growing very rapidly, and it is important that the investment underlying this new growth be climate-friendly. Capital invested now will have a long life. In the rich countries, by contrast, growth will be more modest, and the rate of capital turnover lower. Rather than have the poor countries grow like the rich countries and *then* transition to a new technology base, as implied by the Kyoto model, it would be much better for these countries to grow using new technologies.

4.4 Short run measures

[8] This approach also avoids the political economy disadvantage of Kyoto. What will be the reaction if European countries seek to comply with Kyoto by paying Russia for its surplus permits? Money would be transferred without emissions being cut—all for the purpose of meeting arbitrary allocations of emission entitlements.

The R&D and standards protocols address climate change in the longer run. But they can and should be complemented by a protocol that seeks to reduce emissions in the short run. Indeed, rather than be seen as an alternative to Kyoto, the R&D and standards protocols should be seen as complementary instruments. The difficulty with Kyoto, as mentioned before, is that its success depends entirely on effective enforcement. An agreement like Kyoto would be more helpful, I believe, if the pretense of international enforcement were dropped. The focus would then shift to the "appropriate measures" that countries can and should undertake domestically and in the short run. Countries could, as in Kyoto, establish targets and timetables. They could also develop trading arrangements, as are now being developed in Europe. Alternatively, they could pledge to adopt policies and measures (ironically, an approach suggested much earlier in the negotiation process). The essential contrast with Kyoto is that all these pledges would be enforced *domestically*. This would not be the same as a purely unilateral approach, however, because these pledges would be cast within a multilateral framework. The process of pledging might create a kind of "tote board" for action, and so have some minimal effect over and above pure unilateralism (see Levy, 1993).

4.5 Adaptation assistance

Finally, it must be acknowledged that climate change is almost sure to happen no matter what we do now to try to mitigate it. Since the developing countries are relatively the most vulnerable, and since the industrialized countries are largely responsible for the cumulative build-up of atmospheric concentrations, these countries should help developing countries adapt. Adaptation assistance is a necessary ingredient for establishing fairness in the international response. Incorporating "cooperative adaptation" also creates an incentive for parties to balance adaptation and global mitigation.

4.6 Political feasibility

Though the approach proposed here is radically different from Kyoto, it would not in any way undermine Kyoto. Nor is it inconsistent with the current policy of the United States or any of the new policies being proposed for the United States. For both reasons, it is a politically feasible proposal—an arrangement towards which the international system can evolve. It is, I believe, our best chance for ensuring that collectively "appropriate measures" are taken to address this extraordinary challenge.

5. An historical perspective

In the introduction, I asked how we might view all of this a century from now. There is a reason for posing this question. One of the main justifications for sticking with Kyoto is that so much has been invested in this process that we cannot abandon it for an alternative. This, in my view, is irrational. What has been invested so far is sunk; it's lost, and we can't get it back. But even if we turn to consider a different approach, this earlier investment would not have been wasted. If it is looked upon as an investment in learning—learning about the nature of the problem and of how we can best address it—then it will be seen as having been worthwhile and perhaps even necessary.

Indeed, this is not the first time that a treaty has been painstakingly negotiated only to stall at the starting gate, or to enter into force but not be implemented, or to enter into force and be implemented but fail to make a material difference. A striking example is the approach taken to limit the deliberate release of oil at sea by tankers. Negotiation of agreements to limit oil tanker releases began in 1926. But the first attempts failed to enter into force, mainly because countries could see no way in which agreed obligations could be enforced. Eventually, an agreement to reduce deliberate oil releases (the International Convention for the Prevention of Pollution of the Sea by Oil or OILPOL, adopted in 1954) did enter into force, but this provided little more than a framework for further negotiations, as the quantitative limits set out in this agreement were not enforced. Later attempts to improve on this agreement encountered similar enforcement problems. The problem was with the approach to setting quantitative limits, not the aim.

In 1978 a very different approach was tried: a new agreement establishing a technology standard to separate oil from ballast water. The new agreement, known as the International Convention for the Prevention of Pollution from Ships (MARPOL), entered into force five years after being adopted and has since been strengthened by a number of mutually supporting amendments (the most recent requires double hulls for new tankers). In contrast to the earlier agreements, MARPOL has been an enforcement success. Participation is nearly universal (today, it covers 97 percent of global tonnage); compliance has been perfect (Mitchell 1994).

MARPOL succeeded where earlier attempts failed by strategically manipulating incentives. First, in contrast to quantity releases at sea, compliance with the technology standard is easily verified. Second, coastal states had nationalistic incentives to enforce compliance, to protect their shorelines and near-shore ecosystems. Third, a positive feedback was created whereby, as more countries participated, the incentive for tanker owners to comply increased (the value of owning a tanker increases in the number of ports to which the tanker is permitted access). And as more tankers complied, the incentive for port states to participate and enforce compliance increased (the cost of excluding standard-violating tankers fell). Essentially, the agreement created a “tipping” effect (Barrett 2003).

Of course, climate change is a much more challenging problem, and different problems require different remedies. But the lessons of this diplomatic history have much to teach climate negotiators. Unfortunately, most negotiators are unfamiliar with this story. The history of the Montreal Protocol negotiations is better known, but as I have explained elsewhere (Barrett 2003), the wrong lessons have been drawn from this experience.

6. Conclusions

The global climate regime consists of two agreements, the Framework Convention on Climate Change and the Kyoto Protocol. Participation in the Framework Convention is almost universal, but this agreement only establishes a collective goal for global action; it

does not allocate responsibilities to individual countries for meeting the goal. This is the harder challenge—the task left so far to the Kyoto Protocol.

The goal of the Framework Convention—to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"—is reasonable enough. In practice, however, it will be impossible to identify the "right" level of atmospheric concentrations with any precision. Rather than try to identify such a level, it would be better to focus attention on the "appropriate measures" that can and should be adopted to reduce the damages and risks associated with climate change. This choice must also reflect concerns about the costs and risks associated with mitigation.

The Kyoto Protocol will not stabilize concentrations. To do that would require a much more ambitious agreement, one that constrains the emissions of all the major countries by a substantial amount indefinitely. Kyoto was meant to be a first step; its architects believed it could be broadened and deepened over time. But Kyoto will only work if it can be enforced, and it cannot be. It certainly cannot enforce very substantial cuts in emissions—the levels needed if concentrations are to be stabilized.

And yet Kyoto need not be rejected or abandoned. It is only essential that Kyoto not stand in the way of alternative approaches. Serious mitigation will require a broader approach, one in which a number of mutually supporting protocols are adopted. In my view, these must include protocols that create a positive feedback between the short term and the long term (collective R&D into a new generation of energy technologies) and among countries (technology standards agreements, used to diffuse the new technologies).

Mitigation must be undertaken globally. Put a little crudely, any climate agreement that does not constrain the emissions of countries like the United States and China (and, of course, Kyoto does not restrict the emissions of either) will simply not be effective. The US is the world's largest emitter, and must be a party to any agreement aiming to reduce global emissions. China's participation is also important, for China is growing rapidly and will soon enough be a bigger emitter than the US. China wants to develop and is entitled to develop. But concerns about climate change mean that the world as a whole can gain if China shifts to a different development path, using a different energy technology. The world thus needs to make it attractive for China to make such a shift.

Getting countries on a different development path will require new technologies, and this in turn will require investment in R&D. Kyoto provides virtually no incentive for R&D. It aims to reduce emissions by only a little for just five years. It is entirely silent on what comes after 2012. No wonder parties to this agreement have actually cut their energy R&D budgets. This situation needs to change.

Finally, the climate is likely to change no matter how successful we are at mitigation, and the greatest victims (in relative terms) are likely to be the developing countries. Provisions must therefore also be made to assist these countries to adapt to climate

change. Climate change is not just an environmental challenge. It is a development challenge. It is a development challenge from the perspective of mitigation, which will require a technological revolution, diffused throughout the world. And it is a development challenge from the perspective of adaptation. Just as benefits and costs must be balanced in choosing “appropriate measures,” so must climate change mitigation and adaptation be balanced in future development policy.

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