AN INTERNATIONAL POLICY ARCHITECTURE FOR THE POST-KYOTO ERA

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An International Policy Architecture for the Post-Kyoto Era

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The Kyoto Protocol (1997) to the United Nations Framework Convention on Climate Change (1992) came into force in 2005 without U.S. participation, but its direct effects on climate change will be trivial. At the same time, the economic and scientific consensus points to the need for a credible international approach. A reasonable starting point is the Framework Convention on Climate Change (FCCC), which was signed by 161 nations and ratified by 50, including the United States, and entered into force in 1994. Some analysts see the Kyoto Protocol as deeply flawed, while others see it as an acceptable or even laudable first step. But virtually everyone agrees that the Protocol is not sufficient to the overall challenge, and that further, subsequent steps will be required. This is my starting point for proposing a three-part, post-Kyoto policy architecture: first, all nations would be involved through the use of economic trigger mechanisms, such as growth targets; second, long-term targets would be required — in the short-term, firm, but moderate targets, and in the long-term, flexible, but much more stringent targets; and third, market-based policy instruments would be part of the package — emissions trading, carbon taxes, or hybrids of the two. This overall approach can be made to be scientifically sound, economically rational, and politically pragmatic.

1. INTRODUCTION

After seven years of uncertainty, the Kyoto Protocol (1997) to the United Nations Framework Convention on Climate Change (FCCC, 1992) came into force in February, 2005, but without participation by the United States. With Russian ratification late in 2004, requirements for implementation were met, namely ratification by a minimum of 55 nations (127, in fact), including — importantly, since this was the binding constraint — Annex I (industrialized) countries representing at least 55 percent of 1990 industrialized world emissions of carbon dioxide (CO_2).

The impacts of the Kyoto Protocol on emissions of greenhouse gases,[2] targeted for the compliance period 2008–2012, will be much less than originally anticipated. Nonparticipation by the United States is quantitatively important, and the rules written at the Conferences of the Parties (COPs) of the FCCC in Bonn and Marakesh in 2001 had the effect of significantly relaxing the aggregate target. But a scientific consensus has continued to form regarding the likelihood of future climate change due to anthropogenic emissions of greenhouse gases (Watson 2001, Pachauri 2005), and economic analysis increasingly points to the wisdom of some kind of policy action (Shogren and Toman 2000; Kolstad and Toman 2001).[3] Thus, there is a dilemma. The Kyoto Protocol has come into force without U.S. participation; its effects on climate change will be trivial; but the economic and scientific consensus points to the need for a credible international approach.[4] What can be done?

A reasonable starting point is the FCCC, which was signed by 161 nations and ratified by 50—including the United States—and which entered into force in 1994. Among other things, the FCCC established the principle of "common but differentiated responsibilities," meaning that all nations should engage in the solution (because of the global-commons nature of the problem) but that different countries could participate in different ways (United Nations 1992).

If the FCCC provides a reasonable starting point, can the Kyoto Protocol provide the way forward? It is helpful to examine the Protocol in terms of its major architectural elements. Its targets apply only to industrialized nations; it contains ambitious, short-term emissions-reduction targets but no long-term targets; and it provides flexibility through market-based mechanisms, such as tradable permits. This architecture has been widely criticized, chiefly because it would impose high costs, fail to provide for full participation by developing countries, and generate modest short-term climate benefits while failing to provide a long-term solution.[5] On the other hand, the argument has been made that the Kyoto Protocol is essentially "the only game in town," and instead of suggesting alternatives, analysts "should concentrate on convincing policymakers how to get the long-term climate policy instruments right that build on Kyoto's foundations" (Michaelowa 2003).

Thus, some analysts see the agreement as "deeply flawed" (Victor 2001; Cooper 2001; McKibbin and Wilcoxen 2002, 2004), while others see it as an acceptable first step (Grubb 2003; Michaelowa 2003). But virtually everyone agrees that the Kyoto Protocol is not sufficient to the overall challenge and that further steps will be required. As Eileen Claussen, President of the Pew Center on Global Climate Change, wrote in 2003, "whether or not the Protocol enters into force, the same fundamental challenge remains: engaging all countries that are major emitters of greenhouse gases in a common long-term effort. We need a durable strategy that can take us beyond Kyoto" (Claussen 2003, p. ii).

2. A Three-Part Policy Architecture

I outline the basic features of a post-Kyoto international global climate policy agreement, which contains three essential elements: a means to ensure that key nations — industrialized and developing — are eventually involved; an emphasis on an extended time path of targets (employing a cost-effective pattern over time); and inclusion of market-based policy instruments. This architecture is consistent with fundamental aspects of the science, economics, and politics of global climate change.[6]

2.1 Expanding Participation

Broad participation — by major industrialized nations and by key developing countries — is essential to effectively and efficiently address the global commons problem of climate change. The share of global emissions attributable to developing countries is significant and growing, and developing countries are likely to account for more than half of global emissions by the year 2020, if not before (Nakicenovic and Swart 2000; Pies and Schröder 2002). But it certainly can be argued — on an ethical basis — that industrialized countries should take the first emission-reduction steps on their own. The simple reality, however, is that developing countries provide the greatest opportunities for relatively low-cost emissions reductions (Watson 2001). It would therefore be unnecessarily costly to focus emissions-reductions activities exclusively in the developed world.

A reasonable response to this observation about cost-effectiveness is that industrialized countries — almost by definition — are responsible for the bulk of anthropogenic concentrations of greenhouse gases in the atmosphere. Hence, industrialized countries should go first with emissions reductions, with developing countries taking actions only later. Although sensible arguments can be made in support of this position on grounds of distributional equity, there is a serious problem.

If developing countries are not included in an agreement, comparative advantage in the production of carbon-intensive goods and services will shift outside the coalition of participating countries, making developing countries' economies more carbon intensive than they otherwise would be, through "emissions leakage."[7] Rather than helping developing countries move onto less carbon-intensive paths of development, the industrialized world would be pushing those nations onto more carbon-intensive growth paths, increasing their cost of joining the coalition later. Still, on equity grounds, it is unreasonable to expect developing nations to incur significant emissions-reduction costs in the short term, because it would retard their economic development.

This poses a policy conundrum. On the one hand, for purposes of environmental effectiveness and economic efficiency, key developing countries should be participants in an international effort to reduce greenhouse gas emissions. On the other hand, for purposes of distributional equity (and international political pragmatism[8]), they cannot be expected to incur the consequent costs. The solution is that these countries must get on the "global climate policy train" without necessarily paying full fare. How can this be accomplished?[9]

At first sight, a trigger mechanism appears to be required, whereby developing countries would be obligated to take on binding commitments only when their per capita gross domestic product (GDP) reached agreed levels. But there is no reason to limit thinking to such a simple, dichotomous instrument. Rather, a preferable approach would be "growth targets" that become more stringent for individual developing counties as those countries become more wealthy (Lutter 2000).[10] In the short term, such indexed targets could be set at business-as-usual (BAU) emissions levels, but would become more stringent over time as the countries became wealthier. In other words, a growth target is not a number but an equation that relates targeted emissions to per-capita income and possibly other variables. Two necessary characteristics of a growth target formulation are that it not create perverse incentives that would encourage nations to increase their emissions and that it should be relatively simple, so as not to create impediments to negotiation (Aldy, Baron, and Tubiana 2003).

Note that the short-term targets for developing countries could even be set at emissions levels that are above BAU levels. If combined with an international trading program (discussed later), such headroom would provide a direct economic incentive (subsidy) for developing-country participation. Developing countries could fully participate without incurring prohibitive costs (or even any costs in the short term). That is, cost-effectiveness and distributional equity could both be addressed.[11]

2.2 An Extended Time Path of Targets

Global climate change is a long-term problem, due to the fact that the relevant greenhouse gases remain in the atmosphere for decades to centuries. The Kyoto Protocol fails to reflect this fundamentally important reality, namely, the cumulative, stock-pollutant nature of the problem. The Protocol has only short-term targets, an average 5 percent reduction from 1990 levels by the 2008–2012 compliance period. This sounds like a modest reduction, but it translates into a severe 25–30 percent cut for the United States from its BAU emissions path. The reason for this is that the United States economy grew at an exceptionally rapid rate during the 1990s, exhibiting a remarkable 37 percent increase in real GDP from 1990 to 2000.[12]

Thus, the Kyoto Protocol's targets are too little, too fast: They do little about the problem, but are unreasonable for countries that enjoyed significant economic growth after 1990. Two elements are needed to ameliorate this problem: firm but moderate targets in the short term to avoid rendering large parts of the capital stock prematurely obsolete, and flexible but more stringent targets for the long term to motivate (now and in the future) technological change, which in turn is needed to bring costs down over time (Goulder and Schneider 1999; Jaffe, Newell, and Stavins 1999; Pershing and Tudela 2003). Specifically, emissions targets ought to start out at BAU levels, then gradually depart from these, so that emissions targets in the short term would, in fact, be increasing over time but at rates below the rate of increase exhibited by BAU levels. Importantly, these intertemporal emissions targets should not be monotonically increasing but should reach a maximum level and then begin to decrease — eventually becoming substantially more severe than the constraints implied by the Kyoto Protocol's short-term targets.[13]

It is important to recognize that the word "target" should be taken generically to refer not only to emission targets (as in the Kyoto Protocol, and as described above), but also "intensity targets," that is, emissions per unit of gross domestic product. For that matter, the proposal I am offering here is also consisted with a time-path of targets denominated in purely financial units, that is, carbon prices (levels of taxes on the carbon content of fossil fuels).

In any event, the pattern I have suggested would be consistent with estimates of the least-cost time path of emissions for achieving long-term greenhouse-gas concentration targets: short-term increases in emissions — just slightly below the BAU path — and subsequent emission reductions (Wigley, Richels, and Edmonds 1996; Manne and Richels 1997).[14] Such a time path of future targets, put in place now, would be consistent with what is often denigrated as "politics as usual." That is, politicians are frequently condemned for the fact that in representative democracies there are strong incentives to place costs on future, not current voters and, if possible, future generations. It is typically the politically pragmatic strategy. In the case of global climate policy, it can also be the scientifically correct and economically rational approach.

2.3 Market-Based Policy Instruments

The final component of the three-part policy architecture is — in principle — part of the Kyoto Protocol: working through the market rather than against it. There is widespread agreement that conventional regulatory approaches cannot do the job, certainly not at acceptable costs. To keep costs down in the short term and bring them down even lower in the long term through technological change,[15] it is essential to embrace market-based instruments as the chief means of reducing greenhouse gas emissions (Stavins 1997).

On a domestic level in some countries, systems of tradable permits might be used to achieve national targets. This is the same mechanism that was used in the United States to eliminate leaded gasoline from the market in the 1980s at a savings of more than $250 million per year (Stavins 2003), and the same mechanism now being used to cut sulfur dioxide (SO_2) emissions as a precursor of acid rain in the United States by 50 percent, at a savings estimated to be $1 billion per year (Schmalensee, *et al.* 1998; Stavins 1998; Ellerman, *et al.* 2000). Of the two systems, the better model for climate change policy is the upstream lead-rights system (analogous to trading based on the carbon content of fossil fuels), rather than the downstream SO_2 emissions-trading system.[16]

For some countries, systems of domestic carbon taxes may be more attractive.[17] Another promising market-based approach is a hybrid of tax and tradable-permit systems — that is, an ordinary tradable permit system, plus a government promise to sell additional permits at a stated price (Roberts and Spence 1976; Kopp, *et al.* 2000; Pizer 2002; McKibbin and Wilcoxen 2002). This creates a price (and thereby cost) ceiling, and has hence been labeled a safety-valve system.[18]

International policy instruments are also required to solve this fundamentally international problem. The Kyoto Protocol includes in Article 17 a system whereby the parties to the agreement can engage in trading their "assigned amounts," that is, their reduction targets, translated into quantitative terms of emissions (United Nations 1997). In theory, such a system of international tradable permits — if implemented only for the industrialized countries (as under the Kyoto Protocol) — could reduce costs by 50 percent. If such a system also included major developing countries, costs could be lowered to 25 percent of what they otherwise would be (Edmonds *et al.* 1997).[19]

In an emissions permit–trading system, sources that have low costs of control have an incentive to take on added reductions, so that they can sell their excess permits to sources that face relatively high control costs and would hence wish to reduce their control efforts (Hockenstein, Stavins, and Whitehead 1997). An undisputed attraction — in theory — of an international trading approach is that the equilibrium allocation of permits, the market-determined permit price, and the aggregate costs of abatement are independent of the initial allocation of permits among countries. However, this is only true as long as particularly perverse types of transaction costs are not prevalent (Stavins 1995) and individual parties—be they nations or firms—do not have market power (Hahn 1984). The latter concern is a real one in the Kyoto context.[20] In any event, the initial allocation can be highly significant in distributional terms, implying possibly massive international wealth transfers. Some analysts have highlighted this as a major objection to an international carbon trading regime (Cooper 1998), but it is essentially because of this feature that a permit system can be used to address cost-effectiveness *and* distributional equity.

If an international trading system is used, it must be designed to facilitate integration with domestic policies that nations use to achieve their respective domestic targets.[21] In the extreme, if all countries use domestic tradable permit systems to meet their national targets (that is, allocate shares from the international permit system to private domestic parties), then an international system can — in theory — be perfectly cost-effective. But if some countries use non-trading approaches, such as greenhouse gas taxes or fixed-quantity standards — which seems likely — cost minimization is not ensured (Hahn and Stavins 1999).[22] Thus, individual nations' choices of domestic policy instruments to meet their targets can substantially limit the cost-saving potential of an international trading program. In this realm, a trade-off exists between the degree of domestic sovereignty and the degree of cost-effectiveness.

Not long ago, most observers would have predicted that few, if any, European countries would employ tradable permit systems, given the European Union's strenuous opposition to such approaches dating to back to the time of the Kyoto Protocol. But the EU has now launched its own continent-wide trading system (Kruger and Pizer 2004). Furthermore, by the time of the COPs in Bonn (summer 2001) and Marrakech (fall 2001), China and the G-77 (the coalition of developing nations) had, in effect, dropped their opposition to international emissions trading. Combined with

the strong U.S. preference for trading, these realities represent important political arguments for this element of a future international climate policy architecture.

International permit trading thus remains a promising approach to achieving global greenhouse targets, despite the challenge that any program must be integrated carefully with domestic policies. It is probably fair to state that the more one studies international tradable permit systems to address global climate change, the more one comes to believe that this is the worst possible approach — except, of course, for all the others (bringing to mind Winston Churchill's famous observation about democracy).[23]

3. Conclusion

The three-part global climate policy architecture outlined above builds upon the U.N. Framework Convention on Climate Change and can serve eventually as a successor to the Kyoto Protocol. For such an approach to work, key nations have to be involved, including major developing countries through the use of economic trigger mechanisms such as growth targets. In addition, cost-effective time paths of targets are required: firm, but moderate in the short term, and in the long term, much more stringent and flexible. Finally, market-based policy instruments ought to be part of the package, whether emissions trading, carbon taxes, or hybrids of the two.

This overall approach can be made scientifically sound, economically rational, and politically pragmatic. There is no denying that the challenges facing adoption and successful implementation of this type of climate policy architecture are significant, but they need not be insurmountable, and they are not necessarily any greater than the challenges facing other approaches to the threat of global climate change.

REFERENCES

Aldy, Joseph E., Scott Barrett, and Robert N. Stavins. "Thirteen Plus One: A Comparison of Global Climate Policy Architectures." *Climate Policy* 3, no. 4 (2003):373–97.

Aldy, Joseph E., R. Baron, and L. Tubiana. "Addressing Cost: The Political Economy of Climate Change." Elliot Diringer, ed., *Beyond Kyoto: Advancing the International Effort Against Climate Change*, pp. 85-110. Arlington, Virginia: Pew Center on Global Climate Change, 2003.

Andersen, M. S. "Regulation or Coordination: European Climate Policy Between Scylla and Charybdis." Paper presented at 10th Symposium of the Egon Sohmen Foundation, "Climate Protection and Emissions Trading — U.S. and European Views," Dresden, Germany, October 25-26, 2002.

Barrett, Scott and Robert N. Stavins. "Increasing Participation and Compliance in International Climate Change Agreements." *International Environmental Agreements: Politics, Law and Economics* 3, no. 4 (2003):349–76.

Bodansky, Daniel. *International Climate Efforts Beyond 2012: A Survey of Approaches.* Arlington, Virginia: Pew Center on Global Climate Change, December 2004.

Bruvoll, A. and B. M. Larsen. "Greenhouse Gas Emissions in Norway: Do Carbon Taxes Work?" *Energy Policy* 32, no. 4 (2004): 493–505.

Claussen, Eileen. "Forward," Eliot Diringer, ed., *Beyond Kyoto: Advancing the International Effort Against Climate Change*. Arlington, Virginia: Pew Center on Global Climate Change, December 2003.

Cooper, Richard. "Toward a Real Treaty on Global Warming," *Foreign Affairs* 77, no. 2 (1998): 66–79.

Cooper, Richard. "The Kyoto Protocol: A Flawed Concept." FEEM Working Paper No. 52.2001, July 2001.

Den Elzen, M. G. J. "Exploring Climate Regimes for Differentiation of Future Commitments to Stabilise Greenhouse Gas Concentrations." *Integrated Assessment* 3, no. 2 (2002): 343–59.

Edmonds, J. , S. H. Kim, C. N. McCracken, R. D. Sands, and M. A. Wise. *Return to 1990: The Cost of Mitigating United States Carbon Emissions in the Post-2000 Period*. Washington, D.C.: Pacific Northwest National Laboratory, operated by Battelle Memorial Institute, 1997.

Ellerman, Denny, Paul Joskow, Richard Schmalensee, Juan-Pablo Montero, and Elizabeth Bailey. *Markets for Clean Air: The U.S. Acid Rain Program*. New York: Cambridge University Press, 2000.

Frankel, Jeffrey. "Greenhouse Gas Emissions." *Policy Brief* No. 52. Washington, D.C.: Brookings Institution, June 1999.

Frankel, Jeffrey. "You're Getting Warmer: The Most Feasible Path for Addressing Global Climate Change Does Run Through Kyoto." Working Paper, June 25, 2002, prepared for M. Tamborra and J. Maxwell, eds., *Trade and the Environment in the Perspective of the EU Enlargement*. Cheltenham, United Kingdom: Edward Elgar Publishers, forthcoming.

Goulder, Lawrence H. and Stephen H. Schneider. "Induced Technological Change and the Attractiveness of CO_2 Abatement Policies." *Resource and Energy Economics* 21, no. 3–4 (1999): 211–53.

Grubb, Michael. "The Economics of the Kyoto Protocol," *World Economics* 4, no. 3 (2003): 143–89.

Hahn, Robert W. "Market Power and Transferable Property Rights." *Quarterly Journal of Economics 99*(1984):753-765.

Hahn, Robert W. and Robert N. Stavins. *What Has the Kyoto Protocol Wrought? The Real Architecture of International Tradable Permit Markets*. Washington, D.C.: American Enterprise Institute Press, 1999.

Hammitt, James. "Evaluating Endpoints and Climate Policy: Atmospheric Stabilization, Benefit-Cost Analysis, and Near-Term Greenhouse Gas Emissions." *Climatic Change* 41, no. 3–4 (1999):447–68.

Heller, Thomas C. and P. R. Shukla. "Development and Climate: Engaging Developing Countries." *Beyond Kyoto: Advancing International Effort Against Climate Change*, pp. 111-140. Arlington, Virginia: Pew Center on Global Climate Change, 2003.

Hockenstein, Jeremy B., Robert N. Stavins, and Bradley W. Whitehead. "Crafting the Next Generation of Market-Based Environmental Tools." *Environment*, May 1997, 12–20 and 30–33.

Jacoby, Henry D. and A. Denny Ellerman. "The Safety Valve and Climate Policy." *Energy Policy* 32, no. 4 (2004): 481–91.

Jaffe, Adam B., Richard G. Newell, and Robert N. Stavins. "Energy-Efficient Technologies and Climate Change Policies: Issues and Evidence." Climate Issue Brief No. 19 (Washington, D.C.: RFF, December 1999), reprinted in Michael A. Toman, ed., *Climate Change Economics and Policy* (Washington, D.C.: RFF, 2001), 171–181.

Jaffe, Adam B. Richard G. Newell, and Robert N. Stavins. "Technological Change and the Environment." Karl-Goran Mäler and Jeffrey Vincent, eds., *Handbook of Environmental Economics*, Volume I, pp. 461–516. Amsterdam: Elsevier Science, 2003.

James, R. R., ed.. *Winston S. Churchill: His Complete Speeches, 1897–1963*, Volume 7. New York: Chelsea House, 1974.

Kagan, Robert. "Power and Weakness." *Policy Review*, June/July 2002, Issue 113, pp. 3-28.

Kopp, Raymond J., Richard D. Morgenstern, William A. Pizer, and Michael A. Toman. "A Proposal for Credible Early Action in US Climate Policy." K. L. Brockmann and M. Stonzik, eds., *Flexible Mechanisms for Efficient Climate Policy: Cost Saving Policies and Business Opportunities*. Heidelberg, Germany: Physica-Verlag, 2000.

Kolstad, Charles D. and Michael Toman. "The Economics of Climate Policy." Discussion Paper 00-40REV (Washington, D.C.: Resources for the Future, 2001), forthcoming in Karl-Goran Mäler and Jeffrey Vincent, eds., *Handbook of Environmental Economics*, Volume II. Amsterdam: Elsevier Science.

Kruger, J. A. and W. A. Pizer. "Greenhouse Gas Trading In Europe: The New Grand Policy Experiment." *Environment*, November 2004, pp. 8–23.

Lackner, Klaus. "Carbon Management Technology." Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Lindzen, Richard. "Global Warming, The Origin and Nature of the Alleged Scientific Consensus." *Regulation*, Volume 15, Number 2, 1992.

Lindzen, Richard. "Is There a Basis for Global Warming Alarm?" Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Longhai, Shen. "Prioritizing Energy Conservation, Developing Cyclic Economy, and Building Conservation-Minded Society: China's Correct Choice for the Reduction of Greenhouse Gas Emissions." Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Lutter, Randall. "Developing Countries' Greenhouse Emissions: Uncertainty and Implications for Participation in the Kyoto Protocol." *The Energy Journal* 21, no. 4 (2000): 93–120.

Manne, Alan and Richard Richels. *On Stabilizing CO_2 Concentrations — Cost-Effective Emission Reduction Strategies*. Stanford, California: Stanford University and Electric Power Research Institute, April 1997.

Manne, Alan and Richard Richels. "U.S. Rejection of the Kyoto Protocol: The Impact on Compliance Costs and CO_2 Emissions." *Energy Policy* 32, no. 4 (2004): 447–54.

McKibbin, Warrick and Peter Wilcoxen. "The Role of Economics in Climate Change Policy." *Journal of Economic Perspectives* 16, no. 2 (2002):107–29.

McKibbin, Warrick and Peter Wilcoxen. "Estimates of the Costs of Kyoto: Marrakesh versus the McKibbin-Wilcoxen Blueprint." *Energy Policy* 32, no. 4 (2004): 467-479.

Mendelsohn, Robert. "The Impacts of Climate Change: What Do Impacts Tell Us About Near Term Climate Policy?" Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Michaelowa, Axel. "Global Warming Policy." *Journal of Economic Perspectives* 17, no. 3 (2003): 204–05.

Michaelowa, A., M. Stronzik, F. Eckermann, and A. Hunt. "Transaction Costs of the Kyoto Mechanisms." *Climate Policy* 3, no. 3 (2003): 261–78.

Nakicenovic, N. and R. Swart, eds.. *Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios*. Cambridge, United Kingdom: Cambridge University Press, 2000.

National Commission on Energy Policy. *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges*." Washington, D.C.: National Commission on Energy Policy, December 2004.

Newell, Richard G. and William A. Pizer. "Regulating Stock Externalities Under Uncertainty." *Journal of Environmental Economics and Management* 45, no. 2, supplement 1 (2003): 416–32.

Nordhaus, William D. and Joseph Boyer. *Warming the World: Economic Models of Global Warming*. Cambridge: The MIT Press, 2000.

Nordhaus, William D. "Economic Analyses of Kyoto Protocol: Is There Life After Kyoto?" Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Pachauri, Rajendra K. "Re-Examining the Evidence." Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Paltsev, S. V. "The Kyoto Protocol: Regional and Sectoral Contributions to the Carbon Leakage." *The Energy Journal* 22, no. 4 (2001): 53–79.

Parikh, Jyoti K. "Climate Change: India's Perspective." Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Pershing, J. and F. Tudela. "A Long-Term Target: Framing the Climate Effort." Eliot Diringer, ed., *Beyond Kyoto: Advancing the International Effort Against Climate Change*, pp. 11-36. Arlington, Virginia: Pew Center on Global Climate Change, December 2003.

Pies, I. and G. Schröder. *Causes and Consequences of Global Warming: How Rational is Our Policy on Climate Change?* Munich: Policy Consult, 2002.

Pizer, William A. "Combining Price and Quantity Controls to Mitigate Global Climate Change." *Journal of Public Economics* 85, no. 3 (2002): 409–34.

Reis, Eustáquio. "Linking Climate Change Control and Development Policies: The Brazilian Case." Paper presented at "Global Warming: Looking Beyond Kyoto," Yale University, New Haven, Connecticut, October 21-22, 2005.

Richels, Richard G., Alan S. Manne, and Thomas M. L. Wigley. "Moving Beyond Concentrations — The Challenge of Limiting Temperature Change." AEI-Brookings Joint Center working paper no. 04-11 Washington, D.C.: AEI-Brookings Joint Center, 2004.

Roberts, Mark and Michael Spence. "Effluent Charges and Licenses under Uncertainty." *Journal of Public Economics* 5, no. 3–4 (1976): 193–208.

Schmalensee, Richard. "Greenhouse Policy Architecture and Institutions," W. D. Nordhaus, ed., *Economics and Policy Issues in Climate Change.* Washington, D.C.: Resources for the Future, 1998.

Schmalensee, Richard, Paul Joskow, Denny Ellerman, Juan-Pablo Montero, and Elizabeth Bailey. "An Interim Evaluation of Sulfur Dioxide Emissions Trading." *Journal of Economic Perspectives* 12, no. 3 (1998): 53–68

Shogren, Jay F. and Michael A. Toman. "Climate Change Policy." Paul R. Portney and Robert N. Stavins, eds., *Public Policies for Environmental Protection*, Second Edition, pp. 125-168. Washington, D.C.: Resources for the Future Press, 2000.

Springer, U. and M. Varilek. "Estimating the Price of Tradable Permits for Greenhouse Gas Emissions in 2008–12." *Energy Policy* 32, no. 5 (2004): 611–21.

Stavins, Robert N. "Transaction Costs and Tradeable Permits." *Journal of Environmental Economics and Management* 29, no. 2 (1995): 133–48.

Stavins, Robert N. "Policy Instruments for Climate Change: How Can National Governments Address a Global Problem?" *The University of Chicago Legal Forum*, volume 1997, pp. 293-329.

Stavins, Robert N. "What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading." *Journal of Economic Perspectives*, 12, no. 3 (1998): 69–88.

Stavins, Robert N. "After Kyoto: Climate Change Strategies for the United Nations." Presentation prepared for United Nations Secretary-General Kofi Annan, April 24, 2002.

Stavins, Robert N. "Experience with Market-Based Environmental Policy Instruments." Karl-Goran Mäler and Jeffrey Vincent, eds., pp. 355–435. *Handbook of Environmental Economics*, Volume I. Amsterdam: Elsevier Science, 2003.

Stavins, Robert N. "Forging a More Effective Global Climate Treaty." *Environment* 46(2004), December, number 10, pp. 23-30.

Stavins, Robert N. "Beyond Kyoto: Getting Serious About Climate Change." *The Milken Institute Review*, volume 7, number 1, 2005, pp. 28-37.

Sugiyama, T. and L. Deshun. "Must Developing Countries Commit [to] Quantified Targets? Time Flexibility and Equity in Climate Change Mitigation." *Energy Policy* 32, no. 5 (2004): 697–704.

United Nations. "United Nations Framework Convention on Climate Change." 1992.

United Nations. "Kyoto Protocol to the Convention on Climate Change." 1997.

Victor, David G. *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming*. Princeton, New Jersey: Princeton University Press, 2001.

Watson, Robert T., ed., *Climate Change 2001: Synthesis Report. Contributions of Working Group I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press, 2001.

Wigley, Thomas, Richard Richels, and Jae Edmonds. "Economic and Environmental Choices in the Stabilization of Atmospheric CO_2 Concentrations." *Nature*, 18 January 1996, 240–43.

ENDNOTES

1.Albert Pratt Professor of Business and Government, John F. Kennedy School of Government, and Director, Environmental Economics Program at Harvard University; and University Fellow, Resources for the Future. This paper draws upon Stavins (2002, 2004, 2005), and benefitted from comments by participants in the conference, "Global Warming: Looking Beyond Kyoto," at Yale University, October 21-22, 2005.

2.Carbon dioxide (CO_2) is the primary anthropogenic driver of climate change. Other important anthropogenic greenhouse gases are methane (CH_4), nitrous oxide (N_2O), and various halocarbons (Watson 2001).

3.My claim that a consensus continues to form regarding the likelihood of future climate change due to anthropogenic emissions of greenhouse gases and regarding the desirability, from an economic perspective, of some long-term actions to address the threat does not suggest that there is unanimity either with regard to the science or the economics. See, for example, Lindzen (1992, 2005). In this essay, I simply take as given the desirability of limiting long-term concentrations of CO_2 (and other greenhouse gases) in the atmosphere. For examinations of dynamically efficient policies (which maximize present value net benefits), see: Hammitt 1999; Nordhaus and Boyer 2000; and McKibbin and Wilcoxen 2002.

4.Given the global commons nature of the climate problem, a multinational—if not fully global—approach is required. As long as global marginal benefits exceed every nation's own marginal benefits, countries will either want to avoid participating or avoid complying fully if they do participate. Successful international cooperation must change these incentives (Barrett and Stavins 2003).

5.For a summary of critiques of the Kyoto Protocol and alternatives that have been proposed, see Aldy, Barrett and Stavins (2003). A more comprehensive survey of proposals is provided by Bodansky (2004).

6.The general importance of focusing on policy "architecture" and institutions in the global climate domain was first emphasized by Schmalensee (1998).

7.Such emissions leakage can be significant, with rates ranging from 5 percent to 34 percent for individual countries (Paltsev 2001).

8.International agreements are approved on the basis of one country, one vote; and developing countries greatly outnumber industrialized nations.

9.For perspectives from three key developing countries — China, India, and Brazil — see the papers by Longhai (2005), Parikh (2005), and Reis (2005) in this volume.

10.This is a natural extension of the pattern of target allocation present in the Kyoto Protocol. The extension is from the industrialized world to the developing world and from the cross-sectional dimension to the temporal dimension. The Kyoto Protocol's targets exhibit positive correlation between national wealth (in particular, gross domestic product — GDP — per capita) and the degree of targeted emissions reduction. In fact, the Kyoto targets exhibit an "income elasticity of reductions" of about 0.10, that is, for a 10 percent increase in per-capita GDP, the targets — on average — become about one percent more stringent (Frankel 1999, 2002).

11.If provision is not made for growth targets or some other mechanism that includes developing countries at low or no cost to them, then analysis inevitably points to a trade-off between cost-effectiveness (or efficiency) and distributional equity (Sugiyama and Deshun 2004). For an alternative approach to engaging developing countries that emphasizes integrating development objectives among developing nations with global climate policy objectives, see: Heller and Shukla (2003).

12.This contrasts dramatically with the situation in Europe and elsewhere: economies were stagnant or grew much more slowly. Furthermore, emissions of CO_2 from the United Kingdom, Germany, and Russia fell significantly subsequent to 1990 (the Kyoto Protocol's baseline year) and for reasons having nothing to do with climate change or other environmental policy. Emissions fell in the United Kingdom because of structural changes in the domestic coal industry

initiated by Prime Minister Margaret Thatcher's government (1979–1990); emissions fell in Germany because reunification led to the closure of energy-inefficient plants in the former East Germany; and emissions fell in Russia because of its economic collapse in the 1990s (McKibbin and Wilcoxen 2002). Importantly, it has been estimated that 80 percent of the European Union's CO_2 reductions under the Kyoto Protocol will be achieved by two countries — Germany and the United Kingdom, facilitated via the EU bubble that is part of the Protocol (Andersen 2002). These factors help explain the very different perspectives on the Kyoto Protocol held by Europeans and Americans, but other historical phenomena are also at work (Kagan 2002).

13.The longer-term targets should be flexible, because there is considerable uncertainty throughout the policy-economics-biophysical system, some of which will be resolved over time (Richels, Manne, and Wigley 2004). On this, see the paper by Mendelsohn (2005) in this volume. For a broader survey of the relationship between technological change and the environment, see Jaffe, Newell, and Stavins (2003). For an analysis of the implications of combining such an intertemporal pattern of targets with gradual expansion of the coalition of nations that take on targets, see Den Elzen (2002).

14.For the global goal — often discussed — of stabilizing atmospheric concentrations of CO_2 at twice pre-industrial levels (that is, approximately 550 parts per million), Wigley, Richels, and Edmonds (1996) estimated that the cost-effective time path of emissions would involve global emissions peaking in 2030. Manne and Richels (1997) found that severe emission reductions should take place only in the second half of the twenty-first century. The recommended intertemporal pattern of emissions targets is also consistent with recommendations for the use of "intensity targets" (targets expressed in terms of emissions per unit of economic activity), as recently highlighted in the United States by the National Commission on Energy Policy (2004).

15.See the paper by Lackner (2005) in this volume.

16.It is not necessary that the (upstream) level of compliance be the same as the (possibly downstream) level of initial allocation.

17.Norway introduced a carbon tax in 1991. Despite its considerable magnitude and consequent induced increases in fuel prices, impacts on CO_2 emissions were modest, in part because of extensive tax exemptions (Bruvoll and Larsen 2004).

18.For a description of the origin and evolution of the concept in climate policy deliberations, an assessment of its potential application as a domestic policy instrument and an evaluation of potential problems it would present if adopted as an international policy instrument, see: Jacoby and Ellerman (2004).

19.Others have argued in favor of an international tax regime. See, for example: Cooper (1998); McKibbin and Wilcoxen (2002); Pizer (2002); Newell and Pizer (2003); and Nordhaus (2005) in this volume.

20.If, for example, the majority of excess permits (allowable emissions in excess of BAU emissions, or so-called "hot air") is found in a relatively small number of nations in Central and Eastern Europe and the former Soviet Union, then the possibility of collusion among such sellers becomes quite likely (Manne and Richels 2004; Springer and Varilek 2004).

21.The Kyoto Protocol explicitly provides for national sovereignty regarding domestic instrument choice in Article 2.

22.In such cases, achieving the potential cost savings of international trading would require some form of project-by-project credit program, such as the Kyoto Protocol's Clean Development Mechanism (CDM). But theory and experience with such programs indicates they are unlikely to facilitate major cost savings because of large transaction costs, government participation, and the absence of well-functioning markets (Michaelowa, *et al.* 2003).

23."It has been said that democracy is the worst form of government, except all those other forms that have been tried from time to time." This is the most common form of the quotation, and is reproduced from debate in the House of Commons, November 11, 1947 (James 1974).