

“You’re Getting Warmer: The Most Feasible Path
for Addressing Global Climate Change Does Run Through Kyoto”

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When I first arrived at the White House in September 1996, I had no idea that one of the issues on which I would spend the most time during my period as a Member of President Clinton’s Council of Economic Advisers was global climate change. But UnderSecretary of State Tim Wirth had the month before announced a major change in policy: that the United States would in multilateral negotiations now support “legally binding” quantitative targets for the emission of greenhouse gases. This left 15 months for the US Administration to decide what kind of specifics it wanted, at the Third Conference of Parties of the UN Framework Convention on Climate Change (UNFCCC), scheduled for November 1997 in Kyoto. Because other countries take their cue from the superpower (whether it is to support or oppose US positions), this countdown engendered a certain amount of suspense: What specifically would the U.S. propose at the Kyoto Conference, most notably regarding how the numerical targets should be determined? Outsiders demanded to know – with particular tenacity in the case of the U.S. Congress, who feared the worst. I was a member of a large inter-agency group that worked intensively on what was to become the Kyoto Protocol.

I never thought that the agreement had a large chance of being ratified by the U.S. Senate, or of coming into force in a serious way. There were too many unbridgeable political chasms, as I will explain. Furthermore I understand the reasons why almost all economists, at least in the United States, disapprove of the Kyoto Protocol. Nevertheless, I am prepared to defend the Clinton version of the treaty, and I believe it was a step in the right direction.

I will begin by noting that the weight of scientific opinion seems indeed to have concluded that the Earth is getting warmer, that increasing concentrations of carbon dioxide and other greenhouse gases are the major cause, and that anthropogenic emissions are in turn responsible. I am not a scientist. But the latest IPCC report concludes “The globally averaged surface temperature is projected to increase by 1.4 to 5.8 degrees Celsius” over the period 1990 to 2100, and “global mean sea level is

projected to rise by 0.09 to 0.88 metres.”¹ The evidence has become clearer over the last ten or twenty years. President George Bush, the Second, made a big mistake when he initially allied himself with the minority of disbelievers. It was a political mistake if nothing else. Even granting that the incoming administration in 2001 did not want to pursue Kyoto, it was foolish and unnecessary for the White House to dismiss the climate change problem.

This paper will take as given that the problem of global climate change is genuine, and is sufficiently important to be worth addressing by steps that are more than cosmetic. Because the externality is purely global – a ton of carbon emitted into the air, no matter where in the world, has the same global warming potential – the approach must be multilateral. Individual countries will not get far on their own, due to the free rider problem.² Specifically, multilateral negotiations have since the Rio Summit of 1992 proceeded under the UNFCCC.

The paper will summarize major decisions that the Clinton Administration had to make, and why it made them as it did. What were the quantitative limits on emissions to be? How would greenhouse gases other than carbon dioxide be treated? Would trading across time or across countries be permitted? And so on. In my time in the government, I was surprised to discover that policy makers often must make such technical-sounding decisions with relatively little help from the body of technical knowledge and opinion outside the government. It is not just that academic research is too abstract to be of much direct help with the minutia of specific policy decisions. The pronouncements of think tanks and op-ed writers also ignore practical complexities, because they seek to make big points for general audiences. We were largely on our own.

Some years from now, the world may be politically ready for a more serious treaty, one that requires some sacrifice of sovereignty and wealth. Those who design this future treaty will have to grapple with some of the same issues that we did. An explanation of the thinking that went into Kyoto might help.

As I see it, the Kyoto Protocol, particularly its flexibility mechanisms, is a good foundation on which to build. The subtitle of this paper is: “The Most Feasible Path for Addressing Global Climate Change Does Run Through Kyoto.” This is also the second meaning of the paper’s main title, “You’re Getting Warmer.” In the American game, a child looks for a hidden object, being told “you’re getting colder “ whenever he or she looks in the wrong vicinity, and “you’re getting warmer” when coming closer to the objective. Kyoto was a step closer.

“Targets and Timetables”

The economist’s approach to designing a strategy to address an environmental problem, of course, is to take into account economic costs. In principle, cost benefit analysis is the right way to do this, along the lines of the Integrated Assessment Models

¹ *Climate Change 2001: The Scientific Basis, Summary for Policymakers*, report of Working Group I of the Intergovernmental Panel on Climate Change, P.13-16.

² A few will try, which is commendable. But absent a commonly-agreed set of rules or incentives, voluntary individual efforts are unlikely to total up to much, and rather to remain a matter of “private virtue” (a phrase of Vice President Dick Cheney’s).

pioneered by Bill Nordhaus.³ The prescription that often emerges is a very long-term plan of emission reductions relative to the Business as Usual path (BAU) -- with cuts that are very small initially, but that become larger late in the 21st century -- implemented by a price mechanism such as a global carbon tax.

Although academic research can and should proceed with such models, the problem faced by policy-makers in 1997 was more constrained in a number of ways. In practice, full cost benefit analysis in the case of global climate change is less helpful than is at first apparent, for two major reasons. The first reason is the tremendous uncertainties involved in any model. Just the range of uncertainty about the proper discount rate, alone, can give every answer from large immediate cuts to a path that begins with no cuts.⁴ Further, it is impossible to put probabilities on the catastrophe scenarios (an end to the Gulf Stream current, melting of the Antarctic ice shelf, an unstable feedback loop through release of methane from thawing permafrost, and so on).

One is thus led to accept an arbitrary environmental goal, such as limiting the increase in carbon dioxide to twice pre-industrial levels by 2100 (from 270 PPM to 550 PPM), and to ask the cost-minimizing path to achieve this goal. We at the Council of Economic Advisers used estimates by Alan Manne and Rich Richels on alternative paths to such a goal.⁵ According to their estimates, the most efficient paths involved heavy cuts below current levels of emission only in the second half of the 21st century. It was assumed that new technologies, now unknown, could be developed that far into the future. In the early decades, the most efficient path featured emission targets that would continue to rise, though at a rate modestly below the BAU path. To see why heavy cuts in the early decades would be too expensive, consider electric power generation. Today's fuel mix relies heavily on the dirtiest fuel, coal. Power plants have a natural life of at least forty years. To cut domestic emissions of carbon dioxide heavily in the first two decades would require shutting down coal-fired power plants before the end of their useful lives, at great expense, replacing them for example with natural gas. Waiting three or four decades to begin the heavy cutting below the BAU path is far cheaper, provided firms know that they need to begin planning for the change now. The Manne-Richels least-cost path for achieving the specified goal of 550 PPM showed global

³ William Nordhaus, 1994, *Managing the Global Commons: The Economics of Climate Change*, MIT Press: Cambridge MA.

⁴ E.g., William Cline (1992), *The Economics of Global Warming*, Institute for International Economics: Washington DC. For an introduction to the discount rate issue, see Lawrence Goulder and Robert Stavins, "How and Why Economists Discount the Future," June 3, 2002; forthcoming in *Nature*. For a more recent and general review of the timing issues, see Joseph Aldy, Peter Orszag, and Joseph Stiglitz, "Climate Change: An Agenda for Global Collective Action," conference on *The Timing of Climate Change Policies*, Pew Center on Global Climate Change, October 2001.

⁵ Manne and Richels, "On Stabilizing CO₂ Concentrations – Cost-Effective Emission Reduction Strategies," Stanford University and Electric Power Research Institute, April 1997. Subsequently, James Hammett, "Evaluation Endpoints and Climate Policy: Atmospheric Stabilization, Benefit-Cost Analysis, and Near-Term Greenhouse Gas Emissions, Harvard University, *Climatic Change* 41: 447-468, 1999, estimated that the least-cost emissions path for stabilizing at 550 PPM lies below the fully optimizing path of cost-benefit analysis, until 2024, and then crosses above it.

emissions peaking in the decade 2040-2050, and rich-country emissions peaking several decades earlier.⁶

As we became more familiar with the politics, we soon realized that even the cost-minimization solution would not serve. These 100-year paths were of little use to political leaders. Politicians have short horizons, for very good (electoral) reasons. The difficulty created by the inability of policymakers to make credible long-term commitments is in the field of monetary policy referred to as the problem of dynamic inconsistency. Once in a great while, a leader can try credibly to commit to a project with a ten-year horizon, even though the public knows he will not still be in office to see its completion. President Kennedy, for example, committed the US to reach the moon by the end of the 1960s. Some attempts have been made to “fix” social security on a ten-year horizon. But it is out of the question for political leaders to commit to policies 100 years in advance. Even 30 years is too long a horizon. A president who proposed to cut emissions 30 years in the future would be laughed out of Washington. Everyone would think “it’s just words,” and they would be correct. None of the countries participating in Kyoto, neither the Europeans and others who were arguing for very ambitious targets, nor those arguing for gradualism, proposed setting targets far into the future. All the discussion concerned targets for the period 2008-2010. Most of those participating (though not all) understood that, for this reason, the cuts under discussion would make only minute contributions to reducing greenhouse gas concentrations, temperatures, and sea-level rises later in the century. We estimated that if participation were limited to the countries undertaking commitments at Kyoto, then the effect of the agreement would be to reduce the temperature in 2050 by only roughly 1/10 of one degree Celsius (relative to a baseline increase of 1.15 degrees). Even so, the longest journey begins with a single step.⁷

The implication of these considerations is that the targets had to involve a concrete non-fudgeable commitment of some sort within a horizon of ten years or so. My personal choice was a commitment that emissions should reach a peak – that is, that they be observed to level off -- in the decade 2010-2020, with absolute reductions to follow in later decades. Climate mitigation under this proposal was almost the same as the plan to return to 1990 levels by 2010, and yet the impact on energy prices would be only about one eighth as much. But peaking two decades hence was not a sufficiently ambitious goal for the environmentalists and was thought – correctly, I am sure – to be a political non-starter with the Europeans. They were all thinking in terms of the (voluntary) goals that had been set at Rio, which were phrased in terms of 1990 levels of emissions. The Europeans thought they would achieve 1990 levels by 2000, i.e., that

⁶ Thomas Wigley, Richard Richels, and Jae Edmonds, 1996, “Economic and Environmental Choices in the Stabilization of Atmospheric CO₂ Concentrations,” *Nature*, vol. 379, 18 January, had earlier proposed a path to this goal (which Manne-Richels found to be almost as cost-efficient as theirs), showing Annex I emissions peaking in 2010, developing countries peaking in 2050, and the global average peaking in 2030.

⁷ I want to be clear that it still makes sense for most academic models to work in terms of long-term paths. But it is also important to realize that no given policy-maker gets to choose a long-term path. The job of each, at most, is to choose the size of one link in the chain. The economic adviser who insists on talking about 100-year paths is making the common mistake of refusing to answer the question that the policymaker has hired him to answer.

they were already peaking (as called for at Rio). True, the United States could have told the Europeans “take it or leave it;” but President Clinton wanted an agreement.

A good solution, in terms of economics, would have been an early US “down-payment” policy measure to demonstrate sincerity, such as a substantial domestic energy tax. But such tax increases are extremely unpopular, and were ruled out on political grounds. The Clinton Administration had unsuccessfully proposed a BTU tax in its first year, and felt severely burned by the experience. An alternative, if the desire to be more ambitious was genuine, would be to set a target path in which emissions peaked in some year earlier than 2010. But such proposals were too concrete and immediate; they ran into the paradoxically simultaneous brick walls of being too ambitious economically and insufficiently ambitious environmentally.⁸

In October 1997, the President decided that the US position going in to Kyoto would be to return carbon emissions to 1990 levels by 2008-2012. In the end, in order to break a negotiating deadlock at Kyoto in November, the US gave some ground, agreeing to reduce a combination of six gases to 7 percent below 1990 levels. The US team figured that the flexibility inherent in tradeoffs among the six gases made the cost almost equivalent to that of the President’s October position. Other countries agreed to similar cuts, some larger and some smaller, totaling 5 percent relative to BAU.

Political chasms

The small interagency group that met frequently during this period in the White House office of the Director of the National Economic Council developed its own ways of speaking of the political constraints of climate change policy. It was decided that nobody around the table was allowed to dismiss someone else’s proposal on the grounds “that is politically impossible.” All options were “politically impossible”. Rather, you had to identify an alternative proposal that was less politically impossible than the one you were arguing against. I also noticed that an option where the political impossibility was immediate and certain would be dominated by another that was also “politically impossible” but where the constraint would be encountered in the more distant future and with less certainty. In “Butch Cassidy and the Sundance Kid,” Butch (Paul Newman) proposes that the only way out for the two outlaws, who are trapped on a rock ledge, is to jump off the cliff into the river far below. Robert Redford confesses, “I can’t swim.” Paul Newman replies, “Are you crazy? The fall will kill you anyway!”

Any US policy to address climate change had to contend with four political chasms. Each was so deep as to be virtually unbridgeable, and also so wide that the constituents living on the opposite sides were barely communicating with each other. Each of the gaps remains wide today, although some progress has been made.

(1) The first was the gap between environmentalists and the Congress on understanding of the climate change issue and willingness to bear some economic costs to address it. The Congress in 1997 passed the Byrd-Hagel resolution, which opposed a treaty along the lines of Kyoto, by a vote of 95-0. At the same time, environmentalist NGOs considered the agreement and related Clinton policies to be inadequate. Many environmentalists pronounced the Administration a profound disappointment, and

⁸ On several occasions, I would try to explain an intermediate value theorem to my colleagues: Before emissions returned to 1990 levels, their rate of growth would have to turn negative, and before that, their first derivative would have to fall to zero. But nobody wanted to discuss the leveling off date.

support for the Green Party's Ralph Nader in the year 2000 election turned out to be (one of many things) great enough to deny the presidency to Al Gore, the candidate with the most knowledge and concern regarding the environment of any top political leader in US history.

Where did the median American citizen stand? On both sides of the chasm. On the one hand, polls say that a heavy majority of Americans are concerned about the environment in general, and global warming in particular, and want to do something about it.⁹ On the other hand, I think most of them could not answer correctly whether global warming is scientifically the same phenomenon as the greenhouse effect, stratospheric ozone depletion, or acid rain. In a poll, 59 % responded that it was either definitely true or probably true that the greenhouse effect was caused by a hole in the earth's atmosphere, while only 26 per cent thought this was probably or definitely not true.¹⁰ The polls also show that the median American voter opposes substantial energy taxes to address climate change.¹¹

The United States will not address the issue seriously until public awareness rises. The negotiation and debate over the Kyoto Protocol itself has helped raise the visibility of the issue a great deal. A very hot summer, and some natural catastrophes, would help more. Some say the American public will never accept a substantial increase in the price of energy, whether in the form of taxes or otherwise. But I would not completely rule out a major shift in attitudes at some point in the future. It may have to be tied in part to other objectives such as other environmental goals, and reducing dependence on oil for national security reasons. Political salability of an energy tax would be enhanced if it came at a time of falling world energy prices (because avoiding a decline in price is much less damaging politically than causing an increase), and if the tax revenue were visibly seen to be recycled directly back to the public in another, popular, form. But for now, it is not an option.

(2) The second wide political chasm lay between the United States and the European Union. On one side, the EU, correctly pointing out that it had already reduced the ratio of energy use to GDP while the United States had continued its profligate policies, insisted that cuts in domestic emissions be sufficiently severe to impose economic costs on the United States. In the negotiations, this translated both into support for aggressive targets for reductions in emissions, and opposition for schemes whereby members could pay other countries to do the cutting for them. On the other side, the United States favored "flexibility" mechanisms such as international trading of emission permits, to reduce the economic costs of achieving a given target. Many Europeans felt that such trading was immoral. The US response was that if the Europeans opposed such market-oriented mechanisms to reduce the economic costs of

⁹ Awareness is also increasing over time. Steven Kull, December 10, 1998, "Americans on Global Warming: A Study of US Public Attitudes," Program on International Policy Attitudes, University of Maryland, p. 3-6.

¹⁰ The source is a survey conducted by the National Opinion Research Center, for the US Council for Energy Awareness, in 1993.

¹¹ Only 48% favor increasing the tax on gasoline by 10 cents a gallon, according to a Mellman Group poll in August 1997, although a majority is willing to pay more for gasoline in an unspecified way, if it will significantly reduce global warming (73% will pay 5 cents a gallon, and 60% will pay 25 cents), according to a Pew Poll in November 1997. Kull, *ibid.* p. 12.

achieving a given environmental goal, they must have some strange ulterior motive. Their goal must be scoring debating points with their domestic green parties or inflicting pain on the United States for its own sake, rather than achieving an agreement that would lead to a better environment.¹²

The gulf between the EU and US became even clearer in the wake of Kyoto, never more so than at the Sixth Conference of Parties at the Hague in November 2000. The EU made a mistake symmetric in nature and comparable in magnitude with the mistake made a few months later by the incoming Bush Administration in rejecting Kyoto out of hand. The EU refused to agree to the Clinton-Gore position on flexibility mechanisms (particularly unrestricted international trading of emission permits, and use of sinks), even though the known alternative was dealing with the far more hostile Republicans. The symmetry arises in that both the EU and Bush passed up the chance to offer apparent concessions secure in the knowledge that the other side would not agree, and thereby to pin the blame for the failure of multilateral negotiations on the unreasonableness of the other.

(3) The third political chasm lay between the United States and the developing countries. Many Americans opposed taking any costly steps unless the developing countries were participating as well.¹³ This was also the gist of the Byrd-Hagel resolution. After Kyoto, industry ran prominent advertisements that showed a map of the world with the non-participating countries cut out, as giant holes in the system. The most commonly articulated reason why the absence of developing countries was considered fatal was the adverse impact on American economic competitiveness. Although competitiveness is not the proper way to articulate the concern, I will argue below that we do indeed need the developing countries inside the system. The developing countries, for their part, argued, quite reasonably that the rich countries should have to go first, since they created the problem and the poor countries should not be forced to forego their own industrialization to solve it. In this they were supported by the Berlin Mandate, wherein the UNFCCC negotiators had already agreed in 1995 that the developing countries would be exempted in the first round.

(4) The fourth chasm was intellectual rather than political – between the engineers and the economists. Engineers promised that new technologies were already available that could save energy and save money at the same time, and that reducing emissions thus need not entail any economic costs. Their favorite example was so-called “green light bulbs,” though many other technologies had their proponents [low-flow shower heads, fuel cells, solar and wind power, cogeneration, and so forth]. The engineers used so-called “bottom up” models, essentially large-scale linear programming exercises that used technical coefficients from laboratory experiments, with little allowance for human behavior. A prime example was the “five-labs” study that the Department of Energy

¹² Some others share this feeling as well, e.g., Michael Sandel, “It’s Immoral to Buy the Right to Pollute,” *New York Times*, Dec. 15, 1997, p.A29; reprinted in Stavins, Robert, 2000, Economics of the Environment: Selected Readings, 4th Edition (Norton: New York) 449-452.

¹³ 44 % said the US should refuse to sign the Kyoto Treaty until all the less-developed countries commit to limits, while 53% said the industrialized countries should proceed with as many countries as will commit to limits. Steven Kull (1998), p. 10.

(DoE) produced to back up claims that the Kyoto reductions could be achieved at very little economic cost.¹⁴ They called “lemon-suckers” those who argued that an increase in the price of carbon was necessary to induce the desired shift in the amount and composition of energy that consumers and firms use.

The economists -- the lemon-suckers -- in turn called their opponents techno-optimists. They asked why such energy-saving technologies were not already in use, if they were so profitable.¹⁵ It is probably in fact a poor tactic for economists to deny the possibility that any money-saving technologies could exist unutilized. The claim that everyone is rational alienates non-economists unnecessarily. But there are other problems with the argument that technologies already exist that have the potential to save us. One is the difficulty in knowing which of the many candidate technologies are the winners. Another is in overcoming whatever social barriers currently exist to the use of the techniques – some of which result from irrational or inefficient “market barriers” (incomplete information, incorrect discount rates), but others of which may be perfectly rational given the absence of economic incentives (many consumers are genuinely averse to fluorescent light, low-flow shower heads, and small toilet tanks, no matter how much environmentalists wish the truth were otherwise). In either case, it is foolish to think that people will start using new technologies that they were not previously using merely because the president gives a speech, the Senate ratifies a treaty, or Environmental Protection Agency (EPA) bureaucrats hand out leaflets on street corners. People need incentives to change their ways. In this light, it makes little difference whether the people have been acting fully rationally or not.

It should go without saying that technology is part of the solution. But technology is not a policy lever. Only measures like taxes, tax breaks, research subsidies, permit requirements and other forms of regulation, are policy levers. To make an analogy, we can agree scientifically that burning calories is technically the way for a person to lose weight. But this is not a prescription for avoiding the hard work of getting exercise. Exercise is the policy lever and burning calories is the intermediating variable, to cut weight. Similarly, creating incentives to save energy is the policy lever and use of cleaner techniques is the intermediating variable, to cut energy use.

The economists’ models were called “top down” models, because they relied on econometric equations estimated from aggregate data on energy use, income, price, and so forth. It was not precisely correct to say that these models were pessimistic. The models said that little progress could be made reducing carbon emissions if there were no increase in the price of carbon, especially in the short run. But, based on the data of past history such as the response to the 1970s oil shocks, the models predicted that substantial adjustments were possible in response to an increase in price, especially in the long run. The patterns of behavior implicit in the estimated equations included the development and implementation of new technologies not currently contemplated, given generous

¹⁴ U.S. Department of Energy, “Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy-Efficient and Low-Carbon Technologies by 2020 and Beyond,” 1997.

¹⁵ Al Gore’s book on climate change repeats the old joke about a man not wanting to pick up a \$20 bill on the sidewalk, under the theory that it couldn’t be real because somebody else would have already picked it up. *Earth in the Balance: Ecology and the Human Spirit*, 1993 (Plume, Penguin Books: New York), p. 186.

enough incentives, and in that sense could actually be more optimistic than the engineers' approach.

Why do I list the conceptual gap between techno-optimists and economists as one of the chasms that needs to be bridged if climate change is to be seriously addressed? I do not believe that it does the environment any service to pretend that greenhouse gases can be reduced without raising the price of emissions, without paying any economic costs, or without making any special effort. If it is so easy, then why would we need a treaty? An agreement that resulted from such a pretense would prove to be cosmetic. People need to realize that there will be some price, even if it is only a moderate one, and need to decide that it is worth paying, not just because it is the truth, but also because the effort will not be sustained if it is based on unrealistic promises.

Flexibility mechanisms

Techno optimism might be good enough for DoE or EPA, or even, if the truth be told, the President and Vice President. But the White House wanted the Council of Economic Advisers to be able to testify to Congress that the economic costs of Kyoto would be modest. There was pressure on the economists, from some parts of the US government, to accept estimates made by the bottom-up modelers, that technology would achieve large reductions in domestic emissions at low cost. The CEA was not prepared to accept these estimates, or to testify favorably regarding any propositions that were contradicted by the leading economic models. In the aggregate models, the parameter under dispute was the rate of improvement of the Autonomous Energy Efficiency Index. We considered a trend of 1.0 percent a year plausible, a small increase above the 0.9 percent number in the Energy Information Agency's *Annual Energy Outlook*. We did not consider it wise to assume that such initiatives as the \$6.3 billion 5-year package of tax cuts and R&D that President Clinton proposed in the FY 1999 budget would over the short span of 10-15 years have a payoff greater than this.

There was only one honest way we could see to reconcile the models with the claim that the quantitative targets of Kyoto need not imply large economic costs. This was to give full sway to the flexibility mechanisms: the treaty had to specify the environmental goals in an aggregate way, and let the market decide how most efficiently to achieve them. We identified provisions falling under three kinds of flexibility: "when-flexibility," "what-flexibility," and "where-flexibility," all of which were in the end accepted by the other parties at Kyoto.

(1) "When flexibility" loosened up the constraint whereby a given country might otherwise have had to hit a given target precisely in a given year. That would have been very difficult, given the imprecision of measurement and, in particular, the unpredictabilities of the weather and the business cycle. Rather, countries are allowed to average over the five years of the budget window, 2008-2012, and to "bank" any reductions beyond the target for future budget periods.

(2) "What flexibility" loosened up the constraint whereby a country might otherwise have had to hit individual numerical targets for carbon dioxide, methane, and four other greenhouse gases. The other gases were considered important enough sources of global warming to include, as scientists have a relatively good idea of their contribution to the greenhouse effect. But we will not know until we try which gases

firms will find it easiest to cut back on. Thus a linear combination of the six was specified, rather than separate targets for each. The protocol also specified a role for sinks – sequestration of carbon, particularly into growing forests – though how exactly countries would receive credits for sinks was to some extent left for future negotiation.

(3) “Where flexibility,” the most contentious set of issues, loosened the constraint regarding within whose borders physical reductions in emissions occurred. It is far easier for some countries to cut emissions relative to the BAU path than for others. It is far cheaper for China to refrain from building a coal-fired power plant that it would otherwise have built, using natural gas in its place, than for the United States to tear down an existing coal-fired plant. The latter can pay the former for the trade, and both come out ahead.

At the insistence of the United States -- and allies within the “umbrella group,” which included Japan, Canada, Australia and New Zealand – the text agreed at Kyoto allowed international trading of emission permits. The United States was careful to allow that trading could be undertaken by individual entities within a country and need not go through the government. It wanted to be able to respond to charges that US taxpayers were being asked to pay other sometimes-corrupt countries for the right to use energy, by arguing that trading would only take place if private individuals voluntarily wished it. The language specified that countries pay others for emission reductions “supplemental” to those achieved domestically. Left for future negotiations was the definition of “supplemental” – Europeans insisting on a cap on trading such as 50% of targeted reductions, and Americans thinking anything up to 99% was fair game. Other details of the trading scheme as well were left to be worked out in the future, such as whether buyers or sellers would face legal liability, and whether there would be penalties for abuse. (In my own view, if a country sells several years’ worth of emission permits in the first year of the budget period, it should then have to make good with accounted-for domestic cuts before it can sell any more. This was called an “empty-tank provision.”)

Besides international trading, the other key geographical flexibility provision was the inclusion of developing countries. As already noted, the Kyoto Protocol followed the Berlin Mandate in specifying targets only for the so-called Annex I countries –the industrialized countries and some of the formerly-industrialized countries of the former Soviet bloc. In practice, this meant that that the United States and other rich countries would compete to buy permits from Russia and the Ukraine. (The latter two would find it easy to reduce emissions relative to 1990 levels, for two reasons. First, they consume six times as much energy per dollar of output as does even the United States. Second, their economies had collapsed in the intervening decade, and therefore their emission levels. Thus some, but certainly not all, of the reductions they would be paid for would be “paper tons” or “hot air,” that is, reductions that would have occurred even in the absence of an agreement.)

President Clinton signed the Kyoto Protocol one year later, November 1998, at the time of the Fourth Conference of Parties in Buenos Aires. But, at the same time, the Administration adopted the position that it would not submit the treaty to the U.S. Senate for ratification – knowing that it would face certain and overwhelming rejection – unless and until negotiations achieved “meaningful participation” by developing countries. That meant not necessarily that all developing countries need participate fully (the Byrd-Hagel position), but that at least a majority of the key large countries – China, India, Korea,

Brazil, Mexico, Argentina – must participate. “Participation,” in turn, meant adoption of targets, and participation in the voluntary permit trading system.

The Kyoto Protocol included a version of the already existing Joint Implementation, dressed up under the name “Clean Development Mechanism” to sound like a resource-transfer proposal that came from Brazil. These provisions looked much like emissions trading, except that, divorced from the benchmarks provided by targets, countries were in essence selling permits without the existence of property rights. The idea was to pay Costa Rica to preserve forests or to pay China to switch to clean energy sources. The difficulty was knowing what the benchmark was -- what these countries would have done otherwise. Proponents agreed that every effort should be made to insure “additionality,” but in my view gave few real grounds for hope that additionality would in practice be much greater than zero. A caricature version of the proposal would have each of a billion Chinese citizens stepping forward, in turn, to explain that he or she had been thinking of building a dirty power plant or chopping down a forest, but that if paid a modest sum he would agree not to do so. My personal view was that the CDM would do more harm than good, by bringing the valuable principle of international permit trading into bad repute. Others thought that it was better than nothing.

In any case, the Clinton Administration position was that it would not submit the treaty to the Senate until major developing countries agreed to targets of the same nature as the countries that had signed Kyoto. Even assuming that these countries could be persuaded – and most were adamantly opposed even to discussing the issue -- this would require either side agreements with individual countries or negotiating some new parallel agreement.

CEA estimates of the economic costs of the policy

In response to insistent demands from the US Congress, the White House produced a set of CEA estimates regarding the economic effects of achieving the Kyoto targets.¹⁶ These estimates relied on the Second Generation Model, of Battelle Labs, produced with the help of Jae Edmonds.¹⁷ The key findings were as follows:

- (i) International trading, even if just among the Annex I countries, reduced costs by an estimated 50%. If the EU countries chose to forego trading, then the opportunity to buy and sell emission rights within the umbrella group alone (including Russia and some other transition economies) would reduce costs by 60-75%.

¹⁶ *The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis*, White House, July 1998. Summaries included Janet Yellen, Testimony before the US House of Representatives Committee on International Relations, May 13, 1998; and Jeffrey Frankel, “Economic Analysis of the Kyoto Protocol,” *After Kyoto: Are There Rational Pathways to a Sustainable Global Energy System?*, 1998 Aspen Energy Forum, Aspen, Colorado, July 6, 1998.

¹⁷ J.A. Edmonds, H.M. Pitcher, D. Barns, R. Baron, and M.A. Wise, 1992, “Modeling Future Greenhouse Gas Emissions: The Second Generation Model,” in *Modeling Global Climate Change*, Lawrence Klein and Fu-chen Lo, eds., (United Nations University Press: Tokyo), pp. 295-340; J.A. Edmonds, S.H. Kim, C.N. McCracken, R.D. Sands, and M.A. Wise, “Return to 1990: The Cost of Mitigating United States Carbon Emission in the Post-2000 Period,” October 1997, Pacific Northwest National Laboratory, Operated by Battelle Memorial Institute. We made adjustments for the effect of the six-gas objective, as the existing economic models focused on carbon dioxide alone. Joe Aldy was the CEA staff economist who worked with the model.

- (ii) Inclusion of major developing countries in the target and trade system reduced costs further, to a total saving of 80-87%, and
- (iii) With these flexibility mechanisms, costs became quite modest, approximately \$7-\$12 billion a year, or only 0.1% of GDP.
- (iv) While predicted economic costs (lost real income) is the relevant statistic for an economist, the public instinctively considers those numbers less real than predictions of the increase in the price of energy. Our prediction was that energy prices would rise modestly: \$14 to \$23 per ton of carbon equivalent. This translated into increases of 5-9 % in fuel oil prices, 3-4% in the price of electricity, and 3-4 % in gasoline prices (around 4-6 cents per gallon). For the typical household, it would mean an increase of only 3-5 % in overall energy prices, or an increased energy bill of \$70-\$110.¹⁸

It followed directly from the second point, above, that without international trading, the costs of Kyoto would be 5 to 8 times higher, and thus in excess of \$100 per ton of carbon avoided. But we did not include this statistic explicitly in the report, because it would have given hostile opponents a sentence to quote.

Some reacted to our report by suspecting that we must have used a model biased to give low estimates. But in fact the SGM model is roughly in the middle of the pack of economic models (and is *a fortiori* more conservative than the techno-optimist models). Subsequently, ten leading models, those that participate in the Energy Modeling Forum of Stanford's John Weyant (EMF-16), showed a median prediction of costs in terms of permit prices of Kyoto quite close to ours, both in the case of no international trading and in the case of Annex I trading. With full global trading, the SGM results were a bit below the median, but far from the lowest of the models. The others predicted gains of from 70 to 91 percent from full global trading, consistent with our estimates.¹⁹

There was one respect in which our estimates were very optimistic. That was the assumption that there would be effective and unlimited international trading and participation by developing countries, when the EU had not yet agreed to the former and the developing countries were adamantly opposed to the latter. But we were completely explicit about this, and did not offer any estimation that attaining the necessary conditions was politically likely. Better yet, by repeating these estimates and the necessary conditions endlessly in testimony and other public fora, the Administration in effect became completely locked in to the position that it would not submit the treaty for ratification unless or until these conditions were met.

There were also respects in which our estimates were pessimistic. First, as noted, we did not rely on the possibility of immediate technological breakthroughs. Second, we made no allowance for the potentially very important global role of sinks in removing

¹⁸ A plurality of 52% of Americans say they would oppose signing the treaty at a presumed cost level of \$50 a month for an average household (Steven Kull, 1998, p.11). Although the White House did not use or have polling data at the time the policy was formulated, the politically minded aides had a notion of what the public would support that turned out to be about right, judged by subsequent data.

¹⁹ Three models were (substantially) more optimistic than SGM: FUND, G-Cubed (McKibbin-Wilcoxon) and RICE. In the case of global trading, six models were more pessimistic than SGM: MIT, AIM, MRT, CETA, MERGE3, and Oxford (the latter few models were substantially more pessimistic).

carbon from the atmosphere at relatively low cost, in part to be conservative and in part because the specifics were not available. Third, we did not explicitly include auxiliary benefits: the relative price shifts necessary to reduce emissions should produce non-climate benefits in three areas – traffic congestion, highway accidents, and air pollution – that we estimated could offset approximately a quarter of the resource cost of climate change policy. And the most important factor that we left out of the assessment was the long term benefit of beginning to mitigate climate change itself.

On the other hand, as the date gets later, as 2008 approaches and no real action has been taken, it gets harder and harder to attain the Kyoto targets. Already by 1998, US emissions of CO₂ were something like 12 percent above 1990 levels (and of all greenhouse gases 22 per cent above). By now they have risen substantially more. Thus the cuts envisioned at Kyoto were very large relative to the current path that we were – and still are – on. I have not seen any recent estimates, but as of 2002, I would guess that by now, for the United States, attaining the targets would be so economically ruinous as to be almost out of the question, unless perhaps one were able to make generous interpretation of the sinks provision.

Treaty design

Why did the Kyoto Protocol set quantitative targets, instead of the price mechanism favored by many economists?²⁰ A global carbon tax, while meritorious in theory, would be an instance of “common policies and measures,” which was rejected by the parties. The main explanation, again, is that it is not feasible politically. To dictate to each country the instruments to be used to achieve a shared environmental goal is too large an invasion of national sovereignty. Also a uniform tax would require a far higher sacrifice by the United States, relative to the status quo, than Europe or Japan, because the latter already have high taxes on some forms of energy, so it is not sensible to expect the US government to support such a thing. To address the latter problem, the version proposed by Richard Cooper is a uniform *incremental* carbon tax. But then Europe and Japan would have a strong incentive to substitute the additional carbon tax for existing energy taxes.

Skeptics will say that monitoring and enforcement problems are sufficiently great that quantitative targets are meaningless. They are correct that monitoring and enforcement problems are large, but not that the targets for this reason are of no use. The precedent of the successful Montreal Protocol on stratospheric ozone depletion is somewhat encouraging. Compliance problems would inevitably be far greater with global climate change than with ozone, because the number of emitters and range of activities is so much greater. The enforcement clause was left blank at Kyoto, with little in the way of good ideas to be filled in later. In practice, countries would miss targets sometimes -- some explicitly, pointing to factors beyond their control such as natural disasters, civil wars, economic hardship, and so forth, and others hiding behind a mask of shameless accounting. But the more egregious cheaters would feel strong moral suasion

²⁰ E.g., William Nordhaus, “After Kyoto: Alternative Mechanisms to Control Global Warming,” American Economic Association, Atlanta, GA Jan. 4, 2001. Richard Cooper, “Why Kyoto Won’t Work,” *Foreign Affairs* March/April 1998; and “The Kyoto Protocol: A Flawed Concept,” April 2001; forthcoming, this volume (FEEM, Milan).

from others, and when all was said and done, some progress would be accomplished. Unfortunately, the power of moral suasion diminishes sharply if the countries participating know that they are heavily outnumbered by the countries not participating.

An excellent idea that might have helped persuade cost-conscious countries was the safety valve: supplementing quantitative targets with a provision that if the shadow price of carbon (the price of tradable permits) goes above a pre-arranged level, then it is capped by an arrangement that some authority will sell an unlimited number of additional permits at that price.²¹ The selling authority could be national governments in one version, or a multilateral authority in another version, with proceeds earmarked for agreed-upon uses. One attractive feature of this idea is that it “calls the bluff” of the techno-optimist environmentalists. If they are right that there are lots of opportunities for reducing emissions cheaply, then they should have no objection to a safety valve that would kick in only at a relatively high price. The proposal is also called an escape clause or, in trade-policy language, a tariff-rate quota. Even after the Kyoto Protocol was written, there was still scope for incorporating such a provision under the compliance section, as a monetary penalty for non-compliance.

The safety valve idea had more potential support than most ideas that we economists come up with. If the economic team in the Clinton Administration had had its act together better, we just might have been able to get a safety valve accepted as part of the Administration position. Still, it would have been a difficult “sell.” As soon as one names a specific number for the mechanism to be triggered, the number is too high – in that you are admitting to industry the possibility that costs might go that high – and simultaneously too low – in that the environmentalists worry that you are abandoning the objective of putting a ceiling on emissions.

Many regard the absence of the developing countries as the most serious and most intractable shortcoming of the Kyoto Protocol. This is right in the sense that we need these countries in the system. We need meaningful participation by developing countries for three reasons: (1) although the industrialized countries created the climate problem, the developing countries are nevertheless the source of the big increases in emissions in coming years under the BAU scenario. (2) If an international regime is implemented without the developing countries, their emissions are likely to rise even faster than BAU, due to the problem of “leakage.” And (3) As is apparent in the model results, the opportunity for the United States and other industrialized countries to buy emission reductions from developing countries is crucial to keep the economic cost low.

It is also correct that the obstacles to bringing the developing countries in are very large. This was the third of the political gaps identified above. Where I disagree with people like my friend and colleague Dick Cooper, is in his claim that the approach of setting quantitative targets does not lend itself to bringing in the developing countries. Before Kyoto, one would reasonably have thought that it would be impossible for countries to agree on differentiated quantitative targets. But the Annex I countries did precisely that. But how, you will ask, could the developing countries now be brought in?

²¹ E.g., William Pizer, “Prices vs. Quantities Revisited: The Case of Climate Change,” Resources for the Future Discussion Paper 98-02, October 1997; Raymond Kopp, Richard Morgenstern, William Pizer and Michael Toman, 1999, “Domestic Trading: A Credible Early Action,” Resources for the Future, Washington, DC.

In the first budget period, the developing countries should be asked to commit to quantitative targets closely related to their BAU paths. These would not be cuts in absolute terms, which would be completely unreasonable to ask of developing countries, but would rather constitute “growth targets.” I have explained elsewhere ideas for how specifically to do determine these targets.²² To address problems of both equity and uncertainty, targets could be set by a formula based on countries’ past emissions, income levels, and population. Persuading the developing countries to participate should not be quite as difficult as many assume, because they stand to gain from the system, not only environmentally but economically as well, that is, from the opportunity to sell emission credits. As a measure that can offer gains to all parties, both rich and poor, the proposal to add the developing countries to Kyoto by granting them BAU-related paths surely is more likely to be adopted than measures that ask them to make sacrifices.

Here I will add a few words on how I propose setting the targets in subsequent budget periods, after the developing countries are in the system and targets for the first budget have been agreed. For the second budget period, participants should again negotiate targets, according to one formula for Annex I countries and another for developing countries. The formula for the Annex I country targets should incorporate small additional cuts in per capita emissions by taking a step in the direction of the worldwide average of per capita emissions. Meanwhile, the formula for developing countries should incorporate small additional cuts (again, relative to existing growth paths) by taking a step in the direction of their 1990 per capita levels. In the third budget period, the formula for Annex I countries would again place a bit less weight on the Kyoto targets and a bit more weight on the global per capita average; and the formula for developing countries would place a bit less weight on the BAU path and a bit more weight on 1990 levels. In the long run, all countries could converge on a common formula for per capita emissions, as a function of each country’s 1990 emission levels and per capita income levels.

With a long-term framework of this nature, Kyoto would truly turn out to have been the first step on the path toward seriously addressing global climate change.

²² “Greenhouse Gas Emissions,” *Policy Brief* no. 52, The Brookings Institution, Washington, DC, June 1999. The targets could be set slightly below the BAU estimates, comparable – controlling for income levels – to the pattern of reductions implicit in the targets agreed by the industrialized countries at Kyoto