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The Kyoto Protocol should not be a partisan issue. The percentage reduction of greenhouse-gas emissions to which the United States committed itself by signing the 1997 Protocol to the 1992 UN Framework Convention on Climate Change was probably unachievable when the protocol was adopted. The protocol then languished in Washington for the final three years of the Clinton administration, which chose not to present it to the Senate for ratification. In accordance with a Senate resolution calling for the full participation of the main developing countries in the protocol's emissions-cutting requirements, that pause was supposed to allow time for negotiation to bring those countries on board. But nobody thought any such negotiation could produce results, and no negotiation was ever attempted. George W. Bush, succeeding to the presidency three years after the protocol's signing, had some choices and may not have made the best choice when he rejected the plan outright last year. But the one option he did not have was to submit the protocol to the Senate for ratification.

The U.S. "commitment" to the protocol meant cutting emissions significantly below their 1990 level by 2010—which required a 25 or 30 percent reduction in projected emissions levels. Such a cut was almost certainly infeasible when the Clinton administration signed the protocol in 1997. Three years later, with no action toward reducing emissions, no evidence of any planning on how to reduce emissions, and no attempt to inform the public or Congress about what might be required to meet that commitment, what might barely have been possible to achieve over 15 years—1997 to 2012—had become unreasonable. The Senate will not confirm a treaty unless it knows what actions the "commitment" entails, and no president could answer that question without a year's preparation. No such preparation appears to have been done in the Clinton administration. Bush, in stating that he would not submit the treaty to the Senate, at least avoided hypocrisy.

In declining to support the Kyoto Protocol, Bush outlined three concerns regarding any future greenhouse-gas

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agreement. First, the main developing countries need to adhere as full participants, as the Senate had earlier resolved; so far, developing countries have made clear they have no intention of doing so. Second, he cited the immense uncertainty about the likely extent of climate change and its impact on society. Third, he expressed a preference for "voluntarism" over enforceable regulation, even though he did not make clear whether his "voluntarism" referred to domestic or international commitments.

A FAIR DEAL?

There is no likelihood that China, India, Indonesia, Brazil, or Nigeria will fully participate in any greenhouse-gas regime for the next few decades. They have done their best to make that point clear, and it serves no purpose to disbelieve them. Although their spokespersons regularly allege that rich countries are the most worried about climate change, developing nations have the most to lose from climate change. They are much more dependent on agriculture and will therefore suffer much more from global warming. Constrained by poverty and technological backwardness, their ability to adapt to climate change is limited. The best way for developing countries to mitigate global warming, therefore, is through economic growth.

There are undoubtedly opportunities in those countries for improved energy efficiencies that may simultaneously cut carbon dioxide emissions and improve public health; China, for example, could easily reduce its dependence on coal. But any major reductions in worldwide carbon dioxide emissions over the next few decades will have to be at the expense of the rich countries. Calling for the immediate participation of the big developing nations is futile. Once the developed countries have demonstrated that they can cooperate in reducing greenhouse gases, they can undertake arrangements to include developing countries in a greenhouse-gas regime, aiding them with economic incentives.

THE UNCERTAINTY PRINCIPLE

As Bush has emphasized, there are many uncertainties in the greenhouse-gas debate. But what is least uncertain is that climate change is real and likely to be serious. In any case, residual ambiguity about this question should not delay essential research and development in nonfossil energy sources, energy conservation, and policies to exploit the most cost-effective ways to reduce emissions.

A huge uncertainty that will make any lasting regime impossible for many decades to come, however, is how much carbon dioxide can safely be emitted over the coming century. A reading of the evidence—including climate sensitivity, regional climate changes, likely severity of impact, and the effectiveness of adaptation—suggests that the highest ceiling for carbon dioxide concentration, beyond which damage would be unacceptable, is probably between 600 and 1,200 parts per million. (It is currently about 370 ppm.) Further uncertainty exists about how much carbon dioxide can be absorbed into various natural sinks—oceans and forests—or sequestered underground or deep in the ocean. Thus any estimate of the level at which total carbon dioxide emissions worldwide over the coming hundred years should be capped is wide-ranging, falling between

500 billion tons and 2 trillion tons. (Worldwide emissions are currently approaching 7 billion tons, half of which stays in the atmosphere.) In any event, what is ultimately unacceptable depends on the costs of moderating emissions, and these costs are also uncertain.

As a result, any "rationing scheme" would necessarily be subject to repeated revision and renegotiation. It is noteworthy that the Intergovernmental Panel on Climate Change—the international body, comprising more than a thousand scientists from scores of countries, that is the acknowledged (if controversial) authority on the subject—has never proposed what concentration of greenhouse gases would constitute unacceptable damage. Nor has any other representative body yet dared to hazard an estimate.

IN THE LONG RUN

The Kyoto Protocol had a short-term focus. It assumed correctly that developed countries could achieve significant reductions in emissions fairly promptly. As the National Academy of Sciences emphasized ten years ago, there are a number of opportunities to reduce emissions at little or no cost. They are mostly one-time measures that are not indefinitely exploitable. Had they been promptly attempted, they might have made the Kyoto approach feasible. Postponing these steps merely loses time.

But the protocol was embedded in the 1992 Convention on Climate Change, which was oriented toward the long term. So it has been interpreted as heralding the beginning (for developed countries) of a long-term decline in carbon dioxide emissions. But any reasonable trajectory of emissions in the future ought to show a rise for some decades and a rapid decline later in the century.

There are several reasons for such a trajectory. First, the technologies needed to drastically reduce fossil-fuel consumption through alternative energy sources, greater energy efficiency, and sequestration of carbon dioxide or its removal from fuel are not developed. Decades of investment are needed. The necessary investments will not happen by themselves; government action and support, especially in arranging market incentives, will be essential.

Second, it is economical to use durable equipment until it is due for replacement; early scrapping is wasteful. Much capital, such as electric power plants, is very long-lived. Auto fleets can turn over in 15 or 20 years, but most industrial plants cannot. Furthermore, deferring expenses saves interest on loans for capital investment. Finally, the richer countries will almost certainly have higher incomes in the future and be better able to afford drastic changes in energy use.

The economical trajectory for emissions over the coming century will differ substantially among the developed countries. Thus any reasonable rationing scheme should contemplate a timeline of at least a century, not a few decades. But no possible consensus exists on how much total emissions should be allowed for the coming century. That confusion makes any scheme of fixed quotas, including "emissions trading," out of the question.

In short, the Kyoto Protocol's exclusive focus on the short term neglected the crucial importance of expanding worldwide research and development of technologies to make severe reductions feasible later in the century. It also adopted a format incompatible with the most economical

trajectory of emissions over time: a rise for some decades followed by a sharp decline.

FREE TO CHOOSE?

The Bush administration has favored "voluntary" measures over "mandatory" ones. But it is not clear whether these terms referred mainly to domestic or to international measures. Domestically, a voluntary approach would make the greenhouse question unique among issues of environment and health, which fall under government jurisdiction. The research of the National Institutes of Health, for example, is universally acknowledged to be essential; leaving such research to the market or to voluntary industrial altruism would not appeal to anyone. The same approach should apply to research on new low-carbon or non-carbon energies or carbon sequestration. Major replacement of fossil fuels or reductions in energy demand, carbon dioxide "containment" efforts, or investment in new technologies to bring them about will not occur without serious market incentives. Domestically, "voluntarism" is an ineffectual approach that would put blame only on firms that have no market support for what they may be asked to do.

An international regime, in contrast, can be only voluntary. Commitments will not be "enforceable." At best they may be honored, because respectable governments prefer to keep commitments. The U.S. government has a strong aversion to any commitments it does not think it will keep. And neither the United States nor the other major developed countries will likely accept serious sanctions for missing emissions targets. There is talk of "binding commitments," as if "commitment" itself was not binding, but there is no expectation of penalties for shortfall.

HOT AIR

Emissions trading is popular, especially with economists. Trading means that any nation that underuses its emissions quota (commitment) may transfer its unused quota (the excess of its allowed emissions over actual emissions) to any country that offers financial compensation. The "purchasing" nation then uses its bought allotment to increase its own emissions quota. The idea is to permit emissions to be reduced wherever their reduction is most economical. Countries that have the greatest difficulty (highest costs) in reducing emissions can purchase relief from countries that are comparatively most able to effect emissions reductions.

When 2,000 economists, including some Nobel laureates, circulated a recommendation a few years ago that nations should adopt enforceable quotas for carbon dioxide emissions and allow the purchase and sale of unused quotas, the concept was aesthetically pleasing but politically unconvincing. Although emissions should be reduced in those countries where they can be cut most economically, the economists' proposed trading system was perfectionist and impractical. The problem with trading regimes is that initial quotas are negotiated to reflect what each nation can reasonably be expected to reduce. Any country that is tempted to sell part of an emissions quota will realize that the regime is continually subject to renegotiation, so selling any "excess" is tantamount to admitting it got a generous allotment the last time around. It then sets itself up for stiffer negotiation next time.

Still, the latest version of the Kyoto Protocol, negotiated in November 2001, does contemplate trading and even anticipates who the sellers will be. It conceded carbon dioxide emissions quotas to Russia and Ukraine—countries that, because of their depressed economies, will keep their emissions relatively low during the Kyoto time period. They will have what is called "hot air" to sell to any Kyoto participant willing to pay to remain within its own commitment. This arrangement may have been an essential inducement to get Russia to ratify the Kyoto Protocol, and countries that were not sure they would meet their commitments on their own saw it as a cheap safety valve.

It requires a sense of humor to appreciate this latest modification of the Kyoto Protocol: respectable governments being willing to pay money, or make their domestic industries pay money, to an ailing former enemy in the guise of a sophisticated emissions-trading scheme. The purpose is to bribe the recipient into ratifying a treaty and providing governments a cheap way to buy out of emissions commitments, with the pretense that it serves to reduce emissions in accordance with the principle of comparative advantage.

PAST AS PROLOGUE

There is remarkable consensus among economists that nations will not make sacrifices in the interest of global objectives unless they are bound by a regime that can impose penalties if they do not comply. Despite this consensus, however, there is no historical example of any regime that could impose effective penalties, at least with something of the magnitude of global warming. But there are historical precedents of regimes that lacked coercive authority but were still able to divide benefits and burdens of a magnitude perhaps comparable to the demands of a global-warming regime. (In this case, cutting emissions is the burden; allowing emissions is the benefit.) There are two interesting precedents outside wartime. Both hold promise.

One is the division of Marshall Plan aid, which began in 1948. The magnitude of the aid, as a percentage of the national income of the recipient countries, is not easy to determine today, because most European currencies were grossly overvalued after the war. But a reasonable estimate places the aid's value anywhere from 5 percent to 20 percent of national income, depending on the recipient country.

For the first two years of the Marshall Plan, the United States divided the money itself. For the third year, it insisted that the recipient countries divide the aid among themselves. Government representatives therefore went through a process of "reciprocal multilateral scrutiny." Each government prepared extensive documentation of all aspects of its economy: its projected private and public investments, consumption, imports, exports, what it was doing about railroads and livestock herds, how it was rationing gasoline or butter, and how its living standard compared to prewar conditions. Each government team was examined and cross-examined by other government teams; it then defended itself, revised its proposals, and cross-examined other teams. More aid for one country meant less for the rest.

There was no formula. Rather, each country developed "relevant criteria." The parties did not quite reach agreement, but they were close enough that two

respected people—the secretary-general of the Organization for European Economic Cooperation and the representative of Belgium (which was not requesting any aid)—offered a proposed division that was promptly accepted. Of course, the United States was demanding the countries reach agreement on aid. Today, there is no such "angel" behind greenhouse negotiations. Still, the Marshall Plan represents something of a precedent.

NATO went through the same process a year later (1951–52) in its "burden-sharing exercise." This time, it involved U.S. aid and included targets for national military participation, conscription of soldiers, investments in equipment, contributions to military infrastructure and real estate, and so on. Again, the process was one of reciprocal scrutiny and cross-examination, with high-level officials spending months negotiating. Again, they did not quite reach final agreement. But this time, three officials fashioned a proposal that was accepted. After one more year, NATO proceeded without U.S. aid—except for the contribution of U.S. military forces to NATO itself.

With the possible exception of the reciprocal-trade negotiations that ultimately created the World Trade Organization (WTO), the Marshall Plan and NATO experiences are the only non-wartime precedents in which so many countries cooperated over such high economic stakes. They were not aesthetically satisfying processes: no formulae were developed, just a civilized procedure of argument. Those examples are a model for what might succeed the Kyoto Protocol if it fails or evolves into something else. Their procedure is one that the main developed nations might pursue prior to any attempt to include developing nations. NATO has been an enormous success; member nations made large contributions in money, troops, and real estate. They did it all voluntarily; there were no penalties for shortfalls in performance. And, without explicit trading, they practiced the theory of comparative advantage (in geographical location, for instance, or demographics, or industrial structure). It was an example of highly motivated partnership, involving resources on a scale commensurate with what a greenhouse regime might eventually require.

The WTO experience is also instructive. It involves a much broader array of nations than NATO does, and it has its own system of sanctions: the enforcement of commitments. Because it is essentially a system of detailed reciprocal undertakings, and because most infractions tend to be bilateral and specific as to commodities, offended parties can undertake retaliation and make the penalty fit the crime (thus exercising the principle of reciprocity). A judicial system can evaluate offenses on their merits to authorize or approve the retaliatory measure. Fulfilling or failing WTO commitments is piecemeal, not holistic. There is no overall "target" to which a WTO member is committed. In contrast, if a greenhouse-regime nation fails to meet its target, there is no particular offended partner to take the initiative and penalize the offender—and if there were, it might be difficult to identify an appropriate "reciprocal" retaliatory measure.

PROMISES, PROMISES

One striking contrast between NATO and the Kyoto Protocol deserves emphasis: the difference between "inputs" and

"outputs," or actions and results. NATO nations argued about what they should do, and commitments were made to actions. What countries actually did—raise and train troops; procure equipment, ammunition, and supplies; and deploy these assets geographically—could be observed, estimated, and compared. But results—such as how much each NATO nation's actions contributed to deterring the Warsaw Pact—could not be remotely approximated.

Like NATO, commitments under the WTO's auspices are also made to what nations will do, or will abstain from doing; there are no commitments to specific consequences. No nation is committed to imports of any sort from anywhere; it is committed only to its actions—such as tariffs and other restrictions, subsidies, and tax preferences.

With the Kyoto Protocol, commitments were made not to actions but to results that were to be measured after a decade or more. This approach has disadvantages. An obvious one is that no one can tell, until close to the target date, which nations are on course to meet their goals. More important, nations undertaking result-based commitments are unlikely to have any reliable way of knowing what actions will be required—that is, what quantitative results will occur on what timetable for various policies. The Kyoto approach implied without evident justification that governments actually knew how to reach 10- or 15-year emissions goals. (The energy crisis of the 1970s did not last long enough to reveal, for example, the long-run elasticity of demand for motor fuel, electricity, industrial heat, and so on.) A government that commits to actions at least knows what it is committed to, and its partners also know and can observe compliance. In contrast, a government that commits to the consequences of various actions on emissions can only hope that its estimates, or guesses, are on target, and so can its partners.

SPREADING THE WEALTH

Eventually, to bring in the developing nations and achieve emissions reductions most economically, the proper approach is not a trading system but financial contributions from the rich countries to an institution that would help finance energy-efficient and decarbonized technologies in the developing world. Examples might be funding a pipeline to bring Siberian natural gas to northern China to help replace carbon-intensive coal, or financing the imported components of nuclear-power reactors, which emit no greenhouse gases.

Such a regime will suffer the appearance of "foreign aid." But that is the form it will necessarily take. The recipients will benefit and should be required to assume commitments to emissions-reducing actions. Meanwhile, the burden on the rich countries will undoubtedly be more political than economic. Large-scale aid for reducing carbon dioxide emissions in China is economically bearable but enormously difficult to justify to the American public, or to agree on with Japan and the European Union.

While European countries are lamenting the U.S. defection from the Kyoto Protocol, a major U.S. unilateral initiative in research and development oriented toward phasing out fossil fuels over the next century would both produce welcome returns and display American seriousness about global warming.

The greenhouse gas issue will persist through the entire century and beyond. Even though the developed nations have not succeeded in finding a collaborative way to approach the issue, it is still early. We have been at it for only a decade. But time should not be wasted getting started. Global climate change may become what nuclear arms control was for the past half century. It took more than a decade to develop a concept of arms control. It is not surprising that it is taking that long to find a way to come to consensus on an approach to the greenhouse problem.