November 24, 2008

Designing the Post-Kyoto Climate Regime:

Lessons from the Harvard Project on International Climate Agreements

An Interim Progress Report for the 14th Conference of the Parties, Framework Convention on Climate Change

Poznan, Poland
December 2008

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Harvard Project on International Climate Agreements Research Initiatives

For each of the following initiatives, the full text of the Discussion Paper, as well as a two-page summary, may be downloaded by visiting the Project's website: www.belfercenter.org/climate ; then clicking on "Project Discussion Paper Series" on the left navigation bar.

I. Alternative International Policy Architectures

- Towards a Global Compact for Managing Climate Change
  Ramgopal Agarwala, Research and Information System for Developing Countries, New Delhi
- A Portfolio System of Climate Treaties
  Scott Barrett, SAIS, Johns Hopkins University
- The Case for Charges on Greenhouse Gas Emissions
  Richard Cooper, Department of Economics, Harvard University
- EU Emission Trading Scheme: A Prototype Global System?
  A. Denny Ellerman, MIT Sloan School of Management
- An Elaborated Proposal for Global Climate Policy Architecture: Specific Formulas and Emission Targets for All Countries in All Decades
  Jeffrey Frankel, Harvard Kennedy School
- A Proposal for the Design of the Successor to the Kyoto Protocol
  Larry Karp, University of California, Berkeley, and Jinhua Zhao, Michigan State University
- Linkage of Tradable Permit Systems in International Climate Policy Architecture
  Judson Jaffe, Analysis Group and Robert Stavins, Harvard Kennedy School
- A Sectoral Approach as an Option for a Post-Kyoto Framework
  Akihiro Sawa, Research Center for Advanced Science and Technology, University of Tokyo

II. Key Elements in an International Policy Architecture

A. Assessing Targets and Goals

- Metrics for Evaluating Policy Commitments in a Fragmented World: The Challenges of Equity and Integrity
  Carolyn Fischer and Richard Morgenstern, Resources for the Future
- Justice and Climate Change
  Eric Posner, University of Chicago School of Law and Cass Sunstein, Harvard Law School
- Designing a Bretton Woods Institution to Address Global Climate Change
  Joseph Aldy, Resources for the Future

B. The Role and Means of Technology Transfer

- Industrialized-Country Mitigation Policy and Resource Transfers to Developing Countries: Improving and Expanding Greenhouse Gas Offsets
  Andrew Keeler, John Glenn School of Public Affairs, and Alexander Thompson, Department of Political Science, Ohio State University

- International Climate Technology Strategies
  Richard Newell, Nicholas School of the Environment, Duke University

- Possible Development of a Technology Clean Development Mechanism in a Post-2012 Regime
  Fei Teng, Wenying Chen, and Jiankun He, Tsinghua University, Beijing

C. Including Deforestation in a Global Climate Policy

- International Forest Carbon Sequestration in a Post-Kyoto Agreement
  Andrew Plantinga, Dept. of Agricultural & Resource Economics, Oregon State University; Kenneth Richards, School of Environmental & Public Affairs, Indiana University

D. Compliance Mechanisms

- Toward a Post-Kyoto Climate Change Architecture: A Political Analysis
  Robert Keohane, Woodrow Wilson School of Public and International Affairs, Princeton University, and Kal Raustiala, UCLA School of Law

III. Important Issues in the Development of International Policy Architecture

A. Negotiation Process

- How to Negotiate and Update Climate Agreements
  Bård Harstad, Kellogg School of Management, Northwestern University

B. Economic Development, Adaptation, and International Climate Policy

- Reconciling Human Development and Climate Protection
  Jing Cao, School of Economics and Management, Tsinghua University, Beijing

- Opportunities for Developing Country Participation in an International Climate Change Policy Regime
  Jiang Kejun, Energy Research Inst., National Development & Reform Commission, Beijing

- Policies for Developing Country Engagement
  Daniel S. Hall and William A. Pizer, Resources for the Future; Michael Levi, Council on Foreign Relations; and Takahiro Ueno, Central Research Institute of Electric Power Industry, Tokyo

  What Do We Expect from an International Climate Agreement? A Perspective from a Low-Income Country
  E. Somanathan, Planning Unit, Indian Statistical Institute, New Delhi

- Climate Accession Deals: New Strategies for Taming Growth of Greenhouse Gases in Developing Countries
  David Victor, Program on Energy and Sustainable Development, Stanford University

C. Global Climate Policy and International Trade

- Global Environmental Policy and Global Trade Policy
  Jeffrey Frankel, Harvard Kennedy School

IV. Modeling Impacts of Alternative Allocations of Responsibility

- Modeling Economic Impacts of Alternative International Climate Policy Architectures: A Quantitative and Comparative Assessment of Architectures for Agreement
  Valentina Bosetti, Carlo Carraro, Alessandra Sgobbi, Massimo Tavoni; Fondazione Eni Enrico Mattei (FEEM), Italy

- Sharing the Burden of GHG Reductions
  Henry D. Jacoby, Mustafa H. Babiker, Sergey Paltsev, and John M. Reilly, Massachusetts Institute of Technology

- Technology and International Climate Policy
  Leon Clarke, Kate Calvin, Jae Edmonds, Page Kyle, and Marshall Wise; Joint Global Change Research Institute, Pacific Northwest National Laboratory and University of Maryland

- Revised Emissions Growth Projections for China: Why Post-Kyoto Climate Policy Must Look East
  Geoffrey J. Blanford and Richard G. Richels, Global Climate Change Research Program, Electric Power Research Institute; and Thomas F. Rutherford, Swiss Federal Institute of Technology

- Expecting the Unexpected: Macroeconomic Volatility and Climate Policy
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SPONSORS

Major funding for the Harvard Project on International Climate Agreements has been provided by a grant from the Climate Change Initiative of the ***Doris Duke Charitable Foundation.***

Additional support has been provided by Christopher P. Kaneb; the James M. and Cathleen D. Stone Foundation; Paul Josefowitz and Nicholas Josefowitz; the Enel Endowment for Environmental Economics at Harvard University; the Belfer Center for Science and International Affairs at the Harvard Kennedy School; and the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School.

Project website: www.belfercenter.org/climate
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Citation Information
Aldy, Joseph E., and Robert N. Stavins. "Designing the Post-Kyoto Climate Regime: Lessons from the Harvard Project on International Climate Agreements; Interim Progress Report," Cambridge, Mass.: Harvard Project on International Climate Agreements, November 2008. The views expressed in the Interim Progress Report are those of the authors and do not necessarily reflect those of the John F. Kennedy School of Government or of Harvard University. The Interim Progress Report has not undergone formal review and approval; it is intended to elicit feedback and to encourage debate on an important public policy challenge.

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Executive Summary

A way forward is needed for the post-2012 period to address the threat of global climate change. The Harvard Project on International Climate Agreements is an international, multi-year, multi-disciplinary effort to help identify the key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture. Leading thinkers from academia, private industry, government, and non-governmental organizations around the world have contributed and will continue to contribute to this effort. The foundation for the Project is a book published in September 2007 by Cambridge University Press, *Architectures for Agreement: Addressing Global Climate Change in the Post-Kyoto World* (Aldy and Stavins 2007). From that starting point, the Harvard Project on International Climate Agreements aims to help forge a broad-based consensus on a potential successor to the Kyoto Protocol. The Project includes 28 research teams operating in Europe, the United States, China, India, Japan, and Australia.

The work of the Project is being carried out in three stages. The first stage featured meetings with key domestic and international policy constituencies to discuss considerations regarding potential successors to Kyoto. The second stage focused on policy analysis and economic modeling to develop a small set of promising policy frameworks and key design elements. In the third stage, Project researchers are exploring key design principles and alternative international policy architectures with domestic and international audiences, including the new administration and Congress in the United States. This interim report identifies some of the key principles, promising policy architectures, and guidelines for essential design elements that have begun to emerge, building upon lessons learned from the 28 research initiatives.

Learning from Kyoto

Among the strengths of the Kyoto Protocol is its inclusion of provisions for market-based approaches—the three so-called flexibility mechanisms. A second feature of the Protocol is that it provides freedom for nations to meet their national targets and commitments in any way they want. Third, the agreement has the appearance of fairness in that it focuses on the wealthiest countries and those most responsible for the current stock of greenhouse gases in the atmosphere, consistent with the principle—first enunciated in the Framework Convention on Climate Change—of common but differentiated responsibilities and respective capabilities. Fourth, the fact that the Protocol was signed by more than 180 countries and subsequently ratified by a sufficient number of Annex I countries to come into force may be taken as an indicator of its political viability.

The weaknesses of the Kyoto Protocol also provide valuable lessons. First, some of the largest emitters are not constrained by Kyoto. The Protocol has not been ratified by the United States, and it does not include emissions targets for some of the largest and most rapidly growing economies in the developing world. Second, a relatively small number of countries are asked to take action, which has resulted in concerns about emissions leakage and competitiveness. Third, the nature of the Protocol's emissions trading elements has caused concern. The provision in Article 17 for international emissions trading among nation-states is unlikely to be effective, if it is utilized at all. And the Clean Development Mechanism (CDM) is plagued by criticisms that it is crediting projects that would have happened anyway (commonly known as the problem of "additionality"). Fourth, the Kyoto Protocol—with its five year time horizon (2008 to 2012)—represents a relatively short-term approach for what is fundamentally a long-term problem. Finally, the agreement may not provide sufficient incentives for compliance.

Key Principles for a New International Agreement

Our research teams identified a number of key principles for the design of a scientifically sound, economically rational, and politically pragmatic post-2012 international climate policy architecture. These principles constitute some of the core premises underlying our work:

- Climate change is a global commons problem, and therefore a cooperative approach involving many nations—whether through a single international agreement or some other regime—will be necessary to address it successfully. Since sovereign nations cannot be compelled to act against their wishes, successful treaties must create adequate internal incentives for compliance, along with external incentives for participation.

- A credible global climate change agreement must be equitable. Industrialized countries should accept responsibility for historic emissions of greenhouse gases. Likewise, it will be necessary for key developing countries with rapidly growing economies to take on increasingly meaningful roles. All countries will need to move onto less carbon-intensive growth paths.

- A credible global climate change agreement must be cost-effective and must bring about significant technological change and technology transfer. Also, it must be consistent with the international trade regime.

- A credible global climate change agreement must be practical and build, where possible, on existing institutions and practices. It must also include mechanisms for judging whether countries have complied with their commitments. Negotiations need to include attention to short-term achievements, as well as recognition of medium-term consequences and long-term goals. A credible global climate change agreement must be realistic. Because no single approach guarantees a sure path to ultimate success, the best strategy may be to pursue a variety of approaches simultaneously.

Promising International Climate Policy Architectures

The Harvard Project on International Climate Agreements does not currently endorse a single approach to international climate policy because we recognize that the decision to adopt a particular architecture is ultimately a political one that must be reached by the nations of the world, taking into account a complex array of factors. Rather, we describe four architectures—each of which has advantages as well as disadvantages—because each is promising in some regards and raises important issues for consideration. One of these architectures falls in the category of targets and timetables; two exemplify harmonized domestic policies; and one is in the category of coordinated and unilateral national policies.

Targets and Timetables: Formulas for Evolving Emission Targets for All Countries

This plan calls for an international agreement to establish a global cap-and-trade system, where emissions caps are established using a set of formulas that assign quantitative emissions limits to countries in every year through 2100. The cap-and-trade scheme would essentially link national and regional cap-and-trade systems so that trading would occur across firms and sources. Political realities would inform the formulas used to set caps. First, developing countries are not asked to bear any cost in the early years. Second, developing countries are not asked to make any sacrifice that differs from the sacrifices of industrialized countries, accounting for differences in income. Third, countries are not asked to accept targets that cost more than 1% of GDP in present value terms, or more than 5% of GDP in any given year.

The formula used to set emissions caps incorporates three elements: a progressivity factor, a latecomer catch-up factor, and a gradual equalization factor. The progressivity factor requires richer countries to make more severe cuts relative to their business-as-usual emissions. The latecomer catch-up factor requires nations that did not agree to binding targets under the Kyoto Protocol to make gradual emissions cuts to account for their additional emissions since 1990. The gradual equalization factor moves emissions in each country by small steps in the direction of the global average of per capita emission. With this framework, every country will feel that it is contributing its fair share.

Harmonized Domestic Policies: A Portfolio of International Treaties

This proposal adopts a very different sort of architecture than the Kyoto Protocol: it relies on a system of linked international agreements to separately address various sectors and gases, as well as key issues. First, sector-level agreements would establish global standards for specific industries or categories of greenhouse gas sources. Developing countries would not be exempted from these standards, but would be offered financial aid to help them comply. Trade restrictions would be used to enforce agreements governing trade-sensitive sectors where such sanctions can be both effective and credible. Second, because of the enormity of the technology challenge implicit in successfully addressing climate change, there would be additional international agreements that focused on research and development. Finally, separate agreements could be included to cover adaptation assistance to developing countries, as well as last-resort remedies such as geoengineering and air capture of greenhouse gases.

Such a multi-track climate treaty system is hardly perfect, but could offer advantages over target-and-timetable approaches, which aggregate all types of emissions from all sectors and focus primarily on emissions mitigation while tending to ignore other options for managing climate risks. By avoiding the enforcement problems of an aggregate approach and by taking a broader view of risk reduction, the portfolio approach could provide a more effective and flexible response to the long-term challenge posed by climate change.

Harmonized Domestic Policies: A System of National Carbon Taxes

This architecture consists of harmonized domestic taxes on emissions of greenhouse gases from all sources. The tax (or charge) would be internationally adjusted from time to time, and each country would collect and keep the revenues it generates. This approach begins from the premise that seriously addressing carbon dioxide (CO_2) emissions requires a worldwide approach. Changing the prices of goods and services made with fossil fuels is the most effective way to influence the daily consumption decisions made by more than a billion households and firms around the world. If CO_2-emitting activities are to be reduced, then the prices of those activities must be increased. Levying a charge on CO_2 emissions does that directly.

In terms of design, the geographic coverage of a carbon tax should be as broad as possible. The initial scheme need not cover all countries, but it should cover the countries that account for the vast majority of world emissions. Additionally, the tax should cover all the significant greenhouse gases, insofar as practical. The level of the tax would be set by international agreement and could be subject to periodic review every five or ten years. To minimize administrative costs, the charge should be assessed at upstream locations—that is, on the carbon content of fossil fuels. For example, the carbon content of oil should be taxed at refineries, natural gas should be taxed at major pipeline collection points, and coal at mine heads. All but the poorest nations should have sufficient administrative capacity to administer such a plan. Fortunately, the countries that lack this capacity are likely to be low emitters.

Coordinated National Policies: Linkage of National and Regional Tradable Permit Systems
With tradable permit systems emerging as the favored national and regional approach to climate change policy worldwide, there is increased attention and pressure to link these systems. Linkage would have a number of benefits, producing significant cost savings and reducing transaction costs, market power, and overall price volatility. But linkage brings with it the automatic propagation of cost-containment design elements. That is, when cap-and-trade systems are directly linked, the effects of any banking, borrowing, and safety valve provisions in one system effectively transfer to the other. This means that linkage will require advance efforts to harmonize some of the design features of different programs. If, however, cap-and-trade systems are linked with an emission-reduction-credit system, such as the CDM, then the linkage among the cap-and-trade systems is indirect. All the benefits of linkage occur, but the potential downsides of propagating design elements across systems are greatly diminished.

Indirect linkage of cap-and-trade systems through the CDM is already occurring, because virtually all of the cap-and-trade systems that are in place, as well those that are planned or contemplated, allow for offsets from the CDM to be used to meet domestic obligations. In fact, this kind of linkage among the world's cap-and-trade systems may already be evolving into the *de facto*, if not the *de jure*, post-Kyoto international climate policy architecture. In the long term, a post-2012 international climate agreement could include elements that would facilitate future linkages: establishing an agreed trajectory of emissions caps or allowance prices, specifying cost-containment measures, and defining a process for making future adjustments to key design elements. If the aim is to facilitate linkage, a future agreement should also avoid imposing supplementarity restrictions that require countries to achieve some specified percentage of emission reductions domestically.

Key Design Issues in International Policy Architecture

Regardless which overall international policy architecture is chosen, a number of key design issues stand out as particularly important, including burden-sharing, technology transfer, CDM reform, addressing deforestation, and making global climate policy compatible with global trade policy. All of these issues involve the relationship between global climate policy and economic development.

Burden-Sharing in an International Climate Agreement
The most challenging aspect of establishing a post-Kyoto international climate regime will be reaching agreement on burden-sharing among nations. One approach is to start by focusing on what is politically possible and to identify an allocation of responsibility— with appropriate changes over time—that makes every country feel it is doing only its fair share. The architecture described above—dynamic formulas combined with cap-and-trade—would set national emissions caps through a set of formulas that assign quantitative emissions limits to countries in every year until 2100. Importantly, developing countries would not assume any cost burden in the early years and would not be asked to make sacrifices that differ from the sacrifices of industrialized countries, after accounting for differences in income, in later years.

The different factors included in this formula for burden sharing respond, respectively, to three aspects of equity. The progressivity factor requires richer countries to make more severe cuts relative to their business-as-usual emissions; the latecomer catch-up factor requires nations that did not agree to binding targets under the Kyoto Protocol to make gradual emissions reductions to account for their additional emissions since 1990; and the gradual equalization factor moves all countries toward equal per capita emissions, consistent with producing an ultimate outcome that could be viewed, from a variety of perspectives, as equitable.

Technology Transfer in an International Climate Agreement

Achieving long-term climate change policy goals will require a ramp-up in the innovation and deployment of energy-efficient and low-carbon technologies. Thus, a suite of policies is needed to provide the proper incentives for technological change. Three categories of policies are potentially important: international carbon markets, technology transfer to developing countries, and coordinated innovation and commercialization programs. First, the most powerful tool for accelerating the development and deployment of climate-friendly technologies will be policies that affect the current and expected future prices of fossil fuels relative to lower-carbon alternatives. Cap-and-trade programs and emission reduction credit systems, such as the CDM, can finance emission mitigation projects in the industrialized and developing countries alike. But putting a price on carbon may not facilitate new investment flows in developing countries with weak market institutions. Further, the public good nature of R&D means that a price on carbon will not be sufficient, by itself, to overcome the general disincentive for private sector investments in researching and developing new climate-friendly technologies.

Beyond putting a price on carbon, the next international climate agreement can provide several mechanisms to facilitate the development and deployment of climate-friendly technologies. Examples include providing a venue for countries to pledge resources for technology transfer and R&D and coordinating agreement on principles for allocating resources. Likewise, barriers to the transfer of climate-friendly technologies could be reduced through a World Trade Organization (WTO) agreement that lowered tariff and non-tariff barriers to trade in environmental goods and services. Finally, strategies could be put in place to resolve impediments to knowledge transfer in the context of policies for the protection of intellectual property.

Reforming the Clean Development Mechanism

Serious concerns have emerged about the additionality of offset projects being credited under the existing CDM mechanism (that is, whether these projects are really producing emission reductions that are 'additional' to what would have happened in any case). To some degree, these problems could be addressed by establishing better criteria and procedures to ensure that CDM offsets are awarded only for emission reductions that are additional, real, verifiable, and permanent, but there are also a number of alternative, more dramatic changes in the CDM that merit consideration. One approach would involve less emphasis on strict ton-for-ton accounting and more emphasis on a range of activities that could produce significant long-term benefits. The criteria for offsets would be changed from "real, verifiable, and permanent reductions" to "actions that create real progress in developing countries toward mitigation and adaptation." A specified portion of offset credits could be sold up front, and the proceeds put in a fund to make investments in projects throughout the developing world. International negotiations would be focused on establishing guidelines for these efforts and clearly delineated tasks would be delegated to new and existing institutions for the purpose of managing and safeguarding the integrity of the overall program.

Alternatively, a fundamentally different approach could be taken, such as pursuing Climate Accession Deals (CADs) as a new strategy for engaging developing countries. A CAD would consist of a set of policies that is tailored to gain maximum leverage on a single developing country's emissions, while still aligning with that country's interests and capabilities. Industrialized countries would support CADs by providing specific benefits such as financial resources, technology, administrative training, or security guarantees. For example, a CAD for China could focus on making new power plants more efficient, encouraging greater use of natural gas and nuclear fuel for generating electricity, and improving the efficiency of the electric power grid, while a CAD for India could emphasize improvements in the efficiency of coal-based electricity production. CADs for Brazil and Indonesia, meanwhile, might focus on preventing and reversing deforestation.

Addressing Deforestation in an International Climate Agreement

Because changes to forests can have enormous impacts on the global carbon cycle, terrestrial carbon management ought to be an element of the next international agreement on climate change. One promising option for moving forward could be to develop a national inventory approach, in which nations receive credits or debits for changes in forest cover relative to a measured baseline. Over time, the measured forest stock would be compared with a pre-negotiated baseline to determine the quantity of offset credits that can be redeemed, or debits that must be covered, in the permit market. Under this approach, national governments, rather than project developers, pursue carbon sequestration activities through the development of domestic policies. The reference stock used as a baseline for measuring future forest changes would be determined through international negotiations, which could also be used to address equity issues and provide incentives for countries—especially countries with declining stocks—to participate in the agreement.

The national inventory approach would reduce the problems of additionality, leakage, permanence, and adverse selection that plague the current CDM. It could also provide a comprehensive way to cover climate-related impacts from deforestation because it would apply equally to all participating countries and to all measurable changes in forest carbon stocks. There are also some concerns about this approach. First, the scope of carbon sequestration activities would be limited to those that can be measured. Second, providing incentives to governments rather than private project developers may be a disadvantage in countries with weak institutions or corruption. Third, problems with additionality and permanence may resurface in connection with policies pursued by national governments.

Making Global Climate Policy Compatible with Global Trade Policy

Global efforts to address climate change could be on a collision course with efforts through the WTO to reduce trade barriers. The question is how to address concerns about leakage and competitiveness in a way that does not run afoul of WTO rules and avoids derailing progress toward free trade and climate goals alike. National provisions that would be likely to conflict with WTO rules include: (1) unilateral measures applied by countries that do not participate in the Kyoto Protocol or its successors; (2) judgments made by politicians vulnerable to pressure from interest groups for special protection; (3) unilateral measures that seek to sanction an entire country, rather than targeting narrowly defined energy-intensive sectors; (4) import barriers against products that are further removed from carbon-intensive activity; and (5) subsidies—whether in the form of money or extra permit allocations—to domestic sectors that are considered to have been put at a competitive disadvantage.

Border measures that are more likely to be WTO-compatible include tariffs or requirements for importers to surrender tradable permits, particularly if they are designed with attention to certain guidelines: (1) trade measures follow some multilaterally-agreed set of guidelines among countries participating in the emission targets of the Kyoto Protocol and/or its successors; (2) judgments about which countries are complying, which industries are involved and their carbon content, and which countries are entitled to respond with border measures are made by independent panels of experts; (3) measures are applied only by countries that *are* reducing their emissions against countries that are not reducing emissions, whether as a result of their refusal to join an agreement or their failure to comply; and (4) import penalties target fossil fuels and five or six of the most energy-intensive major industries—e.g., aluminum, cement, steel, paper, glass, and perhaps iron and chemicals.

The Path Ahead

Whether the Kyoto Protocol was a good first step or a bad first step, a second step is required for the post-2012 period. It is with this in mind that the Harvard Project on International Climate Agreements was launched as a global, multi-year, multi-disciplinary effort intended to help the countries of the world identify the key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture.

Going forward, the Harvard Project will continue to draw on leading thinkers from academia, private industry, government, and non-governmental organizations around the world. We will also continue to work with our 28 research teams in Europe, the United States, China, India, Japan, and Australia and meet in a wide variety of venues with those who can share their expertise and their insights, whether at the Fourteenth Conference of the Parties to the Framework Convention on Climate Change in Poznan; or at meetings in Brussels, Tokyo, Beijing, New York, or Washington.

This interim report summarizes lessons learned from our diverse research initiatives and outreach efforts to date. We look forward to receiving extensive feedback regarding all elements of our work—including reactions to the lessons we draw from Kyoto, the design principles we have identified as being especially important to the success of a new international agreement, and the potential policy architectures we have highlighted—and in that spirit welcome corrections, additions, and comments of any kind.

Designing the Post-Kyoto Climate Regime: Lessons from the Harvard Project on International Climate Agreements

Interim Progress Report

Co-Directors
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INTRODUCTION

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) marked the first significant attempt by the community of nations to curb the greenhouse gas emissions that are changing the Earth's climate. This agreement, though a significant first step, is not sufficient for the longer-term task ahead. The United States, one of the world's two largest emitters of greenhouse gases, has not ratified the Protocol, and other rapidly growing major economies have not been required to reduce their emissions. Some observers support the policy approach embodied in Kyoto and would like to see it extended—perhaps with modifications—beyond the first commitment period, which ends in 2012. Others maintain that a fundamentally new approach is required.

Whether one thinks the Kyoto Protocol was a good first step or a bad first step, everyone agrees that a second step is required. A way forward is needed for the post-2012 period. The Harvard Project on International Climate Agreements was launched with this imperative in mind. The Project is a global, multi-year, multi-disciplinary effort intended to help identify the key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture for addressing the threat of climate change.

Whether one thinks the Kyoto Protocol was a good first step or a bad first step, everyone agrees that a second step is required.

By "scientifically sound" we mean an international agreement that is consistent with achieving the objective of stabilizing atmospheric concentrations of greenhouse gases at levels that avoid dangerous anthropogenic interference with the global climate. By "economically rational" we mean pursuing an approach or set of approaches that are likely to achieve global targets at minimum cost—that is, cost effectively. And by "politically pragmatic" we mean a post-Kyoto regime that is likely to bring on board the United States and engage key, rapidly-growing developing countries in increasingly meaningful ways over time.

The Project draws upon leading thinkers from academia, private industry, government, and non-governmental organizations around the world. It includes 28 research teams (listed earlier in the Report) operating in Europe, the United States, China, India, Japan, and Australia, and has benefited from meetings with leaders from business, NGOs, and governments in many more countries. (The Report lists in Appendix A selected individuals with whom the Project Co-Directors have met, as well as, in Appendix B, workshops and conferences conducted by the Project.)

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The origins of this Project are in May 2006, when the Harvard Environmental Economics Program hosted a workshop that brought together 27 leading thinkers from around the world with expertise in economics, law, political science, business, international relations, and the natural sciences. This group developed and refined six policy frameworks, each of which could form the backbone of a new international climate agreement. These six frameworks, which range from a stronger version of the Kyoto Protocol to entirely new approaches, are the subject of a book published in September 2007 by Cambridge University Press, *Architectures for Agreement: Addressing Global Climate Change in the Post-Kyoto World* (Aldy and Stavins 2007). With these proposals as the starting point, the Harvard Project on International Climate Agreements aims to help forge a broad-based consensus on a potential successor to Kyoto.

The Harvard Project seeks to identify...key design elements of a scientifically sound, economically rational, and politically pragmatic post-2012 international policy architecture for addressing the threat of climate change.

The Project is proceeding in three stages. In the first stage, we met with key domestic and international policy constituencies to discuss considerations regarding potential successors to Kyoto. In the second stage, we conducted policy analysis and economic modeling to develop a small set of promising policy frameworks and identify critical design elements. In the third stage, we are exploring key design principles and alternative international policy architectures with domestic and international audiences, including the new administration and Congress in the United States.

The first stage of our work, which focused on establishing the importance of considering alternative architectures for the post-2012 period, featured wide-ranging and inclusive discussions of all six proposed alternatives, as well as others not addressed in *Architectures for Agreement*. It also featured meetings with government officials, business leaders, NGOs, and academics around the world.

In the second stage of the Project, we focused on developing a small menu of promising frameworks and key design principles, based upon analysis by leading academics from a variety of disciplines—including economics, political science, law, and international relations—as well as ongoing commentary from leading practitioners in the NGO community, private industry, and government. Economic analysis has been supplemented with political analysis of the implications of alternative approaches, as well as legal examinations of the feasibility of respective proposals.

From the beginning, there have been no constraints on what might emerge from the Project. We have maintained from the outset that anything is possible—from highly centralized Kyoto-like architectures for all countries to proposals that are outside of the context of the UNFCCC, such as proposals for G8+5 or L20 agreements. This interim report is based upon the findings of our diverse research initiatives in Australia, China, Europe, India, Japan, and the United States.

In the third stage of the Project, we are discussing our findings concerning key design elements and promising international policy architectures with domestic and international audiences. This includes meetings with the European Union, the United Nations, developing countries, the business community, and NGOs. We also intend to meet with the new U.S. President's economic, energy and environmental, and foreign policy teams, as well as with members of the new U.S. Congress. All such meetings are intended to be educational—the Project and its principals have not and will not engage in any lobbying activities.

Learning from Experience: The Kyoto Protocol

It is helpful to reflect on the lessons that can be learned from examining the Kyoto Protocol's strengths as well as weaknesses. Among the Protocol's strengths is its inclusion of several provisions for market-based approaches that hold promise for improving the cost-effectiveness of a global climate regime. We refer, for example, to the well-known flexibility mechanisms such as Article 17, which provides for emissions trading among the Annex I countries[1] that take on targets under the Protocol. More specifically, this provision allows the governments of Annex I countries to trade parts of their reduction responsibilities to meet their country-level emissions targets. Second, the Protocol's Joint Implementation provisions allow for project-level trades among the Annex I countries. Finally, the Protocol established the Clean Development Mechanism (or CDM), which provides for the use of project-level emission offsets created in non-Annex I countries (the developing countries of the world) to help meet the compliance obligations of firms in Annex I countries.

A second advantage of the Kyoto Protocol is that it provides flexibility for nations to meet their national emissions targets—their commitments—in any way they want. In other words, Article 2 of the Protocol recognizes domestic sovereignty by providing for flexibility at the national level. The political importance of this provision in terms of making it possible for a large number of nations to reach agreement should not be underestimated.

Third, the Kyoto Protocol has the appearance of fairness in that it focuses on the wealthiest countries and those responsible for the majority of the current stock of anthropogenic greenhouse gases in the atmosphere. This is consistent with the principle enunciated in the UNFCCC of "common but differentiated responsibilities and respective capabilities."

Fourth and finally, the fact that the Kyoto Protocol was signed by more than 180 countries and subsequently ratified by a sufficient number of Annex I countries for it to come into force speaks to the political viability of the agreement, if not to the feasibility of all countries actually achieving their targets.

In the realm of public policy, as in our everyday lives, we frequently learn more from our mistakes or failures than from our successes.

In the realm of public policy, as in our everyday lives, we frequently learn more from our mistakes or failures than from our successes. So, too, in the case of the Kyoto Protocol. Therefore, we also examine some key weaknesses of the Protocol and explore what potentially valuable lessons they may hold for the path forward.

First, it is well known that some of the world's leading greenhouse gas emitters are not constrained by the Kyoto Protocol. The United States—until recently the country with the largest share of global emissions—has not ratified and is unlikely to ratify the agreement. Also, some of the largest and most rapidly growing economies in the developing world do not take on targets under the agreement. Importantly, China, India, Brazil, South Africa, Indonesia, Korea, and Mexico are not listed in Annex B of the Kyoto agreement. Rapid rates of economic growth in these countries have produced rapid rates of growth in energy use, and hence carbon dioxide (CO_2) emissions. Together with continued deforestation in tropical countries, the result is that the developing world will soon overtake the industrialized world in total emissions. Indeed, China's CO_2

[1] We use Annex I and Annex B interchangeably to represent those industrialized countries that have commitments under the Kyoto Protocol, though we recognize that a few countries are included in one Annex but not the other.

emissions have already surpassed those of the United States; moreover, China's emissions are expected to continue growing much faster than U.S. emissions for the foreseeable future (Blanford, *et al*. 2008).

These realities raise the possibility that the Kyoto Protocol is not as fair as originally intended, especially given how dramatically the world has changed since the Framework Convention divided countries into two categories in 1992. For example, approximately 50 non-Annex I countries—that is, developing countries and some others—now have higher per capita incomes than the poorest of the Annex I countries with commitments under the Kyoto Protocol. Likewise, 40 non-Annex I countries rank higher on the Human Development Index in 2007 than the lowest ranked Annex I country (Aldy 2008).

A second weakness of the Kyoto Protocol is associated with the relatively small number of countries being asked to take action. This narrow but deep approach may have been well-intended, but one of its effects will be to drive up the costs of producing carbon-intensive goods and services within the coalition of countries taking action. (Indeed, increasing the cost of carbon-intensive activities is the intention of the Protocol and is fully appropriate as a means to reduce emissions.) Through the forces of international trade, however, this approach also leads to greater comparative advantage in the production of carbon-intensive goods and services for countries that do not have binding emissions targets under the agreement. The result can be a shift in production and emissions from participating nations to non-participating nations—a phenomenon known as emissions "leakage." This leakage will not be one-for-one (in the sense that increased emissions in non-Annex 1 countries would be expected to fully negate emission reductions in Annex 1 countries), but it will reduce the cost-effectiveness and environmental performance of the agreement, and perhaps worst of all, push developing countries onto a more carbon-intensive growth path than they would otherwise have taken, rendering it more difficult for these countries to join the agreement later.

A third concern about the Kyoto Protocol centers on the nature of its emissions trading elements. The provision in Article 17 for international emissions trading is unlikely to be effective, if indeed it is utilized at all (Hahn and Stavins 1999). The entire theory behind the claim that a cap-and-trade system is likely to be cost effective depends upon the participants being cost-minimizing entities. In the case of private-sector firms, this is a sensible assumption, because if firms do not seek, and indeed succeed in, minimizing their costs, they will eventually disappear, given the competitive forces of the market. But nation-states can hardly be thought of as simple cost-minimizers—many other objectives affect their decision-making. Furthermore, even if nation-states sought to minimize costs, they do not have sufficient information about marginal abatement costs at the multitude of sources within their borders to carry out cost-effective trades with other countries.

There is also concern regarding the CDM. This is not a cap-and-trade mechanism, but rather an emissions-reduction-credit system. That is, when an individual project results in emissions below what they would have been in the absence of the project, a credit—which may be sold to a source within a cap-and-trade system—is generated. This approach creates a challenge: comparing actual emissions with what they would have been otherwise. The baseline—what would have happened had the project not been implemented—is unobserved and fundamentally unobservable. In fact, there is a natural tendency, because of economic incentives, to claim credits precisely for those projects that are most profitable, and hence would have been most likely to have been executed without the promise of credits. This so-called "additionality problem" is a serious issue. There are ways to address it through future restructuring and reform of the CDM; we examine some of these options later in this report.

Fourth, the Kyoto Protocol, with its five year time horizon (2008 to 2012), represents a relatively short-term approach for what is fundamentally a long-term problem. Greenhouse gases have residence times in the atmosphere of decades to centuries. Furthermore, to encourage the magnitude of technological change that will be required to meaningfully address the threat of climate change it will be necessary to send long-term signals to the private market that stimulate sustained investment and technology innovation (Newell 2008).

Finally, the Kyoto Protocol may not provide sufficient incentives for countries to comply (Barrett 2008). Some countries' emissions have grown so fast since 1990 that it is difficult to imagine that they can undertake the emission mitigation or muster the political will and resources to purchase enough emission allowances or CDM credits from other countries to comply with their targets under the Protocol. In short, the enforcement mechanism negotiated for the Kyoto Protocol does not appear to induce policy responses consistent with agreed upon targets.

Alternative Policy Architectures for the Post-Kyoto Period

The book that launched this Project, *Architectures for Agreement: Addressing Global Climate Change in the Post-Kyoto World*, describes potential post-Kyoto international policy architectures as falling within three principal categories: targets and timetables, harmonized national policies, and coordinated and unilateral national policies (Aldy and Stavins 2007). The policy architectures that have subsequently been examined as part of the Harvard Project on International Climate Agreements—while still falling within the same three categories—also move substantially beyond what was articulated in our 2007 book. In this section, we provide an overview of these various types of international policy architectures. Later sections provide a more substantive discussion—based on current Project research—of specific climate policy architectures.

The book that launched this Project, Architectures for Agreement, describes potential post-Kyoto architectures within three principal categories: targets and timetables, harmonized national policies, and coordinated and unilateral national policies.

The first category—**targets and timetables**—is the most familiar. At its heart is a centralized international agreement, top-down in form. This is the basic architecture underlying the Kyoto Protocol: essentially country-level quantitative emissions targets established over specified time frames. An example of an approach that would be within this realm of targets and timetables, but would address some of the perceived deficiencies of the Kyoto Protocol, would be a regime that established emission targets based on formulas rather than specified fixed quantities. In lieu of *ad hoc* negotiations over emission caps, this formula approach would establish principles that can be translated into quantitative metrics for determining emission obligations. These formulas could be structured to have some of the appealing properties of indexed growth targets: setting targets as a function of a country's gross domestic product (GDP) per capita, for example. As countries became wealthier, their targets would become more stringent.[2] Conversely, when and if countries faced difficult economic periods, the stringency of their targets would be automatically reduced.

Such an approach does not divide the world simply into two categories of countries, as in the Kyoto Protocol. Rather, it allows for a continuous differentiation among the countries of the world while including all of them. In this way it reduces if not eliminates problems of emissions leakage, yet still addresses the key criterion of distributional equity and does so in a more careful, more sophisticated manner.

The second category—**harmonized domestic policies**—focuses more on national policy actions than on goals and is less centralized than the first set of approaches. In this case, countries agree on similar domestic policies. This reflects the view that national governments have much more control over their countries'

[2] This is similar to the graduation mechanism proposed by Michaelowa (2007). As developing countries realize growth in per capita income and per capita emissions on par with Annex I countries, they would be expected to take on binding emission targets.

policies than over their emissions. One example is a set of harmonized national carbon taxes.[3] With this approach, each participating country sets a domestic tax on the carbon content of fossil fuels, thereby achieving cost-effective control of emissions within its borders. Taxes would be set by nations, and nations would keep the revenues they generate. Countries could design their tax policies to be revenue-neutral—for example, by returning the revenues raised to the economy through proportional cuts in other, presumably distortionary taxes, such as those on labor and capital. In order to achieve global cost-effectiveness, carbon taxes would need to be set at the same level in all countries. This would presumably not be acceptable to the poorer countries of the world. Therefore, significant financial transfers—i.e., side payments from the industrialized world to the developing world—would most likely need to accompany such a system of harmonized carbon taxes to make it distributionally equitable and hence politically feasible.

The third and final category that we have used to classify potential post-Kyoto climate policy architectures is **coordinated and unilateral national policies**. This category includes the least centralized approaches that we have considered—essentially bottom-up policies that rely on domestic politics to drive incentives for participation and compliance (Pizer 2007). Although these approaches are the least centralized, they should not be thought of as necessarily the least effective. One example of a bottom-up approach—linking independent national and regional tradable permit systems—holds promise for being potentially effective and is examined below.

THE BALI ROAD MAP AND THE RESEARCH OF THE HARVARD PROJECT

At the December 2007 UN-sponsored climate change talks in Bali, Indonesia (COP 13), the international community reached agreement on the Bali Action Plan, a two-year road map to guide the negotiation of a framework that builds on and succeeds the Kyoto Protocol. This road map identifies many important issues that merit consideration and resolution in the design of an international climate policy architecture. While the Bali Action Plan is intended to yield an international framework at the 2009 climate change talks in Copenhagen, Denmark (COP 15), the road map also provides something of a framework for the international climate policy debate—and thus for actions undertaken domestically by participating countries—for some years beyond the Copenhagen meetings.

The Bali road map has informed the work of the Harvard Project on International Climate Agreements. The research program pursued in the second stage of the project addresses key issues in the road map with the aim of informing the design and evaluation of various policies that would comprise the next international climate regime. Specifically, Harvard Project research teams have brought their scholarship to bear on each of the five major elements of the Bali Action Plan: a long-term global climate policy goal, emission mitigation, adaptation, technology transfer, and financing.

> ***...Harvard Project research teams have brought their scholarship to bear on each of the five major elements of the Bali Action Plan...***

The Bali road map calls for a “shared vision for long-term cooperative action” that would include **“a long-term global goal for emission reductions”** as a means to implement the ultimate objective of the UNFCCC. The issue of setting long-term goals has received considerable attention by policy makers around the world. While we believe that the setting of a long-term global climate policy goal does not fall within the domain of scholars but rather should be decided by national leaders, our work can inform the identification and review of

[3] McKibbin and Wilcoxen (2007) advance the idea of parallel, unlinked domestic cap-and-trade programs as a way to move forward in international climate policy. Similar to Cooper (2008), they recommend a harmonized safety valve price mechanism in their domestic cap-and-trade programs.

various long-term emission objectives. The research undertaken for this project and in writing *Architectures for Agreement* identifies a variety of means for constructing a long-term international climate policy architecture—for example, Bosetti, *et al*. (2008) evaluated the long-term concentration and temperature implications of a half dozen approaches to climate policy. Additional analyses highlight the challenge of achieving long-term concentration goals with incomplete participation (Jacoby, *et al*. 2008, Blanford, *et al*. 2008) as well as the need to improve the technology base to make possible the achievement of ambitious long-term goals (Clarke, *et al*. 2008).

The role of emission mitigation continues to be central in international climate change negotiations. The Bali Action Plan calls for **"mitigation commitments or actions"** by developed countries and "mitigation actions" by developing countries, the latter through support for capacity-building and technology transfer from developed countries. In both cases, mitigation efforts should be "measurable, reportable, and verifiable," a requirement that is addressed by Project research aimed at evaluating various kinds of metrics for assessing mitigation activities (Fischer and Morgenstern 2008) and at describing a surveillance institution that can independently review the comparability of effort among participating countries (Aldy 2008). The Bali road map provides guidance for these efforts by identifying several specific forms of mitigation, including reducing deforestation and emissions from changes in land use, an issue investigated by Plantinga and Richards (2008). Sectoral approaches to mitigating emissions also receive attention in the Bali road map; accordingly, Sawa (2008) and Barrett (2008), among others, explore the prospects and pitfalls of a sector-specific approach. Finally, the negotiators in Bali also agreed on the general proposition that market-based approaches should be pursued—an issue that receives attention in many contributions to this project (Agarwala 2008, Cooper 2008, Ellerman 2008, Frankel 2008a, Jaffe and Stavins 2008, Karp and Zhao 2008, and Keohane and Raustiala 2008).

The Kyoto Protocol only mentions the word **"adaptation"** twice. In contrast, the Bali Road Map elevates the importance of this issue. Several contributors to this project recognize the need to effectively integrate climate change and economic development in the design of future climate change policy, including Cao (2008), Hall, *et al*. (2008), Somanathan (2008), and Victor (2008). For example, Barrett (2008) argues that efforts to transfer resources and facilitate the development of capacity in developing countries should play an important role in the next climate agreement. Newell (2008) points out that efforts to promote technological innovation can address adaptation needs while also identifying new ways to lower the cost of emission mitigation. Others maintain that promoting economic development, diversifying economic activity, and improving economic resilience, especially in agriculture, should guide climate change policy for the least developed countries (Barrett 2008, Somanathan 2008).

The Bali Road Map also focuses on the need to enhance **technology transfer** to developing countries. Given the rapid growth of emissions in these countries, technology transfer is needed to promote a more climate-friendly trajectory for economic development. The Harvard Project has explored potential reforms of the CDM that would focus on moving more technologies to developing countries (Teng, *et al*. 2008); it has also examined options for the design of clean technology funds oriented to developing countries (Hall, *et al*. 2008, Keeler and Thompson 2008). Of course, the success of technology transfer will depend on the development of new technologies—an issue addressed by Newell (2008) in exploring the potential for policy to induce more innovation on climate-friendly technologies. Along all of these dimensions of action—mitigation, adaptation, and technology transfer—the Project has assessed opportunities to **finance** a serious and sufficient climate policy program as called for in the Action Plan.

Finally, the Harvard Project has also advanced research on important issues that, while not identified in the Bali Road Map, are critical to the design of a successful post-2012 international climate policy architecture. This includes analysis of the equity implications of international climate agreements (Posner and Sunstein

2008); possible means for promoting compliance with internationally-negotiated commitments (Keohane and Raustiala 2008); avenues for structuring a dynamic, robust series of negotiations that can facilitate broad participation and agreement (Harstad 2008); and trade-climate interactions that could enhance an international climate policy agreement (Frankel 2008b).

PRINCIPLES FOR AN INTERNATIONAL FRAMEWORK

Before turning to some promising, alternative international climate policy architectures and key design issues and elements that have emerged over the course of the Project, we take note of certain principles that our research teams have identified as being important for the design of a scientifically sound, economically rational, and politically pragmatic post-2012 international climate policy architecture. Real progress will require addressing these principles (immediately below), which constitute some of the core premises underlying various policy architectures and design elements discussed later, in part 5 of the report.

Real progress will require addressing some of the core premises underlying various policy architectures and design elements.

Climate change is a global commons problem, and therefore a cooperative approach involving many nations—whether through a single international agreement or some other regime—will be necessary to address it successfully. Because greenhouse gases mix uniformly in the atmosphere, the location of emissions has no effect on the location of impacts, which are dispersed worldwide. Hence, it is virtually never in the economic interest of individual nations to take unilateral actions. This classic free-rider problem means that cooperative approaches are necessary (Aldy and Stavins 2008a).

Since sovereign nations cannot be compelled to act against their wishes, successful treaties should create adequate incentives for compliance, along with incentives for participation. Unfortunately, the Kyoto Protocol seems to lack incentives of both types (Barrett 2008, Karp and Zhao 2008, Keohane and Raustiala 2008).

Since carbon-intensive economies cannot be replicated throughout the world without causing serious disruption of the global climate, it will be necessary for all countries to move onto much less carbon-intensive growth paths. The rapidly emerging middle class in the developing world seeks to emulate lifestyles that are typical of the industrialized world and may be willing to depart from this goal only if the industrialized world itself moves to a more sustainable path (Agarwala 2008).

A credible global climate change agreement must be equitable. If past or present high levels of emissions become the basis for all future entitlements, the developing world is unlikely to participate (Agarwala 2008). Developed countries are responsible for more than 50% of accumulated stocks of anthropogenic greenhouse gas emissions, and their mitigation effort should reflect this responsibility (Agarwala 2008). In the long term, burdens of responsibility among nations should be the same or similar at the individual level—that is, equalized on a per capita basis (Agarwala 2008, Cao 2008, Frankel 2008a). However, if the goal is a more equitable distribution of wealth, approaches based on metrics other than per-capita-emissions can be better (Jacoby, *et al*. 2008, Posner and Sunstein 2008). It is also important to recognize and acknowledge that in the short term, developing countries may value their economic growth more than future, global environmental conditions (Victor 2008).

To stabilize greenhouse gases in the atmosphere at levels that avoid dangerous anthropogenic interference with the global climate, it will be necessary for key developing countries with rapidly growing economies to take on increasingly meaningful roles in reducing global emissions. This would be necessary even if all countries of the currently industrialized world were to reduce their emissions of greenhouse gases to zero

(Blanford, *et al*. 2008, Bosetti, *et al*. 2008, Cooper 2008, Hall, *et al*. 2008, Jacoby 2008). With appropriate negotiating rules (Harstad 2008), more countries can be brought on board. If developing countries were to agree to "graduate" to more stringent commitments once their per capita incomes reached certain thresholds, then the criteria of environmental performance, cost effectiveness, and international equity could—in principle—be achieved (Cao 2008, Frankel 2008a, Somanathan 2008).

The countries of the world—developing and developed alike—should recognize that climate change imperatives are not a tool that the developed world is using or could use to slow economic growth or political development in the developing world. More and better research on the impacts of global climate change on developing economies is essential. At the same time, developing countries should not "hide behind the poor" (Agarwala 2008); the burgeoning middle class in the developing world is on a path to exceed the population of developed countries, and their lifestyle and per capita emissions are similar to those in much of the developed world.

A credible global climate change agreement must be cost-effective. That means it should minimize the global welfare loss associated with reducing emissions (Aldy and Stavins 2008b, Ellerman 2008, Jaffe and Stavins 2008), and also minimize the risks of corruption in meeting targets (Agarwala 2008, Somanathan 2008). Because of the enormous impacts of natural and anthropogenic changes in forests on the global carbon cycle, it is important to provide a meaningful and cost-effective approach for promoting forest carbon sequestration in an international agreement (Plantinga and Richards 2008).

A credible global climate change agreement must bring about significant technological change. Given the magnitude of the problem and the high costs that will be involved, it is necessary to bring down mitigation costs over time through massive technological invention, innovation, diffusion, and utilization (Aldy and Stavins 2008c, Blanford, *et al*. 2008, Bosetti, *et al*. 2008, Clarke, *et al*. 2008, Newell 2008, Somanathan 2008). Rapid technology transfer from the developed to the developing world will be needed (Hall, *et al*. 2008, Keeler and Thompson 2008, Newell 2008, Somanathan 2008, Teng, *et al*. 2008).

A credible global climate change agreement should mitigate the risks of climate change across multiple paths of action. Broad participation in efforts to abate emissions, adapt to climate change, and promote technological innovation will all serve to reduce the damages associated with global climate change (Barrett 2008).

An effective global climate change agreement must be consistent with the international trade regime. A global climate agreement can lead to conflicts with international trade law, but it can also be structured to be mutually supportive of global trade objectives (Frankel 2008b, Harstad 2008).

A credible global climate change agreement must be practical. That means it needs institutional mechanisms for effective implementation (Agarwala 2008). Tremendous start-up costs are usually incurred in creating new institutions, and so—whenever appropriate—consideration should be given to maintaining existing institutions, such as the Clean Development Mechanism, and improving them rather than abandoning them (Hall, *et al*. 2008, Karp and Zhao 2008, Keeler and Thompson 2008, Teng, *et al*. 2008). Likewise, it should be recognized that most parts of the industrialized world have signaled their preference for the use of cap-and-trade mechanisms to meet their domestic emissions commitments (Jaffe and Stavins 2008).

A credible global climate change agreement must include mechanisms for judging whether countries have complied with their commitments. Various metrics can be employed to judge the equity and integrity of national commitments, including measures of emissions performance, reductions, or cost (Fischer and Morgenstern 2008). An international surveillance institution could provide credible, third party assessments of participating countries' efforts (Aldy 2008).

A credible global climate change agreement must be realistic. Unless there are tremendous technological breakthroughs, significantly reducing greenhouse gas emissions will be a slow and costly process (Agarwala 2008, Blanford, *et al*. 2008, Bosetti, *et al*. 2008, Jacoby, *et al*. 2008). The best agreements will be robust in the face of inevitable global economic downturns (McKibbin, *et al*. 2008).

Climate change negotiations need to include attention to short-term achievements, while also recognizing medium-term consequences and long-term goals. It is only in this way that an agreement can be both meaningful and relevant (Agarwala 2008, Harstad 2008, Karp and Zhao 2008).

Because no single approach guarantees a sure path to ultimate success, the best strategy may be to pursue a variety of approaches simultaneously. Although a post-2012 agreement under the UNFCCC may be at the core of a post-Kyoto regime, other venues—whether bilateral treaties, or G8+5, or L20 accords—should continue to be explored, as additional agreements and arrangements may be necessary (Hall, *et al*. 2008).

PROMISING INTERNATIONAL CLIMATE POLICY ARCHITECTURES

Of the 28 research initiatives undertaken as part of the Harvard Project on International Climate Agreements, eight propose complete international policy architectures for the post-2012 period, fifteen examine key design issues and elements, and five provide quantitative modeling of alternative policy architectures or allocations of responsibility. In this part of the Interim Report, we highlight four potential architectures. One is within the category of targets and timetables: formulas for dynamic national targets for all countries. Two are within the category of harmonized domestic policies: a portfolio of international treaties and harmonized national carbon taxes. The fourth is within the category of coordinated and unilateral national policies: linkage of national and regional tradable permit systems.

...the decision to adopt a particular architecture is ultimately a political one that must be reached by the nations of the world, taking into account a complex array of factors.

The Harvard Project does not currently endorse a single approach to international climate policy because we recognize that the decision to adopt a particular architecture is ultimately a political one that must be reached by the nations of the world, taking into account a complex array of factors. Rather, we describe four architectures—every one of which has advantages as well as disadvantages—because each is promising in some regards and because each raises important issues for consideration.

Targets and Timetables: Formulas for Evolving Emission Targets for All Countries[4]

This targets-and-timetables proposal offers a framework of formulas that yield numerical emissions targets for all regions of the world in all decades of this century (Frankel 2008a). National and regional cap-and-trade systems for greenhouse gases would be linked in a way that allows trading across firms and sources (Jaffe and Stavins 2008), not among nations *per se* (as in Article 17 of the Kyoto Protocol). Such a global trading system would be roughly analogous to the system already established in the European Union, where sources rather than participating nations engage in trading (Ellerman 2008).[5]

[4] This proposed architecture was developed by Frankel (2008a) and supplemented by Aldy and Stavins (2008b), Cao (2008), Ellerman (2008), and Jacoby, *et al*. (2008). Bossetti, *et al*. (2008) provide an economic analysis of this and several other potential architectures.

[5] For an examination of the possible role and design of cap-and-trade and other tradable permit systems as part of an international policy architecture, see Aldy and Stavins (2008b).

The formulas are based on what is possible politically. This approach reflects a belief that many of the usual science- and economics-based proposals for future emissions paths are not dynamically consistent—that is, future governments will not necessarily abide by commitments made by today's leaders. Several Project researchers have observed that when participants in the policy process discuss climate targets, they typically pay little attention to the difficulty of finding mutually acceptable ways to share the economic burden of emissions reductions (Bosetti, *et al*. 2008, Jacoby, *et al*. 2008).

Many proposals for a post-Kyoto climate change regime are based either on a scientifically-based environmental goal—for example, emissions targets driven by the goal of capping global concentrations at 450 ppm in 2100—or on an economic analysis—for example, weighing the costs of aggressive short-term cuts against long-term environmental benefits. By contrast, the architecture proposed here features a century-long path of emission targets for all countries that is more practical because it reflects political realities, rather than scientific or economic considerations alone. It attempts to solve the most serious problems of the Kyoto Protocol: the absence of targets extending as far as 2100, the lack of participation by the United States and key developing countries, and the lack of motivation for countries to abide by their commitments.

...the architecture proposed here is more practical because it reflects political realities, rather than scientific or economic considerations alone.

This formula-based architecture is premised on four important political realities. First, the United States may not commit to quantitative emissions targets if China and other major developing countries do not commit to quantitative targets at the same time. This is because of concerns about economic competitiveness and carbon leakage. Second, China and other developing countries are unlikely to make sacrifices different in character from those made by richer countries that have gone before them. Third, in the long run, no country can be rewarded for having "ramped up" its emissions high above 1990 levels. Fourth, no country will agree to bear excessive cost.

The proposal calls for an international agreement to establish a global cap-and-trade system, where emissions caps are established using a set of formulas that assign quantitative emissions limits to countries in every year until 2100. Political realities inform the formulas. First, developing countries are not asked to bear any cost in the early years. Second, developing countries are not asked to make any sacrifice that is different from the sacrifices of industrialized countries, accounting for differences in income. Third, countries are not asked to accept targets that cost more than 1% of GDP in present value, or more than 5% of GDP in any given year.

Future emissions caps are determined by a formula that incorporates three elements: a progressivity factor, a latecomer catch-up factor, and a gradual equalization factor. The progressivity factor requires richer countries to make more severe cuts relative to their business-as-usual emissions. The latecomer catch-up factor requires nations that did not agree to binding targets under the Kyoto Protocol to make gradual reductions to account for their additional emissions since 1990. This factor prevents latecomers from being rewarded with higher targets, or from being given incentives to ramp up their emissions before signing on to the agreement. Finally, the gradual equalization factor addresses the complaint that rich countries are responsible for a majority of the accumulated anthropogenic greenhouse gases currently in the atmosphere. During each decade of the second half of the century, this factor moves per capita emissions in each country a small step in the direction of the global average of per capita emissions.[6]

[6] This is similar to Cao's (2008) "global development rights" (GDR) burden-sharing formula and is consistent with calls for movement toward per capita responsibility by Agarwala (2008). On the other hand, it contrasts with the analyses of Jacoby, *et al.* (2008) and Posner and Sunstein (2008). Under Cao's (2008) GDR formula, the lion's share of the abatement burden would fall on the industrialized world in the short term, with developing countries initially accepting a small but increasing share over time, such that by 2020 fast-growing economies such as China and India would take on significant burdens.

Under the formulas, rich nations would immediately begin to make emissions cuts. At the same time, developing countries would agree to binding emissions targets, which—importantly—would follow their business-as-usual emissions for the first decades.[7] Such a commitment precludes carbon leakage and competitiveness losses, while still preserving the ability of developing countries to grow their economies. It also allows developing countries to raise revenues by selling emission permits. In later decades, once developing countries cross certain income and emissions thresholds, their emissions targets would begin to decrease according to a numerical formula. However, targets would change in a way that ensures required emissions cuts for developing countries are no greater than the cuts made by rich nations earlier in the century, accounting for differences in per capita income, per capita emissions, and baseline economic growth. Economic simulations indicate that the total economic costs from emission mitigation under this approach would be below 1% of gross world product.

The strength of this approach, and the glue that holds it together, is that every country is given reason to feel that it is only doing its fair share. Importantly, without such a self-reinforcing framework for allocating the abatement burden, announcements of distant future goals may not be credible and so may not have desired effects on investment. The basic architecture of this proposal—a decade-by-decade sequence of emission targets determined by a few principles and formulas—is also flexible enough that it can accommodate major changes in circumstances during the course of the century.

The strength of this approach, and the glue that holds it together, is that every country is given reason to feel that it is only doing its fair share.

Harmonized Domestic Policies: A Portfolio of International Treaties[8]

This second proposal we highlight is for a very different sort of architecture than that of the Kyoto Protocol. Rather than attempting to address all sectors and all types of greenhouse gases under one unified regime, this approach envisions a system of linked international agreements that separately address various sectors and gases; as well as key issues, including adaptation and technology research and development (R&D); plus last-resort remedies, such as geoengineering and air capture of greenhouse gases.

First, sector-level agreements would provide global standards for specific sectors or categories of greenhouse gas sources, an example being the aluminum industry. Developing countries would not be exempted from these standards, but would be offered financial aid to help them comply. Trade restrictions would be used to enforce agreements governing trade-sensitive sectors where such sanctions can be both effective and credible.

...this approach envisions a system of linked international agreements that separately address various sectors and gases; as well as key issues...

Such a sectoral approach could have the advantage that it protects against cross-contamination: if policies designed for a given sector prove ineffective, their failure need not drag down the entire enterprise. Similar arguments can be made for separate approaches to different types of greenhouse gases: the success of the Montreal Protocol in reducing emissions of certain types of fluorocarbons, for example (compared with the difficulty of achieving meaningful reductions in broad classes of greenhouse gas emissions), highlights the leverage that can be lost over any one category of gases when all of them are pooled together.

[7] Somanathan (2008) would argue against including developing countries in the short term, even with targets equivalent to BAU, as recommended in this proposal. We discuss alternative burden-sharing arrangements below.

[8] This proposed architecture was developed by Barrett (2008), and supplemented by Newell (2008) on research and development policies, by Sawa (2008) on sectoral approaches, and by economic modeling from Bosetti, *et al*. (2008).

In general, sectoral approaches in a future climate agreement can offer some advantages (Sawa 2008). First, sectoral approaches could encourage the involvement of a wider range of countries, since incentives could be targeted at specific industries in those countries. Second, sectoral approaches can directly address concerns about international competitiveness, since industries could make cross-border commitments to equitable targets, mitigating concerns about unfair competition in energy-intensive industries and reducing the potential for emissions leakage. Third, sectoral approaches can promote consensus and reduce uncertainty: because emissions targets could be calculated based on an assessment of available technologies there would be greater certainty about the marginal costs of abatement. Fourth, sectoral approaches can be designed to promote technology development and transfer.

It should also be recognized, however, that sectoral approaches have some significant problems (Sawa 2008). First, it may be difficult to negotiate an international agreement using this approach if negotiators are reluctant to accept the large transaction costs associated with collecting information and negotiating at the sector level. Countries that are already participating in emission trading schemes may tend to avoid any approach that creates uncertainty about their existing investments. Second, a sectoral approach may also complicate negotiations by allowing countries to raise competitiveness issues that are not directly related to carbon restrictions. Third, a sectoral approach would reduce cost-effectiveness relative to some other approaches. For example, compared with an economy-wide cap-and-trade system that maximizes cost-effectiveness by first exploiting the abatement opportunities that have the lowest costs, a sectoral approach would force reductions upon specific sectors. Finally, it is difficult for a sectoral approach to achieve high levels of environmental effectiveness, because it does not induce mitigation actions from all sectors.

A second component of this overall architecture of multiple international agreements could focus on research and development. The technology challenge implicit in successfully addressing climate change along with our other energy problems is enormous. It may require a portfolio of strategies for reducing barriers and increasing incentives for innovation across international agreements and institutions in a way that maximizes the impact of scarce public resources and effectively engages the capacities of the private sector (Newell 2008).[9] One approach would be to link R&D obligations with emission reduction policies. For example, an agreement could require that all new coal-fired power stations be fitted with carbon capture and storage, with this obligation binding on individual countries as long as the treaty's minimum participation conditions were met. Such an agreement would reduce incentives for free-riding and could directly spur R&D investments in areas where countries and firms might otherwise be likely to under-invest.

Third, adaptation assistance to developing countries could be included, consistent with the obligation articulated in Article 3 of the UNFCCC. All nations have strong incentives to adapt, but only rich countries have the resources and capabilities to insure against the consequences of climate change. In fact, rich countries may be tempted to substitute investments in adaptation—the benefits of which can be appropriated locally—for investments in mitigation, the benefits of which are distributed globally. If so, this would leave developing countries even more exposed to climate risks and tend to widen existing disparities. Critical areas for investment include agriculture and tropical medicine. The Kyoto Protocol attempts to address this issue by taxing transactions under the CDM to support an adaptation fund, but this approach has several problems, among them that it disconnects funding levels from need and penalizes mitigation efforts.

Fourth, geoengineering and air capture could play roles in the portfolio of options available to manage climate risks. Geoengineering strategies attempt to limit warming by reducing the amount of solar radiation that reaches the Earth's surface—the most commonly discussed approach in this category involves throwing

[9] In the section below on key design issues, we focus on technology transfer as a key design issue for any international climate policy architecture. Bosetti, *et al*. (2008) analyze the costs and effectiveness of R&D strategies compared with alternative architectures.

particles into the atmosphere to scatter sunlight. Because this form of geoengineering could be implemented relatively cheaply, the greater challenge may be to prevent nations from resorting to it too quickly or over other countries' objections. Geoengineering could also serve as an insurance policy in case refinements in climate science over the next several decades suggest that climate change is much worse than currently believed and that atmospheric concentrations may have already passed important thresholds for triggering abrupt and catastrophic events.

Air capture refers to strategies for removing carbon from the atmosphere. Possible options include fertilizing iron-limited regions of the oceans to stimulate phytoplankton blooms or using a chemical sorbent to directly remove carbon from the air. The latter approach would be very costly and is unlikely to be implemented unilaterally. From an overall risk reduction perspective, further R&D into both geoengineering and air capture would seem justified, along with further efforts to develop an international agreement around the potential use of these options should the need arise.

Such a multi-track climate treaty system is hardly perfect, but could offer advantages over targets-and-timetable approaches, which aggregate all types of emissions from all sectors and focus primarily on emissions mitigation while tending to ignore other options for managing climate risks. By avoiding the enforcement problems of an aggregate approach and by taking a broader view of risk reduction, the portfolio approach could provide a more effective and flexible response to the long-term challenge posed by climate change.

Harmonized Domestic Policies: A System of National Carbon Taxes[10]

This architecture consists of harmonized domestic taxes on emissions of greenhouse gases from all sources. The charge would be internationally adjusted from time to time, and each country would collect and keep the revenues it generates (Cooper 2008). The starting premise for this approach is that seriously addressing carbon dioxide emissions requires a worldwide approach. Since decisions to consume goods and services made with fossil fuels are made on a daily basis by more than a billion households and firms around the world, the most effective way to reach all these decision makers is by changing the prices they pay for these goods and services. If CO_2-emitting activities are to be reduced, then the price of engaging in those activities must be increased. Levying a charge on CO_2 emissions does that directly.

> ***The starting premise for this approach is that seriously addressing carbon dioxide emissions requires a worldwide approach.***

It has been argued that carbon taxes would have several advantages over the chief alternative price-based approach, a cap-and-trade system (Cooper 2008). First, under a cap-and-trade scheme, governments would need to allocate valuable emission permits to domestic firms or residents, which could foster corruption in some countries. A universal carbon tax would avoid such problematic transfers. Likewise, a carbon tax minimizes bureaucratic intervention and the necessity for a financial trading infrastructure (Agarwala 2008). Second, a carbon charge would generate significant revenues that could be used to increase government spending or reduce other taxes, although it should be noted that the same is true of a cap-and-trade system that auctions allowances. In any event, some portion of revenues from a carbon tax might also be used to finance climate-relevant research and development. Third, a carbon tax may be less objectionable to developing nations than an emissions cap (Yue 2007).[11] Fourth, any international climate regime requires some means for evaluating

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[10] This proposed architecture was developed by Cooper (2008) and supplemented by Fischer and Morgenstern (2008) and Aldy (2008) on measurement issues, McKibbin, *et al*. (2008) on a hybrid of this approach, and economic modeling by Bosetti, *et al*. (2008).

[11] China's 2007 National Program on Climate Change indicated that any near-term emissions mitigations will be accomplished using domestic policies designed to address energy efficiency, renewable and nuclear energy, and energy security. The document also indicated that in the longer term, China might be willing place a price on carbon emissions using more direct mechanisms such as an emissions tax or cap-and-trade system (Jiang 2008).

national commitments and performance (Fischer and Morgenstern 2008). A carbon tax system provides a straightforward and useful metric since the marginal cost of abatement activities is always equivalent to the tax rate itself.

Since several economies, most notably the European Union, have embarked on a cap-and-trade system, Cooper investigates whether cap-and-trade systems and charge or tax systems can co-exist. He concludes that the answer is yes, provided that several conditions are met. First, trading prices under the cap-and-trade system should average no less than the internationally agreed carbon charge. Second, if the permit trading price fell below the agreed global tax by some percent for more than a certain period of time, trading partners could be allowed to levy countervailing duties on imports from countries with a low permit trading price. Third, countries could not provide tax rebates on their exports and countries with a cap-and-trade system could not freely distribute emission permits—that is, all permits would have to be auctioned.

Since climate change is a global problem, the geographic coverage of any carbon tax system should be as broad as possible. The initial scheme need not cover all countries, but it should cover the countries that account for the vast majority of world emissions. Additionally, the tax should cover all the significant greenhouse gases, insofar as is practical. The level of the tax would be set by international agreement and could be subject to periodic review every five or ten years. Initially, it should be high enough to affect behavior significantly, but not so high as to lead to unwarranted adjustments.

To minimize administrative costs, the charge should be assessed at upstream points in the energy supply chain, that is, on the carbon content of fossil fuels. For example, the carbon content of oil should be taxed at refineries, natural gas should be taxed at major pipeline collection points, and coal should be taxed at mine heads or rail or barge collection points. All but the poorest nations should have sufficient administrative capacity to administer such a plan. Fortunately, countries lacking this capacity are also likely to have low emissions.

A carbon tax treaty would need to include monitoring and enforcement measures. The International Monetary Fund could assess whether signatory nations have passed required legislation and set up the appropriate administrative machinery to implement the tax (Agarwala 2008). If a country were significantly and persistently out of compliance, its exports could be subject to countervailing duties in importing countries. Non-signatory countries could also be subject to countervailing duties. This possibility would provide a potent incentive for most countries to comply with the agreement, whether or not they were formal signatories.[12]

Each country would retain the revenues it collects from the carbon charge, and could use those revenues to reduce other taxes or increase government expenditures. The macroeconomic impact of the carbon charge could be kept low by introducing the charge gradually, at a pace consonant with increased expenditures or reductions in other taxes. The revenues and economic impacts of a carbon charge would be substantial, but not overwhelming. For example, in 2015, a charge of $15 per ton of CO_2 would generate approximately $500 billion in world-wide revenues, about 0.7% of expected gross world product in that year.[13]

A timely concern centers on how an international climate policy architecture might perform in the presence of unexpected macroeconomic shocks, whether positive shocks to economic growth in developing countries or severe financial distress in the global economy. In the absence of such unanticipated economic shocks, three regimes are similar—in principle—in their ability to reduce emissions efficiently: global carbon cap-and-

[12] In the section on key design issues, below, we discuss the relationship of climate policy architectures with international trade law and practices.

[13] For a thorough economic assessment of the implications of a system of harmonized domestic carbon taxes, see Bosetti, *et al*. (2008).

trade, globally harmonized domestic carbon taxes; and a hybrid system of national long-term permit trading with a globally-coordinated maximum price for permits in each year (a safety valve). However, these three systems differ in how they would transmit economic disruptions from one economy to another (McKibbin, *et al*. 2008). Whereas a cap-and-trade regime would be counter-cyclical, dampening an economic slowdown as carbon prices fall, it also fails to capture the opportunity for significant additional low-cost emissions reductions during a global economic downturn. On the other hand, despite the merits of domestic carbon taxes as a means to address CO_2 emissions, there appears to be a lack of political will in most countries to adopt this approach.

Coordinated National Policies: Linkage of National and Regional Tradable Permit Systems[14]

A new international policy architecture may be evolving on its own based on the reality that tradable permit systems, such as cap-and-trade systems, are emerging worldwide as the favored national and regional approach. Prominent examples include the European Union's Emission Trading Scheme; the Regional Greenhouse Gas Initiative in the northeastern United States; and systems in Norway, Switzerland, and other nations; plus the existing global emission-reduction-credit system, the CDM. Moreover, cap-and-trade systems now appear likely to emerge as the chosen approach to reducing greenhouse gas emissions in an additional set of industrialized countries, including Australia, Canada, Japan, and the United States.

The proliferation of cap-and-trade systems and emission-reduction-credit systems around the world has generated increased attention and increased pressure—both from governments and from the business community—to link these systems. By linkage, we refer to direct or indirect connections between and among tradable permit systems through the unilateral or bilateral recognition of allowances or permits.[15]

The benefits of linkage include, first of all, significant cost savings.

The benefits of linkage include, first of all, significant cost savings. Linkage produces cost savings in the same way that a cap-and-trade system reduces costs compared to a system that separately regulates individual emission sources—that is, it substantially broadens the pool of lower-cost compliance options available to regulated entities. In addition, linking tradable permit systems at the country level reduces overall transaction costs, reduces market power (which can be a problem in such systems), and reduces overall price volatility.

There are also some legitimate concerns about linkage. Most important is the automatic propagation of program elements that are designed to contain costs, such as banking, borrowing, and safety valve mechanisms. If a cap-and-trade system with a safety valve is directly linked to another system that does not have a safety valve, the result will be that both systems now share the safety valve. Given that the European Union seems opposed to using a safety valve in its emission trading scheme, and given that a safety valve could be included in a future emission trading system in the United States, this concern about the automatic propagation of cost-containment design elements is a serious one.

More broadly, linkage will reduce individual nations' control over allowance prices, emission impacts, and other consequences of their systems. However, it is important to recognize that this loss of control over domestic prices and other effects of a cap-and-trade policy is simply a special case of the general proposition that nations, by engaging in international trade through an open economy, lose some degree of control over domestic prices. Indeed, the only way for a nation to have complete control over prices within its borders,

[14] This proposed architecture was developed by Jaffe and Stavins (2008) and supplemented by Ellerman (2008) on the European Union Emissions Trading Scheme as a potential global model, Keohane and Raustiala (2008) on buyer liability, Hall, *et al*. (2008) and Victor (2008) on the importance of domestic institutions, and by economic modeling from Bosetti, *et al*. (2008).

[15] As Ellerman (2008) explains, to some degree the European Union Emission Trading Scheme can serve as a prototype for linked national systems.

whether the prices at issue are for shoes or emission allowances, is to close its borders to international trade, thereby impoverishing its own economy and citizenry.

Nevertheless, because concerns about the automatic propagation of program design elements are significant, some advance harmonization of key elements will likely be necessary prior to directly linking cap-and-trade systems across international borders. The need for harmonization will likely make it challenging to establish direct two-way links between different cap-and-trade systems.

...linkage may [become]... a core element of a bottom-up, de facto international policy architecture

Importantly, there are ways to gain the benefits of linkage without the downside of having to harmonize systems in advance. Any link between a cap-and-trade system and an emission-reduction-credit system, such as the CDM, is of necessity one-way in the sense that the emission-reduction-credit system has no use for allowances. If two cap-and-trade systems both link with the same emission-reduction-credit system, then the two cap-and-trade systems are indirectly linked with one another. All of the benefits of linkage occur: the cost-effectiveness of both cap-and-trade systems is improved and both gain from more liquid markets that reduce transaction costs, market power, and price volatility. At the same time, the automatic propagation of key design elements from one cap-and-trade system to another is much weaker when the systems are only indirectly linked through an emission-reduction-credit system.

Such indirect linkage through the CDM is already occurring, because virtually all cap-and-trade systems that are in place, as well those that are planned or contemplated, allow for CDM offsets to be used (at least to some degree) to meet domestic obligations. Thus, indirectly linked, country- or region-based cap-and-trade systems may already be evolving into the *de facto*, if not the *de jure*, post-Kyoto international climate policy architecture.

Of course, reliance on CDM offsets also gives rise to concerns, especially as regards the environmental integrity of some of those offsets.[16] Some have recommended that a system of buyer liability (rather than seller or hybrid liability) would endogenously generate market arrangements—such as reliable ratings agencies and variations in the price of offsets according to perceived risks—that would help to address these concerns, as well as broader issues of compliance (Keohane and Raustiala 2008). These features would in turn create incentives for compliance without resorting to ineffective inter-state punishments. In addition, this approach gives sellers strong incentives to maintain permit quality so as to maximize the monetary value of these tradable assets.

While, in the near-term, linkage may continue to grow in importance as a core element of a bottom-up, *de facto* international policy architecture, in the longer term, linkage could play several roles. A set of linkages, combined with unilateral emissions reduction commitments by many nations, could function as a stand-alone climate architecture. Such a system would be cost-effective, but might lack the coordinating mechanisms necessary to achieve meaningful long-term environmental results. Another possibility is that a collection of bottom-up links may eventually evolve into a comprehensive, top-down agreement. In this scenario, linkages would provide short-term cost savings while serving as a natural starting point for negotiations leading to a top-down agreement.[17] The top-down agreement might continue use of linked cap-and-trade programs to reduce abatement costs and improve market liquidity.

[16] See section on key design issues below for an examination of ways to reform the Clean Development Mechanism.

[17] Carraro (2007) and Victor (2007) also describe the potential for such an organic emergence of trading from linking a small set of domestic trading programs. This evolution would be analogous to the experience in international trade in goods and services, in which a small number of countries initially reached agreement on trade rules governing a small set of goods. As trust built on these initial experiences, trading expanded to cover more countries and more goods, a process that eventually provided the foundation for the top-down World Trade Organization.

A post-2012 international climate agreement could include several elements that would facilitate future linkages among cap-and-trade and emission-reduction-credit systems. For example, it could establish an agreed trajectory of emissions caps (Frankel 2008a) or allowance prices, specify harmonized cost-containment measures, and establish a process for making future adjustments to key design elements. It could also create an international clearinghouse for transaction records and allowance auctions, provide for the ongoing operation of the CDM, and build capacity in developing countries. If the aim is to facilitate linkage, a future agreement should also avoid imposing "supplementarity" restrictions that require countries to achieve some specified percentage of emission reductions domestically.

KEY DESIGN ISSUES IN INTERNATIONAL POLICY ARCHITECTURE

Regardless which overall international policy architecture is ultimately chosen, a number of key design issues will stand out as particularly important. In this part of the report, we identify some of the lessons identified by our 28 research teams with regard to five issues and elements for a post-2012 international agreement: burden-sharing, technology transfer, CDM reform, addressing deforestation, and making global climate policy compatible with global trade policy. We infuse all five of these discussions with attention to the relationship between global climate policy and economic development.

Burden-Sharing in an International Climate Agreement

The most challenging aspect of establishing a post-Kyoto international climate regime will be reaching agreement on burden-sharing among nations that will be explicitly or implicitly part of the adopted regime. In this context, the interface between global climate policy and economic development becomes particularly important.

> ***The most challenging aspect of establishing a post-Kyoto international climate regime will be reaching agreement on burden-sharing among nations...***

One approach to thinking about how to share the burden is to start by focusing on what is politically possible, and to identify an allocation of responsibility—with appropriate changes over time—that makes every country feel that it is doing only its fair share (Frankel 2008a). The architecture described above—dynamic formulas combined with cap-and-trade—would set national emissions caps through a set of formulas that assign quantitative emissions limits to countries in every year through 2100. Importantly, developing countries would not be asked to assume any cost burden at all in the early years and over time would not be asked to make sacrifices that are different from the sacrifices of industrialized countries, after accounting for differences in income.

A common thread in many discussions about long-term burden-sharing is the desirability of gradually moving all countries toward equal per capita emissions.[18] As a long-term outcome this would be consistent with what many people, from diverse perspectives, regard as ultimately equitable (Agarwala 2008, Cao 2008, Frankel 2008a), although others have noted that if the goal is greater equity in the distribution of wealth, directly targeting wealth redistribution would be more effective (Posner and Sunstein 2008).

[18] Somanathan (2008) argues that although an effective solution to climate change will require the cooperation of developing countries, achieving near-term GHG reductions in these countries will be neither feasible nor desirable because of their other priorities for economic and social development.

More broadly, the three-element formula described in the discussion of formulas for evolving emissions targets above (Frankel 2008a) has the virtue of recognizing the responsibility of industrialized countries for their historic greenhouse gas emissions (Agarwala 2008, Somanathan 2008) and does not reward countries for previous lack of action. Furthermore, this time-path of evolving commitments for developing countries reflects the reality that, in the short term, developing countries value their economic growth more than future environmental conditions (Victor 2008). But by providing for increased participation by developing countries over time, this approach also recognizes that it will be impossible to stabilize atmospheric greenhouse gas concentrations unless rapidly growing developing countries take on an increasingly meaningful role in reducing global emissions (Blanford, *et al*. 2008, Bosetti, *et al*. 2008, Clarke, *et al*. 2008, Cooper 2008, Hall, *et al*. 2008, Jacoby, *et al*. 2008).

Technology Transfer in an International Climate Agreement[19]

Achieving long-term climate change policy goals will require a remarkable ramp-up in the innovation and deployment of energy-efficient and low-carbon technologies in an environment that is already experiencing substantial increases in investment (Aldy and Stavins 2008c, Newell 2008).[20] Transitioning away from fossil fuels as the foundation of industrialized economies and as the basis for development in emerging economies and least developed countries will likely necessitate a suite of policies to provide the proper incentives for technological change (Somanathan 2008). These policies will need to drive the invention, innovation, commercialization, diffusion, and utilization of climate-friendly technologies. Two principal categories of policies are potentially important: international carbon markets and other pricing strategies; and non-price mechanisms, including various means of technology transfer to developing countries and coordinated innovation and commercialization programs.

International Carbon Markets and Technology Transfer

The most powerful tool for accelerating the development and deployment of climate-friendly technologies will be policies that affect the current and expected future prices of fossil fuels relative to lower-carbon alternatives. By setting a price on emissions of greenhouse gases and thereby raising the price of conventional fossil fuels and energy-intensive production practices, these policies—which are at the core of several proposed international climate policy architectures—will induce investment in less emission-intensive technologies. Cap-and-trade programs and emission reduction credit systems, such as the CDM, can thus finance emission mitigation projects in industrialized and developing countries alike. The same would be true of a system of harmonized domestic carbon taxes.

The most powerful tool for accelerating the development and deployment of climate-friendly technologies will be policies that affect the current and expected future prices of fossil fuels relative to lower-carbon alternatives.

Given the long lifetimes of many emission-intensive capital assets—power plants may operate 50 years or more, building shells may last 100 years—long-term carbon price signals may be necessary to allow the owners of such capital to form appropriate expectations and alter the nature of their investments. Blunt policy instruments such as performance standards or bans on carbon-intensive products can also induce innovation, but such approaches are typically less efficient.

[19] Below we address technology transfer in the context of efforts to reform the Clean Development Mechanism.

[20] The International Energy Agency forecasts more than $20 trillion of investment in the global energy infrastructure between now and 2030. Some of this accelerated investment is evident in China, where one out of six coal-fired power plants is less than three years old. But the investment is not universal; populations in least developed countries still suffer from lack of access to power and basic energy poverty that can inhibit advances along a variety of development measures (Aldy and Stavins 2008c).

Pricing carbon can leverage foreign direct investment to promote less carbon-intensive development. For example, the CDM grants emission reduction credits for projects in developing countries that reduce emissions relative to a hypothetical business-as-usual baseline. These credits can then be used by firms that are covered by cap-and-trade programs in developed countries to meet their compliance obligations. Some CDM projects have resulted in the deployment of renewable power, such as wind farms, as an alternative to coal-fired power generation. Other CDM projects have been criticized for rewarding minor process modifications that do not involve substantial investment in new technologies, such as the manufacture of fluorinated refrigerants. Some countries may also consider CDM participation a substitute for taking further emission mitigation efforts or even use the CDM to justify weakening policies in other areas. More broadly, reforming the CDM could facilitate more substantial transfers of technology (Keeler and Thompson 2008, Hall, *et al*., 2008, Teng, *et al*. 2008). We consider such approaches below.[21]

In any event, putting a price on carbon may not facilitate new investment flows and associated technology transfers to developing countries with weak market institutions. If a country has difficulty attracting capital generally, changing the relative prices of carbon-intensive and carbon-lean capital will not resolve this problem. In this case, additional policy efforts would be required to stimulate the transfer of technology to developing countries. Also, while putting a price on carbon will draw more resources into low-carbon technology R&D, it will not be sufficient to fully overcome the general disincentive for private sector investments in R&D. This is because undertaking R&D effectively produces new knowledge, and this knowledge is a public good. Once the knowledge exists, it is difficult for firms to prevent others from sharing its benefits (although patent law provides some protection). Since innovating firms cannot capture all the benefits of their R&D efforts, they tend to under-invest in such activities. Thus, additional policies are needed to promote the public and private sector innovation that will be required to ensure that a next generation of climate-friendly technologies is available for deployment.

Additional Technology Policy in Post-2012 International Climate Agreements

The next international climate agreement can provide several mechanisms to facilitate the development and deployment of climate-friendly technologies (Aldy and Stavins 2008c, Newell 2008, Somanathan 2008). First, the agreement can provide a venue for countries to pledge resources for technology transfer and for R&D activities (Newell 2008). The agreement could also codify such pledges as commitments, on par with commitments to limit emissions as in Annex B of the Kyoto Protocol. Besides negotiating a given level of financial commitment, developed and emerging countries could explicitly articulate how they mean to meet their commitments, thereby promoting credibility and trust in the agreement. This could take the form of identifying a specific revenue stream (for example, auction revenues from a cap-and-trade program) that would be adequate and reliable for supporting financial pledges.

Financing technology transfer will require coordination and agreement on principles for allocating resources. An institutional home for clean technology funds may be necessary, and the international policy community will need to decide whether to centralize such efforts in a new institution, rely on an existing international institution, or manage the program through a decentralized array of national institutions. Likewise, some agreement on the means for coordinating R&D activities will have to be considered in identifying the appropriate institutional design.

A framework for coordinating and augmenting climate technology R&D could be organized through a UNFCCC Expert Group on Technology Development, supported by the International Energy Administration

[21] An alternative to reforming the CDM that could also facilitate greater technology transfer is to establish climate accession deals with individual developing countries (Victor 2008). We discuss this approach below.

(Newell 2008). Broadening IEA participation to include large non-OECD energy consumers and producers could also facilitate such coordination. An agreement could include a process for reviewing country submissions on technology development and for identifying redundancies, gaps, and opportunities for closer collaboration. A fund for cost-shared R&D tasks and international technology prizes could be established to provide financing for science and innovation objectives that are best pursued in a joint fashion. The agreement could also include explicit targets for increased domestic R&D spending on greenhouse gas mitigation.

An independent mechanism for reviewing policies that affect technological development and deployment may benefit these efforts. Rigorous, third-party review of all nations' policies and financing could provide a strong foundation for coordinated, international efforts by providing an authoritative assessment of the comparability of effort among participating countries. This could include reviews of financial contributions by large countries, analyses of the effectiveness of technology transfer activities, and assessments of the best policy practices being implemented around the world. Such reviews could be undertaken by an existing international institution or may require the creation of a new, professional bureaucracy focused on this single, surveillance task (Aldy 2008). The same institution or mechanisms could also help to assess the comparability of efforts on mitigation, adaptation, and other elements of the international agreement.

In addition to increased incentives, barriers to climate-friendly technology transfer could be lowered through a World Trade Organization (WTO) agreement to reduce tariff and non-tariff barriers to trade in environmental goods and services (Newell 2008). Development and harmonization of technical standards—by international standards organizations in consultation with the IEA and WTO—could further reduce impediments to technology transfer and accelerate the development and adoption of climate-friendly innovations.

Strategies are also needed to resolve impediments to knowledge transfer in the context of policies for the protection of intellectual property. To that end, an Expert Group on Technology Development, the World Intellectual Property Organization (WIPO), and the WTO could work jointly to develop recommendations for addressing technology development and transfer opportunities and addressing intellectual property issues (Newell 2008). A fund could be established in WIPO or another appropriate body for related technical assistance, capacity building, and possibly to purchase intellectual property or cover related costs.

Finally, an international climate policy architecture could provide positive incentives for developing and emerging economies to pursue good policy practice. For example, conditioning access to climate technology funds on the implementation of domestic "no regrets" climate policies could substantially increase the "climate return" to technology fund resources. Alternatively, access to clean technology funds could be scaled based on the extent of policy action in developing and emerging economies—as governments implement more climate-friendly policies they could access a larger pool of resources. Such determinations could be made on the basis of independent, expert reviews of countries' climate and energy policies

Reforming the Clean Development Mechanism

One of the important principles identified by our research teams is that because there are very large start-up costs for creating new institutions, consideration should be given to maintaining existing institutions, such as the CDM, and improving them rather than abandoning them (Hall, *et al*. 2008, Karp and Zhao 2008, Keeler and Thompson 2008, Teng, *et al*. 2008).

As we emphasized earlier, serious critiques have been leveled at the CDM in its current form: because the CDM is an emissions-reduction-credit system (not a cap-and-trade system) the concern is that it may credit emission reductions that are not truly additional. There have been numerous calls to address the CDM's problems by putting in place criteria and procedures to increase the likelihood that certified offset credits represent emission reductions that are truly "additional, real, verifiable, and permanent." While such reforms would have merit if they were effective, there are a number of alternative, more dramatic changes in the CDM that should be given consideration.[22]

...because there are very large start-up costs for creating new institutions, consideration should be given to maintaining existing institutions, such as the CDM...

Improved, Expanded, and Focused Greenhouse Gas Offsets

Ironically, one promising approach would involve less emphasis on strict ton-for-ton accounting and more emphasis on a range of activities that could produce significant long-term benefits (Keeler and Thompson 2008). There are five key elements of this approach. First, the criteria for CDM offsets would be changed from "real, verifiable, and permanent reductions" to "actions that create real progress in developing countries toward mitigation and adaptation." The reasoning behind this change is that strict, project-based accounting rules, while intended to protect the environmental integrity of trading programs, have increased transaction costs and thereby limited the utility of the CDM. The argument is that developing country actions are more important than the sanctity of short-term targets in making real progress on mitigating climate change risk.

Second, this proposal would make a significant share of industrialized country commitments (whether international or domestic) achievable through offset payments to developing countries. If industrialized countries aimed to purchase offset credits equivalent to at least 10% of their overall emissions targets, they would greatly expand the flow of resources available to support developing country actions. Third, a specified portion of offset credits (perhaps 50%) would be sold up front, and the proceeds would be put in a fund for supporting investments in projects throughout the developing world. By allowing greater flexibility to support large-scale or non-standard projects, this approach could increase the geographic diversity of mitigation activities and reduce transaction costs.

Fourth, international negotiations would be focused on developing guidelines for an international offsets program. Key issues to be addressed would include: criteria for eligible activities, policies, and investments; requirements for documentation or accountability; mechanisms for *ex-post* adjustment; criteria for the distribution of funds; and set-asides, if any, for particular types of projects or technologies. Fifth, clearly delineated tasks would be delegated to new and existing institutions for the purpose of managing and safeguarding the offsets program. In particular, the World Bank and the Climate Secretariat in Bonn could be given lead roles in program implementation and information-sharing, respectively.

Such reform of the CDM could facilitate more substantial transfers of technology (Aldy and Stavins 2008c). Creating a list of pre-approved technologies could lower the transaction costs of the review and certification process, and thus encourage more projects. Expanding the coverage of the CDM from specific projects to an entire industry, such as the power sector, could promote the exploitation of all low-cost mitigation opportunities in that country's industry, some of which may be too small to be proposed on a project-by-project basis. Modifying the CDM to include policies, as well as projects, could also stimulate further investment in low-carbon technologies. For example, credits could be awarded for implementing fuel economy standards, lowering fossil fuel subsidies, or enforcing land tenure rules that slow deforestation.

[22] We noted above the possibility of addressing the problems of the CDM through a system of buyer liability (rather than seller or hybrid liability), in order to generate market arrangements that would help address these critiques, such as reliable ratings agencies, and variations in the price of offsets according to perceived risks (Keohane and Raustiala 2008). This approach would give sellers strong incentives to maintain permit quality to maximize the monetary value of these tradable assets.

On the other hand, some key challenges confront the improvement of the CDM as a means for transferring climate-friendly technologies to developing countries (Aldy and Stavins 2008c). First, the difficulty of demonstrating additionality in a project context may become even greater in an industry or policy context—that is, the problem of constructing a project-based counterfactual (what would have happened anyway) becomes a similar industry- or policy-based counterfactual estimation problem. Second, limits imposed by industrialized countries on the volume of CDM credits that can enter their carbon markets will lower credit prices and discourage some new technology investment. Third, the CDM may create disincentives for some emerging economies to take on more substantial action domestically or make commitments as part of an international agreement.

If the transfer of climate-friendly technology from developed to developing countries is necessary to address climate change, then some have argued that the CDM should be enhanced by placing explicit focus and emphasis on technology transfer (Teng, *et al*. 2008). Programmatic CDM, policy CDM, and sectoral CDM, as recommended above, focus on scaling up the CDM market, thereby increasing financial flows in carbon markets. Some argue, however, that the objective of a revamped CDM should not be picking low hanging fruit, but spurring new and replicable technology transfer from developed to developing countries (Teng, *et al*. 2008). Consistent with this notion, some have proposed a "Technology CDM" under which technology transfer would be the only emissions-reducing activity for which credits would be awarded. This would offer the opportunity to strengthen the technology transfer effects of the CDM in the near term without redesigning the whole system.

Climate Accession Deals

Others have taken the early limitations of the CDM as evidence that a fundamentally different approach will be needed to make real progress. One such proposal is for climate accession deals to be employed as a new strategy for engaging developing countries (Victor 2008). This approach builds on two premises: first, that developing nations value economic growth far more than future global environmental conditions and second, that many governments of developing nations lack the administrative ability to control emissions.

Under this proposal, climate accession deals would be negotiated on a country-by-country basis. An individual accession deal would essentially consist of a set of policies that are tailored to gain maximum leverage on a single developing country's emissions, while still aligning with its interests and capabilities. Industrialized countries would support each accession deal by providing specific benefits such as financial resources, technology, administrative training, or security guarantees. Because these deals would be complex to engineer, they should be few in number and focused on nations with extremely high potential for reducing emissions.

A given developing country would bid a variety of policies and programs that make sense for its development trajectory. Its bid would include information on existing barriers (funding, technology, access to international institutions, etc.). Subsequent international negotiations would determine the resources that industrialized nations would provide to that country and the metrics for assessing compliance. The notion is that this process of negotiating accession deals could accelerate developing countries down the path of adhering to global norms on the need to control emissions.

Compared to conventional approaches, accession deals could have several advantages (Victor 2008). First, they would be anchored in host countries' interests and capabilities. Second, they would be limited in number and could yield a significant degree of leverage while minimizing external investment. Third, they would engage private enterprise and government ministries that are beyond the environmental and foreign affairs ministries. Fourth, such accession deals would be replicable and scalable. Where they succeed, they could offer templates for similar deals in other countries.

Examples of potential climate accession deals include the following: A deal for China could focus on making new power plants more efficient, encouraging greater use of natural gas and nuclear fuel for generating electricity, improving the efficiency of the electric power grid, and funding joint research projects on new systems for electric supply. A deal for India could leverage India's emissions by boosting the efficiency of coal-based electricity production. Deals for Brazil and Indonesia could focus on preventing and reversing deforestation.

Addressing Deforestation in an International Climate Agreement[23]

Forest carbon flows comprise a significant part of overall global greenhouse gas emissions, with deforestation contributing between 20% and 25% of net greenhouse gas emissions. The amount of carbon sequestered in forest vegetation is approximately 359 billion tons, compared with annual industrial CO_2 emissions of 6.3 billion tons. Thus, changes to forests can have enormous impacts on the global carbon cycle, and carbon management ought to be an element of the next international agreement on climate change. A promising path forward could involve taking a "national inventory" approach, in which nations receive credits or debits for changes in forest cover relative to a measured baseline (Plantinga and Richards 2008).

...changes to forests can have enormous impacts on the global carbon cycle...

The Kyoto Protocol has not been effective at providing landowners and governments with incentives to protect and expand stocks of carbon. First, by considering only "human-induced" changes, the Kyoto approach discourages countries from accepting responsibility for (or benefiting from) all carbon changes under their authority. It also invites endless arguments about which changes are human-induced. Second, the Protocol's CDM provisions are not sufficient to address forest-based carbon—deforestation is not included, and the carbon effects of forestry projects are difficult to measure. Third, the Kyoto Protocol approach may actually accelerate deforestation by shifting timber harvesting from Annex I to non-Annex I countries.

Looking forward, three basic approaches could be taken to address deforestation in the context of an international climate agreement. The first approach, currently used by the CDM, relies on project-level accounting. Under this system, individual landowners can apply for credits for net increases in carbon stored in forests on their land. Once the permitting authority verifies that the claimed sequestration is valid, the landowner can sell the credits in permit markets. But experience has shown that such project-by-project accounting faces serious challenges, especially in establishing the counterfactual baseline against which to evaluate projects. This additionality problem is compounded by problems of leakage (the off-site effects of projects), permanence (the potential for future changes or events to result in the release of sequestered carbon), and adverse selection problems (the most profitable projects, which are most likely to occur anyway, are also the most likely to be offered under project-oriented CDM).

A second policy approach would "delink" forest carbon programs from emission allowance systems. Rather than focusing on carbon credits, the program would focus on inputs such as policies to discourage deforestation, programs to encourage the conversion of marginal agricultural land to forests, and projects to better manage forests in forest-rich countries. These commitments could be funded by overseas development aid, international institutions, or through a separate climate fund. A delinked system would have some advantages in terms of lower transaction costs and by virtue of opening separate negotiations over international forest sequestration and energy emissions. But this approach would also have two serious

[23] This section draws on Plantinga and Richards (2008).

disadvantages. First, incentives for forest-based carbon sequestration would be diminished and participating countries might shift their attention from assuring positive carbon outcomes to attracting project funding. Second, decoupling the forest carbon program from cap-and-trade systems removes one of the best sources of funding to promote land-use changes—emitters seeking lower cost options to reduce their net emissions.[24]

A third, more promising approach is national inventory accounting. Under this approach, nations would conduct periodic inventories of their forest carbon stock. The measured stock would be compared with a pre-negotiated baseline stock to determine the offset credits that can be redeemed, or debits that must be covered, in the permit market. With this approach, national governments, rather than project developers, pursue carbon sequestration activities through the implementation of domestic policies. International negotiations would determine the reference or baseline stock of stored forest carbon. These negotiations could be used to address equity issues, as well as provide incentives for countries — in particular, countries with declining stocks — to participate in the agreement.

A national inventory approach would greatly reduce the problems of additionality, leakage, permanence, and adverse selection that plague the CDM's project-by-project approach. It could also provide comprehensive coverage of changes to forest carbon stocks and be applied equally to all participating countries and to all measurable changes in forest carbon stocks. There are also some reasonable concerns about this approach. First, the scope of carbon sequestration activities is limited to those that can be measured. Second, the approach provides incentives for governments, not private project developers, which may be a disadvantage in countries with weak institutions, high levels of corruption, or powerful special interest groups. Third, problems with additionality, permanence, etc. may resurface with—and reduce the effectiveness of—domestic carbon sequestration policies pursued by national governments.[25]

Making Global Climate Policy Compatible with Global Trade Policy[26]

Global efforts to address climate change could be on a collision course with global efforts through the World Trade Organization (WTO) to reduce barriers to trade (Frankel 2008a). Such a collision would be a nightmare for free trade and climate protection alike.

Global efforts to address climate change could be on a collision course with global efforts to reduce barriers to trade.

With different countries likely to adopt different levels of commitment to climate change mitigation, the concern arises that carbon-intensive goods or production processes could shift to countries that do not regulate greenhouse gas emissions. This leakage phenomenon is viewed as problematic—by environmentalists because it would undermine emission-reduction objectives and by industry leaders and labor unions because it could make domestic products less competitive with imports from nations with weaker greenhouse gas regulations. Thus, various trade measures—including provisions for possible penalties against imports from countries viewed as non-participants—have been included in some climate policy proposals in the United States and Europe, as well as in proposals for a post-2012 international policy architecture (Jaffe and Stavins 2008; Karp and Zhao 2008).

The widespread impression that the WTO is hostile to environmental concerns has little basis in fact. The WTO's founding Articles cite environmental protection as an objective; environmental concerns are

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[24] Bosetti, *et al*. (2008) find that including credits for deforestation in a global cap-and-trade system reduces costs significantly.

[25] A delinked, input-based approach could be used as an interim strategy if measurement technologies are inadequate to support the national inventory approach. An input-based approach could be used temporarily while the scientific community works to develop the measurement capacity necessary to support national inventories.

[26] This section draws extensively on Frankel (2008b), supplemented by Karp and Zhao (2008) on trade sanctions, and Newell (2008) and Hall, *et al*. (2008) on subsidies for international transfers.

also explicitly recognized in several WTO agreements. Recent WTO rulings support the principle that countries not only have the right to ban or tax harmful products, but — perhaps more critically — that trade measures can be used to target processes and production methods (PPM), provided they do not discriminate between domestic and foreign producers. The question is how to address concerns about leakage and competitiveness in a way that does not run afoul of WTO rules and avoids derailing progress toward free trade and climate goals alike.

Future national-level policies to address climate change may be expected to include provisions that target carbon-intensive products from countries deemed to be making inadequate efforts. These provisions need not violate sensible trade principles and WTO rules, but there is a danger that in practice they will. The kinds of provisions that would be more likely to conflict with WTO rules and provide cover for protectionism include the following: (1) unilateral measures applied by countries that are not participating in the Kyoto Protocol or its successors; (2) judgments made by politicians vulnerable to political pressure from interest groups for special protection; (3) unilateral measures that seek to sanction an entire country, rather than targeting narrowly defined energy-intensive sectors; (4) import barriers against products that are further removed from carbon-intensive activity, such as firms that use inputs that are produced in an energy-intensive process; and (5) subsidies — whether in the form of money or extra permit allocations — to domestic sectors that are considered to have been put at a competitive disadvantage.

By contrast, border measures that are more likely to be WTO-compatible include either tariffs or (equivalently) requirements for importers to surrender tradable permits designed with attention to the following guidelines: (1) measures follow some multilaterally-agreed set of guidelines among countries participating in the emission targets of the Kyoto Protocol and/or its successors; (2) judgments about which countries are complying or not, which industries are involved and their carbon content, and which countries are entitled to respond with border measures are made by independent panels of experts; (3) measures are applied only by countries that are reducing their emissions, against countries that are not doing so, either as a result of their refusal to join an agreement or their failure to comply; and (4) import penalties target fossil fuels, and five or six of the most energy-intensive major industries that produce manufactured bulk goods: aluminum, cement, steel, paper, glass, and perhaps iron and chemicals.

The economics and the laws governing the interaction of trade and environmental policy are complex, and a multilateral regime is needed to guide the development of trade measures intended to address concerns about leakage and competitiveness in a world where nations have different levels of commitment to greenhouse gas mitigation. Ideally, this regime would be negotiated along with the successor to the Kyoto Protocol that sets emission-reduction targets for future periods. If that process takes too long, however, it might be useful in the shorter term for a limited set of countries to enter into negotiations to harmonize guidelines for border penalties, ideally in informal association with the secretariats of the UNFCCC and the WTO.[27]

[27] In addition, barriers to climate-friendly technology transfer could be reduced through a WTO agreement to reduce tariff and non-tariff barriers to trade in environmental goods and services (Newell 2008).

CONCLUSION

Great challenges confront the community of nations seeking to establish an effective and meaningful international climate regime for the post-2012 period. But some key principles, promising policy architectures, and guidelines for essential design elements have begun to emerge.

Climate change is a global commons problem, and therefore a cooperative approach involving many nations will be necessary to address it successfully. Since sovereign nations cannot be compelled to act against their wishes, successful treaties must create adequate internal incentives for compliance, along with external incentives for participation. A credible global climate change agreement must be: 1) Equitable. The industrialized world should accept responsibility for historic emissions of greenhouse gases, but developing countries with rapidly growing economies must also take on increasingly meaningful roles. 2) Cost-effective. 3) Able to bring about significant technological change and technology transfer. 4) Consistent with the international trade regime. 5) Practical, in the sense that it builds—where possible—on existing institutions and practices. 6) Attentive to short-term achievements, as well medium-term consequences and long-term goals. 7) Realistic. Because no single approach guarantees a sure path to ultimate success, the best strategy may be to pursue a variety of approaches simultaneously.

The Harvard Project on International Climate Agreements does not currently endorse a single international climate policy architecture. In this interim report, we have highlighted four potential frameworks for a post-Kyoto agreement, each of which is promising in some regards and raises important issues for consideration. One calls for emissions caps established using a set of formulas that assign quantitative emissions limits to countries in every year through 2100. These caps would be implemented through a global system of linked national and regional cap-and-trade programs that allowed for trading among firms and sources. A second would instead rely on a system of linked international agreements that separately address various sectors and gases, as well as key issues, with particular attention to research and development. A third architecture considered here would consist of harmonized domestic taxes on emissions of greenhouse gases from all sources, where the tax or charge would be internationally adjusted from time to time, and each country would collect and keep the revenues it generates. Fourth, we discussed an architecture that—at least in the short term—links national and regional tradable permit systems only indirectly, through the global CDM. This option was noted less as a recommendation and more as a recognition of the structure that may already be evolving as the *de facto* post-Kyoto international climate policy architecture.

Regardless of which overall international policy architecture is chosen, a number of key design issues will stand out as particularly important, including burden-sharing, technology transfer, CDM reform, addressing deforestation, and making global climate policy compatible with global trade policy. All of these issues involve the relationship between global climate policy and economic development, and all are under careful investigation as part of the Harvard Project.

As the Project moves forward, we will continue to draw upon leading thinkers from academia, private industry, government, and non-governmental organizations around the world. We will also continue to work with our 28 research teams in Europe, the United States, China, India, Japan, and Australia and to meet in a wide variety of venues with those who can share their expertise and their insights. We look forward to receiving extensive feedback regarding all elements of our work—including on this interim report.

Appendix A: Selected List of Individuals Consulted

We wish to thank the following individuals – and many others – who took time from their exceptionally busy schedules over the past 18 months to meet with us and offer their observations and insights in regard to the work of the Harvard Project on International Climate Agreements. The Project has benefitted tremendously from these meetings and exchanges. However, none of the individuals listed have reviewed, let alone approved the content of this Interim Report.

Jan Adams
First Assistant Secretary and Ambassador
for Climate Change
Department of Climate Change
Government of Australia

His Excellency Ban Ki-moon
Secretary-General of the United Nations

James L. Connaughton
Chairman, Council on Environmental Quality
Director, Office of Environmental Policy
The White House

Fulvio Conti
Chief Executive Officer and General Manager
Enel SpA

Stavros Dimas
Commissioner for the Environment
European Commission

Elliot Diringer
Vice President, International Strategies
Pew Center on Global Climate Change

Paula Dobriansky
Under Secretary, Democracy and Global Affairs
United States Department of State

David Doniger
Policy Director, Climate Center
Natural Resources Defense Council

Brian Flannery
Manager, Environment & Strategy Development
ExxonMobil

Christopher Flavin
President
Worldwatch Institute

Jody Freeman
Professor of Law
Harvard Law School

Masahisa Fujita
President and Chief Research Officer
Research Institute of Economy, Trade,
and Industry (Tokyo)

Al Gore
Former Vice President of the United States

C. Boyden Gray
Special Envoy for European Affairs
and Eurasian Energy
Mission of the United States to
the European Union

HAN Wenke
Director General, Energy Research Institute
National Development and Reform Commission
People's Republic of China

Connie Hedegaard
Minister of Climate and Energy
Government of Denmark

Dale W. Jorgenson
Samuel W. Morris University Professor
Harvard University

Lars G. Josefsson
President and Chief Executive Officer
Vattenfall

Nathaniel Keohane
Director of Economic Policy and Analysis
Climate and Air Program
Environmental Defense Fund

Fred Krupp
President
Environmental Defense Fund

Jonathan Lash
President
World Resources Institute

LI Liyan
Deputy Director, Office of National Coordination
Committee on Climate Change
People's Republic of China

Bo Lidegaard
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Office of the Prime Minister of Denmark

Christine Loh
Chief Executive Officer
Civic Exchange

LU Xuedu
Deputy Head, Office of Global Environmental Affairs
Ministry of Science and Technology
People's Republic of China

Ichiro Maeda
Deputy General Manager
Tokyo Electric Power Company

Chris Mottershead
Distinguished Advisor, Energy and Environment
BP

Fernando Napolitano
Managing Director
Booz and Company

R.M. Marty Natalegawa
Permanent Representative of the Republic
of Indonesia to the United Nations

Mutsuyoshi Nishimura
Special Advisor to the Cabinet of
the Government of Japan
Senior Fellow, Japan Institute for
International Affairs

Maciej Nowicki
Minister of the Environment
Republic of Poland

PAN Jiahua
Executive Director, Research Centre
for Sustainable Development
Chinese Academy of Social Sciences

PAN Yue
Vice Minister, Ministry of Environmental Protection
People's Republic of China

Janos Pasztor
Director, Climate Change Support Team
Office of the Secretary-General of the
United Nations

His Excellency Anders Fogh Rasmussen
Prime Minister of Denmark

Theodore Roosevelt IV
Managing Director
Barclays Capital

François Roussely
Chairman
Credit Suisse, France

Shyam Saran
Special Envoy for Climate Change
Office of the Prime Minister of India

Masayuki Sasanouchi
Senior General Manager,
Carbon Management Group
Toyota Corporation

Philip Sharp
President
Resources for the Future

Kunihiko Shimada
Principal International Negotiator
Global Environment Bureau,
Ministry of the Environment
Government of Japan

Domenico Siniscalco
Vice Chairman and Managing Director
Morgan Stanley International

Nicholas Stern
IG Patel Professor of Economics and Government
Director, Asia Research Centre
London School of Economics

Todd Stern
Partner, WilmerHale
Senior Fellow, Center for American Progress

Björn Stigson
President
World Business Council for Sustainable
Development

Jerry Stokes
President
Suntech, Europe

Lawrence H. Summers
Charles W. Eliot University Professor
Harvard University

Masakazu Toyoda
Vice-Minister for International Affairs
Ministry of Economy, Trade, and Industry
Government of Japan

Koji Tsuruoka
Director-General for Global Issues
Ministry of Foreign Affairs
Government of Japan

Alvaro Umaña
Director, Fiorello H. LaGuardia Foundation
First Minister of Natural Resources
and Environment, Republic of Costa Rica

Timothy E. Wirth
President
United Nations Foundation

Michael Wriglesworth
Senior Advisor, Climate Change
Centre for European Policy Studies

ZOU Ji
Professor and Head
Department of Environmental Economics
and Management
Renmin University of China

Appendix B: Workshops and Conferences

Sponsored and conducted by the Harvard Project:

Presentation to and discussion with 120 policy makers and business and NGO leaders
Hosted by Resources for the Future, Washington, D.C.
October 4, 2007

Presentation to and discussion with 50 business leaders
Venue: Harvard Club of New York City
October 18, 2007

Presentation to and discussion with 130 scholars and stakeholders
Hosted by the Harvard Kennedy School
October 24, 2007

Workshop with 25 stakeholders from business and the NGO community
Hosted by The Centre (policy research institute in Brussels, Belgium)
November 16, 2007

Official side-event presentation, attended by 250 participants
Thirteenth Conference of the Parties, Bali, Indonesia
December 10, 2007

Workshop with 25 Japanese industry representatives
Hosted by the 21st Century Public Policy Institute (affiliated with Keidanren), Tokyo
March 25, 2008

Seminar discussion with 40 scholars and government officials
Hosted by the Research Centre for Sustainable Development, Chinese Academy of Social Sciences, Beijing
March 28, 2008

Presentations to and discussions with 50 business leaders and, separately, 25 NGO leaders
Hosted by Resources for the Future, Washington, D.C.
September 5, 2008

Official side-event presentation (to be held)
Fourteenth Conference of the Parties, Poznan, Poland
December 6, 2008

Major Harvard Project participation in events sponsored by other organizations:

Principal presentation to and participation in roundtable on “Architectures for Agreement,”
as part of the 2007 World Energy Congress, Rome
November 15, 2007

Participated in and provided key technical presentation at a workshop hosted by
the International Emissions Trading Association
Thirteenth Conference of the Parties, Bali, Indonesia
December 10, 2007

Participated in and provided background technical support for the Copenhagen Climate Dialogues, each attended by 30 senior business, government, and NGO leaders and hosted by Prime Minister Anders Fogh Rasmussen
May 7-8 and September 2-3, 2008

Provided key background technical presentations for a debate between energy and environment representatives of the U.S. presidential campaigns
Hosted by the Progressive Policy Institute, Washington, D.C.
September 16, 2008

Participated in and provided key technical presentations to group of 25 EU officials and business and NGO leaders
Hosted by Bruegel (policy research institute in Brussels, Belgium)
September 24, 2008

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