Symposium:
Post-Kyoto International Climate Policy Architecture

Three Key Elements of a Post-2012 International Climate Policy Architecture

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Introduction

The nations of the world are continuing to strive to negotiate what may become the post-2012 (or post-Kyoto) international climate policy regime. This has been occurring primarily through the United Nations Framework Convention on Climate Change (UNFCCC), most recently through the 17th Conference of the Parties (COP-17) to the convention, held in November–December 2011 in Durban, South Africa. In addition, many of the world's largest emitting countries have held a series of meetings under the auspices of the Major Economies Forum for Energy and Climate and the G20, and a number of nations have met in various bilateral venues. In each of these forums, a goal has been to foster international cooperation to address climate change when the first commitment period of the Kyoto Protocol expires at the end of 2012.

The Kyoto Protocol (United Nations 1997), which came into force in February 2005 and began to restrict emissions for ratified countries in 2008, represents the first significant multinational attempt to curb the greenhouse gas (GHG) emissions that are changing the global climate. The Protocol has both strengths and weaknesses that can provide lessons for the design of a future international climate policy architecture. The design of such a future international policy architecture is the focus of this three-article symposium, which seeks to present a variety of viewpoints on the critical components of any international approach to addressing climate change once the Kyoto Protocol expires.

This first article identifies, describes, and assesses three important features that must be included in virtually any successful post-2012 international climate policy architecture:

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(a) a framework to ensure that key industrialized and developing nations are involved in differentiated but meaningful ways, (b) an emphasis on an extended time path for emissions targets, and (c) the inclusion of flexible market-based policy instruments to help keep costs down and address concerns about international equity. These three elements will be key regardless of whether the post-2012 architecture is ultimately achieved through a centralized top-down agreement, a set of harmonized national policies, or a decentralized bottom-up approach, as illustrated by the Cancun Agreements (Aldy and Stavins 2010).

In the second article, Bosetti and Frankel (2011) provide an empirical examination of a related architecture that uses negotiated formulas to generate emissions targets for all countries through the end of the twenty-first century. Their approach, which builds on political realities and constraints, is designed to limit global carbon dioxide (CO_2) concentrations to 460 parts per million (ppm).

In the third article, Metcalf and Weisbach (2011) argue that the de facto post-2012 international climate policy architecture may quite possibly rely on the bottom-up linkage of a diverse set of domestic climate policies. These authors analyze the advantages, the mechanics, and the challenges of linking such heterogeneous policies, which might include national or regional cap-and-trade systems, carbon taxes, and some other types of regulatory mechanisms.

In the next section of this article, we describe the strengths and weaknesses of the Kyoto Protocol and identify the three key components of any successful future international climate policy architecture. We then evaluate the evidence concerning each of these elements. We offer a summary and conclusions in the final section.

The Kyoto Protocol: Looking Back and Moving Forward

This section assesses the strengths and weaknesses of the Kyoto Protocol and what they imply for the design of a successful post-Kyoto international climate policy architecture.

Strengths of the Kyoto Protocol

Among the Kyoto Protocol's strengths is its inclusion of provisions for market-based approaches intended to lower the cost of the global climate regime: (a) emissions trading among Annex I countries that commit to targets under the Protocol,[1] (b) "joint implementation," which allows for project-level trades among the Annex I countries, and (c) the Clean Development Mechanism (CDM), which provides for the use of project-level emissions offsets created in non-Annex I (developing) countries to help meet the compliance obligations of firms in Annex I countries.

The Kyoto Protocol also recognizes domestic sovereignty and provides flexibility at the national level for countries to meet their emissions targets—their commitments—in whatever manner they choose. Furthermore, the Protocol has at least the appearance of fairness in that it focuses on the wealthiest countries and those responsible for the majority of the

[1]Annex I of the UNFCCC and Annex B of the Kyoto Protocol are often used interchangeably to indicate the industrialized countries that have national emissions targets under the Protocol, although membership differs slightly.

current stock of anthropogenic GHGs in the atmosphere.[2] This is consistent with the principle enunciated in the UNFCCC of "common but differentiated responsibilities and respective capabilities" (United Nations 1992). 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 in terms of participation, if not compliance.

Weaknesses of the Kyoto Protocol

The Kyoto Protocol also has some weaknesses. First, some of the world's leading emitters either have not ratified the treaty or have not committed to specific targets that would restrict emissions. To date, the United States—until recently the country with the largest share of global emissions, about 19 percent (Gregg, Andres, and Marland, 2008)—has not ratified and is unlikely to ratify the agreement. Also, some of the world's largest, most rapidly growing economies, including China, India, Brazil, South Africa, Indonesia, South Korea, and Mexico, do not take on targets. The developing world will soon overtake the industrialized world in total emissions. Indeed, China's CO_2 emissions have surpassed those of the United States (Gregg, Andres, and Marland, 2008), and China's emissions are expected to continue to grow much faster than U.S. emissions (Blanford, Richels, and Rutherford, 2010). Even if all of the Annex I countries, including the United States, were to reduce their CO_2 emissions to zero by 2030, unless there are also significant reductions by China and India, it will be physically impossible for the world to achieve the frequently discussed climate target of stabilizing atmospheric CO_2 concentrations at or below 450 ppm.

The relatively small number of countries that have agreed to take action under the Protocol highlights a second weakness. This "narrow but deep" approach will drive up the costs of producing carbon-intensive goods and services within the coalition of countries taking action. Through the forces of international trade, this approach leads to greater comparative advantage in the production of carbon-intensive goods and services for countries that do not have binding emissions targets, thereby shifting production and emissions from participating nations to nonparticipating nations, a phenomenon known as "carbon leakage." Leakage will reduce the cost effectiveness and environmental performance of the agreement and, worse yet, push developing countries onto more carbon-intensive growth paths than they would otherwise have taken, rendering it more difficult for these countries to later join the coalition of countries taking action.

A third weakness centers on the nature of the Kyoto Protocol's emissions trading elements. The provision in Article 17 concerning international emissions trading is unlikely to be effective because the trading would be among national governments rather than among private-sector firms. The cost effectiveness of cap-and-trade systems depends on the participants being cost-minimizing entities. This is a reasonable assumption for private firms because, given the competitive forces of the market, if such firms fail to minimize their costs, they will tend to disappear. But nation-states are not simple cost minimizers; many other

[2]However, the Kyoto Protocol may not be as fair as originally intended, given how dramatically the world has changed since the UNFCCC divided countries into two categories in 1992. Approximately fifty non-Annex I countries now have higher per capita income than the poorest of the Annex I countries.

objectives affect their decision making. Furthermore, even if nation-states did seek to minimize costs, they would not have sufficient information about the marginal abatement costs of the multitude of sources within their borders to carry out cost-effective trades with other countries (Hahn and Stavins 1999).

Related to the issue of the Protocol's emissions-trading elements, there is also great concern regarding the CDM, which is an emissions-reduction credit system. When an individual project causes emissions to fall 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: how to compare actual emissions with what they would have been otherwise. The baseline, what would have happened had the project not been implemented, is fundamentally unobservable. In fact, because of economic incentives, there is a natural tendency to claim credits precisely for those projects that are most profitable and hence would have been most likely to have been executed without selling credits. This is referred to as the "additionality" problem.

Fourth, with its five-year time horizon (2008–12), the Kyoto Protocol represents a relatively short-term approach to what is fundamentally a long-term problem because GHGs reside in the atmosphere for a very long time—from decades to centuries. Moreover, to encourage the magnitude of technological change that will be required to address the threat of climate change meaningfully, long-term price signals must be sent to the private market to stimulate the necessary sustained investment and technological innovation (Newell 2010).

Finally, the Kyoto Protocol provides insufficient incentives for compliance (Barrett 2010). In particular, the Protocol's enforcement mechanism, a requirement that countries make up any deficit in subsequent compliance periods, is unlikely to induce policy responses that are consistent with the emissions targets.

Moving Forward

Since the negotiation of the Kyoto Protocol, scientific consensus regarding the likelihood of future climate change due to anthropogenic emissions of GHGs has grown (Pachauri 2008; Watson 2001), and economic analysis increasingly points to the wisdom of policy action (Kolstad and Toman 2001; Nordhaus 2008a, 2008b; Shogren and Toman 2000). However, as discussed earlier, the Kyoto Protocol's ambitious targets apply only to the short term and only to some industrialized nations. As a result, the agreement imposes relatively high costs and generates minor short-term benefits while failing to provide a real long-term solution. Therefore, some analysts view the agreement as "deeply flawed" (Cooper 2001; McKibbin and Wilcoxen 2002, 2004; Victor 2001), whereas others see it as an acceptable or good first step (Grubb 2003; Michaelowa 2003). Virtually everyone agrees, however, that the current framework is not sufficient and that further steps will be required.[3]

The negotiation of a post-2012 global climate policy architecture provides an opportunity to consider and address a significant dilemma: how to ensure "wide and deep" international participation when the incentives for individual nations to participate are weak. The Kyoto

[3]For a summary of critiques of the Kyoto Protocol and some proposed alternatives, see Aldy, Barrett, and Stavins (2003). A survey of proposals is provided by Bodansky (2004), and a recent analysis of proposed alternatives is found in Aldy and Stavins (2010).

Protocol came into force with neither U.S. participation nor meaningful participation by developing countries. Thus its effects on climate change will be trivial. The economic and scientific consensus concerning climate change points to the need for a credible international approach. In fact, given the global commons nature of the climate problem, a multinational, if not fully global, approach is required. However, as long as global marginal benefits exceed every nation's own marginal benefits, countries will either want to avoid participating or avoid complying fully if they do participate. A successful post-Kyoto international framework must change these incentives (Barrett and Stavins 2003).

To address the global nature of the climate problem and the weaknesses of the Kyoto Protocol, a post-2012 international climate policy architecture needs to contain the three key elements identified in the introduction to this article and highlighted again here: (a) a framework to expand participation to ensure that the most important industrialized and developing nations are involved in meaningful ways, (b) an emphasis on an extended time path for action on reducing GHG emissions, and (c) the inclusion of flexible market-based policy instruments. The next three sections discuss these three elements in detail.

Expanding Participation

The vast majority of the accumulated stock of anthropogenic CO_2 in the earth's atmosphere was emitted by sources in industrialized countries.[4] Therefore, equity concerns may suggest that industrialized countries should take serious actions to reduce their emissions *before* developing countries are asked to make their own contributions to such efforts. Thus it has been argued that distributional equity favors a narrow coalition of action, as embodied in Annex I of the Kyoto Protocol. However, efficiency concerns or, more accurately, cost-effectiveness concerns favor a broader coalition of action because these criteria focus on the margin; that is, they are forward looking. Indeed, we argue that broad participation, by both major industrialized nations and key developing countries, is essential to address the global commons problem effectively.

Reasons to Expand Participation by Developing Countries

If a post-2012 international climate policy architecture is to be meaningful, the large and rapidly growing developing countries must be involved. There are at least four reasons to expand developing country participation: (a) the magnitude of their current emissions and the expected rates of growth in their emissions, (b) their lower costs of emissions reductions, (c) the increased likelihood of U.S. participation and willingness by other industrialized countries to engage in deeper emissions reductions, and (d) the possibility of carbon leakage.

First, the share of global emissions attributable to developing countries is growing rapidly. China surpassed the United States as the world's largest emitter of CO_2 in 2006. The rate of growth in China's emissions is even more important: China emitted 8 percent of global anthropogenic CO_2 in 1981 and about 21 percent by 2008 (Gregg, Andres, and Marland, 2008;

[4]When land use change (particularly deforestation) is taken into account, the responsibility for the atmospheric stock of anthropogenic CO_2 is more evenly distributed across industrialized and developing countries (Weisbach 2010).

Guan et al. 2009). More broadly, developing countries are likely to account for more than half of global emissions by the year 2020, if not before (Nakicenovic and Swart 2000; Pies and Schröder 2002; U.S. Energy Information Administration 2009). Thus meaningful emissions reductions in the long term simply cannot be achieved without addressing emissions from these countries.

Second, in addition to being an important and growing source of emissions, developing countries provide the greatest opportunities for low-cost emissions reductions (Watson 2001). Therefore, inclusion of key developing countries in a climate regime can reduce overall costs dramatically. According to one estimate, if the major developing countries were to participate in achieving the Kyoto Protocol's emissions targets, total costs could be cut by 50 percent (Edmonds et al. 1997).

A third reason to include key developing countries in any post-2012 international climate policy architecture is that the United States has signaled its unwillingness to commit to significant emissions cuts unless developing countries participate. In fact, in the months leading up to Kyoto, the U.S. Senate voted 95–0 in support of the Byrd-Hagel resolution, which stated that the Senate would not approve any agreement that did not include major developing countries under binding targets. Furthermore, other industrialized countries may be willing to agree to more stringent cuts if the United States, as well as China and other developing countries, are part of the post-2012 architecture. In the December 2009 run-up to the COP-15 in Copenhagen, the European Union (EU) indicated that it would increase the stringency of its reduction target from 20 percent to 30 percent below 1990 levels by 2020 if other countries would make commitments to large reductions.

A final reason to include developing countries in a post-2012 global climate policy architecture is to ensure the environmental effectiveness of emissions reductions by participating countries. As noted in the previous discussion concerning the weaknesses of the Kyoto Protocol, if developing countries are not included in an agreement, comparative advantage in the production of carbon-intensive goods and services may shift outside the coalition of participating countries, making developing countries' economies more carbon intensive than they otherwise would be (through carbon leakage). Although the magnitude of this problem cannot be predicted with certainty, computable general equilibrium models estimate the potential carbon leakage rates under a global climate regime to range from 5 percent to 34 percent (Paltsev 2001).

Cost Effectiveness and Distributional Equity

Although it is essential to involve developing countries in any post-2012 international climate policy framework, many would argue that it would be unreasonable to expect developing nations to incur significant emissions-reduction *costs* in the short term because of the consequences for their economic development. Furthermore, it can be argued on an ethical basis that industrialized countries should take the first emission-reduction steps on their own because they are responsible for the bulk of anthropogenic-based concentrations of GHGs in the atmosphere.

This poses a policy conundrum. On the one hand, for purposes of environmental performance and cost effectiveness, key developing countries must participate in an international effort to reduce GHG emissions. On the other hand, for reasons of distributional equity and international political pragmatism, they cannot be expected to incur the brunt of the resulting costs. Clearly, developing countries must climb aboard the global climate policy "train" but without necessarily paying full fare. How can this be accomplished?

Achieving developing country participation may require a trigger mechanism, that is, imposing binding commitments only when per capita income, emissions per capita, or some other measure of development has reached a predetermined level. But there is no reason to limit action to such a simple discrete instrument. A preferable approach would be to establish continuous "growth targets" for each country that become more stringent as the country becomes wealthier (Lutter 2000). A growth target is not a specific number. Rather it is essentially an equation or set of equations that relates targeted emissions to per capita income and other variables. Two necessary characteristics of a growth target formulation are that it not create perverse incentives that would encourage nations to increase their emissions and that it be relatively simple, so as not to create impediments to negotiation (Aldy, Baron, and Tubiana 2003).

The growth target approach would be a natural, although more complicated, extension of the Kyoto Protocol's current progressive emissions target allocation. More specifically, the Kyoto Protocol's targets exhibit positive correlation between gross domestic product (GDP) per capita and the degree of targeted emissions reduction below business-as-usual (BAU) levels. In fact, according to Frankel (1999, 2005), the Kyoto targets exhibit an "income elasticity of reductions" of about 0.14. This means that for a 10 percent increase in per capita GDP, a country's emissions reduction targets, on average, are about 1.4 percent more stringent.

A Formulaic Approach to Allocating Emissions Targets across Countries

Bosetti and Frankel (2011) propose a formulaic approach to generating emissions targets for all key countries for each five-year period remaining in this century. Their formula contains three elements or factors: progressivity, latecomer catch-up, and gradual movement toward equal per capita emissions while constraining targets so as not to impose costs over the century exceeding an average of 1 percent of GDP per year or 5 percent of GDP for any country in any period (Bosetti and Frankel 2011; Frankel 2010). Game-theoretic analyses suggest that the use of such factors in the formulas for emissions targets can render negotiations more likely to succeed (Harstad 2010).

The progressivity factor would adjust emissions targets based on per capita income (applying the income elasticity of reductions implied by the Kyoto targets). "Latecomer catch-up" prevents the formula from rewarding countries that failed to curb their emissions after 1990, the Kyoto baseline year. This includes countries such as Canada, which ratified the Protocol but are unlikely to comply; the United States, which did not ratify the agreement; and China, which did not commit to targets at Kyoto. The latecomer catch-up factor would help close the gap between 1990 emissions and the starting points for countries that are latecomers to the process. Finally, the "equalization factor" would move all countries in the direction of global average per capita emissions in the second half of the century, asking rich countries to (somewhat) make up for the fact that they previously enjoyed the benefits of unfettered CO_2 emissions, which created an environmental problem for which poor countries bear disproportionate impacts (Frankel 2010).

In the short term, such indexed targets for major developing countries could be set at BAU emissions levels, but they would become more stringent over time as the countries became wealthier. Bosetti and Frankel (2011) propose that the emissions targets for China and the other major emerging economies be equivalent to BAU emissions from 2010 until 2025 and then drop below BAU, but that the poorest countries have targets equal to BAU for the remainder of the century. Keeping even poor countries at or near BAU emissions is an important goal because it prevents the possibility of significant carbon leakage.

Obviously, other burden-sharing formulas have been proposed, and countries have differing views about what is equitable. But if provision is not made for some mechanism that includes developing countries at low or no cost to them, then the inevitable result will be a trade-off between cost effectiveness (or efficiency) and distributional equity (Sugiyama and Deshun 2004). However, if emissions targets at BAU for the short to medium run (or even the long run for some regions) were to be combined with an appropriate international trading program (discussed later), this could, in principle, provide a direct economic incentive (subsidy) for developing country participation. This means that developing countries could fully participate without incurring prohibitive costs (or even any costs in the short term), thus effectively addressing both the cost effectiveness and distributional equity concerns.

An Extended Time Path for Emissions Targets

As discussed earlier, global climate change is a long-term problem, both because the relevant GHGs remain in the atmosphere for decades to centuries and because significant technological change will be required to bring down costs to levels where greater actions can be taken. With its short-term targets—an average 5 percent reduction from 1990 levels by the 2008–12 "first commitment period"—the Kyoto Protocol fails to reflect these fundamentally important realities. More broadly, the Kyoto Protocol's targets can be characterized as seeking to achieve "too little, too fast." That is, the targets do little to reduce global emissions overall, but, due to their excessive focus on the short term, they are unreasonable for those countries that enjoyed significant economic growth after 1990. For example, the apparently modest reductions under Kyoto would have translated into a severe cut for the United States, 25 to 30 percent from its BAU emissions path, due to the fact that the U.S. economy grew at an exceptionally rapid rate during the 1990s (real GDP increased 37 percent from 1990 to 2000).[5]

This problem can be ameliorated through a two-pronged approach: firm but moderate targets in the short term to avoid rendering large parts of the capital stock prematurely obsolete, and flexible but considerably more stringent targets for the long term to motivate (now and in the future) technological change, which in turn is needed to bring costs down over time (Goulder and Schneider 1999; Jaffe, Newell, and Stavins 2001; Newell 2010; Pershing and Tudela 2003).

If they are inflexible, precise numerical emissions targets for long time horizons are impractical due to uncertainty over future economic growth, technological change, and

[5]In contrast, during the same decade, CO_2 emissions fell in the United Kingdom due to structural changes in the domestic coal industry, in Germany due to the closure of inefficient industries in the former East Germany, and in Russia due to its economic collapse early in the decade (McKibbin and Wilcoxen 2002).

the science of climate change and its effects.[6] In addition, because long-run emissions targets would require that current political leaders (especially elected officials) bind future political leaders to costly commitments, many analysts have noted that long-term targets are dynamically inconsistent and must incorporate constraints representing the economic and political reality that no country will abide by an unenforceable international agreement that causes great economic disruption in any particular year or set of years (Frankel 2010). Thus it is essential that long-term targets retain some flexibility.[7]

Emissions targets should start out at BAU levels and gradually become more stringent over time. Globally, the aggregate emissions target should not monotonically increase but rather should reach a maximum level and then begin to decrease, eventually becoming substantially more severe than the constraints implied by the Kyoto Protocol's short-term targets. More specifically, the pattern we suggest is consistent with estimates of the least-cost time path of emissions for achieving a range of feasible long-term GHG concentration targets: short-term increases in global emissions, just slightly below the BAU path, and subsequent global emissions reductions (Manne and Richels 1997; Wigley, Richels, and Edmonds 1996). We endorse no particular target in this article, although a time path of targets involving a small deviation from BAU in the short term, and more significant deviations only in the medium and long term, implies a range of stabilization scenarios above 450 ppm. However, it is useful to note that many recent analyses suggest that achieving stabilization at 450 ppm is politically infeasible (Bosetti and Frankel 2011) and technologically unlikely at current cost estimates (den Elzen and Höhne 2008), given how little progress has been made in global climate policy and the significant increases in global emissions that have occurred since this target was first considered.[8]

Ironically, if a time path of long-term targets were put in place now, it would be consistent with what is often denigrated as "politics as usual." That is, politicians, especially those in representative democracies, are frequently condemned for placing costs on future, rather than current, generations (i.e., voters). This is typically the politically pragmatic approach, and, in the case of global climate policy, to some degree it can also be the scientifically correct and economically sensible strategy.

[6]Some of the considerable uncertainty in the policy-economic-biophysical system may be resolved over time (Mendelsohn 2008; Richels, Manne, and Wigley 2004).

[7]The Intergovernmental Panel on Climate Change (IPCC) has recognized that the international community will have to engage in "iterative risk management" over time, including adaptation and mitigation and taking into account climate change damages, co-benefits, sustainability, equity, and attitudes toward risk. This reinforces the need for long-term flexibility (IPCC 2007; Yohe 2009).

[8]There are dissenting views on this point. For example, Edenhofer et al. (2009) suggest that stabilizing atmospheric CO_2 concentrations at 450 ppm is technically feasible and economically affordable. However, least-cost achievement of this goal in their model intercomparison requires an immediate departure from BAU emissions. See also Edenhofer et al. (2010). More broadly, however, Jaeger and Jaeger (2010) observe that the 450 ppm (or 2°C) target has "emerged nearly by chance" and is representative neither of a threshold separating safety from catastrophe nor of an optimal strategy based on an assessment of benefits and costs. Rather, they characterize this frequently discussed target as a convenient "focal point" that is likely to be exceeded in the present century.

Market-Based Policy Instruments

The third essential component of a post-Kyoto international policy architecture—working through the market rather than against it—is necessary to achieve global cost effectiveness and hence political feasibility. There is widespread agreement that conventional regulatory approaches cannot do the job, certainly not at acceptable costs. Thus, to keep costs down in the short term, and to push them even lower in the long term through technological change, it is essential to embrace market-based instruments (i.e., carbon pricing) as the chief means of reducing GHG emissions (Lackner 2005; Metcalf 2009; Stavins 1997). The main domestic market-based policy options are described next.

Domestic Policy Options

On a domestic level, some countries may use systems of tradable permits, now known as "cap and trade," to achieve national targets. In a cap-and-trade system, there is an incentive for sources that have low abatement costs to take on additional reductions so they can sell their excess permits to sources with relatively high control costs that wish to reduce their control efforts (Hockenstein, Stavins, and Whitehead 1997). This is the same mechanism that was used in the United States in the 1980s to eliminate leaded gasoline from the market, achieving a savings of more than $250 million per year (Stavins 2003). It is also the same mechanism that was used to cut sulfur dioxide (SO_2) emissions from power plants in the United States by 50 percent between 1990 and 2010, at an estimated savings of $1 billion per year (Ellerman et al. 2000; Schmalensee et al. 1998; Stavins 1998). The leaded gasoline trading system, which occurred at the refinery level, is analogous to trading based on the carbon content of fossil fuels, and it is thus a better model for climate change policy than the downstream SO_2 emissions-trading system.

For some countries, domestic carbon taxes may be more attractive than cap-and-trade approaches. Rather than imposing a cap on the quantity of pollution, and then allowing regulated firms to trade allowances to establish a market price for pollution, a tax imposes a specific price on pollution and allows firms to decide how much to emit in response to the price. The effect of a tax on firms' decisions is essentially identical to the effect of the permit price created by a cap-and-trade policy: for each ton of emissions, polluters decide whether to abate that ton (incurring the resulting abatement costs) or pay the tax and continue to emit that ton. Domestic carbon taxes, typically in the form of upstream taxes on the carbon content of fossil fuels, have frequently been recommended by academic economists (Metcalf 2007; Metcalf and Weisbach 2009),[9] but they have received considerably less support in the policy community.

Another promising market-based approach is a hybrid of the tax and tradable-permit systems—that is, an ordinary cap-and-trade system plus a government promise to sell additional permits at a stated price (Kopp et al. 2000; McKibbin and Wilcoxen 2002; Pizer 2002; Roberts and Spence 1976). This hybrid system creates a price (and thereby a cost) ceiling and is thus referred to as a safety-valve system. Likewise, a price floor can be created by

[9]Others have argued in favor of an international rather than a domestic tax regime. See, for example, Cooper (1998, 2010), McKibbin and Wilcoxen (2002), Pizer (2002), Newell and Pizer (2003), and Nordhaus (2008a).

a government promise to purchase allowances from the market at a given price. The combination of the two approaches (i.e., a price ceiling and a price floor), known as a "price collar," may be particularly attractive to policymakers (Murray, Newell, and Pizer 2009).

Among industrialized countries, cap and trade appears to be emerging as the preferred market-based policy instrument (Jaffe and Stavins 2010). In the developing world, the emissions-reduction credit system created under the Kyoto Protocol (the CDM) enjoys a solid constituency of support (Somanathan 2010).

The Promise and Problems of International Emissions Trading

Article 17 of the Kyoto Protocol includes a system whereby the parties to the agreement can engage in trading their assigned reduction targets, converted into quantities of emissions (United Nations 1997). In theory, such a system of international tradable permits, if implemented only for the industrialized countries (as under the Kyoto Protocol), could reduce abatement costs by 50 percent (Edmonds et al. 1997). If such a system also included major developing countries, abatement costs could be lowered to 25 percent of what they would be otherwise (Blanford et al. 2010; Bosetti et al. 2010; Edmonds et al. 1997; Jacoby et al. 2010).

An undisputed attraction, in theory, of an international trading approach is that the equilibrium allocation of permits, the market-determined permit price, and the aggregate costs of abatement are independent of the initial allocation of permits among countries (Montgomery 1972). Emerging empirical evidence supports this hypothesis for some domestic trading systems (Fowlie and Perloff 2008). However, permit allocations and aggregate abatement costs will be independent only if particularly perverse types of transaction costs (e.g., volume discounting) are not prevalent (Stavins 1995), individual parties, be they nations or firms, do not have market power (Hahn 1984), and other conditions, such as cost-minimizing behavior by firms and similar regulatory treatment of firms, hold (Hahn and Stavins 2010). The issue of market power is a particular concern in the context of climate change. In any event, the initial allocation can be highly significant in distributional terms, implying the potential for massive international wealth transfers. Some analysts have highlighted this as a major objection to an international carbon trading regime (Cooper 1998, 2010), but it is essentially because of this feature that a permit system can be used to address cost effectiveness *and* distributional equity, because such transfers would reduce the cost to developing countries of reducing GHG emissions.

If an international trading system is to be used, it must be designed to facilitate integration with domestic policies that nations use to achieve their domestic targets. In the extreme, if all countries were to use domestic cap-and-trade systems to meet their national targets (that is, allocate shares from an international permit system to private domestic parties), then an international system could, in theory, be cost effective because a nation-to-nation trading system would essentially evolve into an international firm-to-firm trading system. However, if, as seems likely, some countries were to use nontrading approaches, such as GHG taxes or various kinds of regulatory standards, cost minimization is less assured (Hahn and Stavins 1999; Metcalf and Weisbach 2010).

Clearly, there is a trade-off between degree of domestic sovereignty and degree of cost effectiveness, which suggests that individual nations' choices of domestic policy instruments to meet their targets can substantially limit the cost-saving potential of an international trading program. One possible solution, which we discuss later, is the linkage of independent domestic and regional cap-and-trade systems, and for that matter, domestic carbon taxes and some types of national regulatory systems, thereby facilitating some degree of cost-effective trades among individual sources (firms), both domestically and internationally.

Is the European Union Emissions Trading Scheme a Useful Model?

The Kyoto Protocol establishes a so-called bubble for the EU; that is, it sets a cap on CO_2 emissions for the EU as a whole, which the EU then allocates to its member states. When the Kyoto Protocol was signed in 1997, few would have predicted that European countries would use cap-and-trade systems, given the EU's strenuous opposition to such approaches. But after some initial consideration of carbon taxes, the EU launched a continent-wide trading system for CO_2 to meet its emissions reduction targets under the Protocol (Kruger and Pizer 2004). The European Union Emission Trading Scheme (EU ETS) was established in 2005, and after a pilot phase, it entered its more meaningful Kyoto phase in January 2008.

The EU ETS is the world's largest emissions trading system, covering some 12,000 facilities in 27 countries as of 2008 and nearly half of EU CO_2 emissions (Convery and Redmond 2007; Ellerman 2010; Ellerman and Buchner 2007, Ellerman and Joskow 2008). The pilot phase of the EU ETS (2005–7) was designed to set up the institutional and operating structures necessary for trading. The cap in this pilot phase was a very small reduction below expected emissions in the absence of the policy. Given that the system was designed not to begin to bind in meaningful ways until 2008, which turned out to be a time of global recession (and hence falling CO_2 emissions), it is much too soon to determine this new carbon market's impact on emissions or the cost savings from the EU ETS relative to more prescriptive approaches.

The EU ETS could conceivably serve as a prototype for a post-2012 international climate regime because the thirty states involved constitute an increasingly diverse set of sovereign countries. Many of the problems encountered and addressed by the EU ETS may be similar to those that a fully international architecture would encounter. Indeed, the EU ETS has not been without its conflicts. Nine of the ten East European countries have sued the European Commission over their allotted emissions caps for 2008–12. But the "club benefits" of continued membership in the EU, including free labor and capital flows and access to broader markets, have apparently outweighed the costs of the EU ETS for these poorer nations because they have chosen to remain within the system (Ellerman 2010).

The Status of Cap and Trade in the United States

Although the U.S. government (i.e., the Senate) did not ratify the Kyoto Protocol, some states have enacted policies to reduce their GHG emissions. The largest U.S. market-based initiative is the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade system initiated in 2003 among ten northeastern states. This trading program, which began in earnest in 2009, covers electricity generators within the region. Allowances under RGGI are auctioned, and firms trade allowances and various financial derivatives (including futures and options contracts) in a secondary market. The RGGI CO_2 emissions cap for 2009–14 roughly equals the sum of recent emissions among covered generators and then declines by 2.5 percent per year from 2015 through 2018.[10]

California continues to take serious steps toward the 2012 launch of its own cap-and-trade system for CO_2 emissions to meet the requirements of its Global Warming Solutions Act of 2006 (otherwise known as Assembly Bill 32, or AB 32), namely achieving emissions in 2020 that are equal to those of 1990 (Jaffe and Stavins 2010).

In June 2009, the U.S. government appeared to be taking a significant step toward establishing a national cap-and-trade policy to reduce CO_2 emissions, with the passage in the House of Representatives of the American Clean Energy and Security Act, also known as the Waxman-Markey bill. The legislation would have capped national GHG emissions from nearly all significant sources (including coal-fired power plants, factories, and natural gas suppliers) and fuels, and set up an economy-wide cap-and-trade system to achieve emissions reductions. The reduction targets for sources covered by the legislation amounted to cuts of 17 percent below 2005 levels by 2020, and progressively steeper future cuts (42 percent by 2030; 83 percent by 2050).

In May 2010, companion legislation, the American Power Act, was introduced in the U.S. Senate by Senators John Kerry and Joseph Lieberman. Like the House legislation, this proposal featured a cap-and-trade system.[11] However, in July 2010, as economic concerns eclipsed the goal of passing comprehensive climate legislation, the Senate abandoned its effort to pass the Kerry-Lieberman bill or any competing proposal.[12] In the process, cap and trade was demonized by conservatives in both houses as "cap and tax," making it much less likely that a meaningful price on carbon will be a component of any U.S. approach, at least in the short run.[13]

Linking National and Regional Cap-and-Trade Systems

A number of other major industrialized countries, including Australia, Canada, Japan, and New Zealand, are currently considering the adoption of national cap-and-trade systems to reduce their CO_2 emissions (Jaffe and Stavins 2010). In addition, China's twelfth Five-Year Plan, adopted in the spring of 2011, incorporates market mechanisms (along with other

[10]The combination of reduced electricity demand (due to the economic recession of 2008–2009) and lower natural gas prices (due partly to increased U.S. supplies of unconventional natural gas) has resulted in the RGGI emissions cap being nonbinding. It is likely to remain so unless the participating states decide to increase the program's stringency.

[11]Competing Senate proposals in 2010 included a proposal by Senators Cantwell and Collins, the Carbon Limits and Energy for America's Renewal Act, a "cap-and-dividend" approach that would have auctioned permits to producers and importers of coal, natural gas, and oil, and rebated 75 percent of auction revenues to consumers each month.

[12]In addition to these events in the U.S. Congress, some U.S. government agencies, such as the National Oceanic and Atmospheric Administration and the National Academy of Sciences, have issued lengthy climate change reports. Although these reports contribute to public dialogue on climate change in the United States, they have not, in our opinion, played an important role in influencing domestic support for participation in an international climate policy effort.

[13]For a critique of this political turn of events from an economic perspective, see Schmalensee and Stavins (2010).

approaches) to achieve domestic carbon-intensity reduction goals, consistent with the country's commitments in Copenhagen and Cancun.[14]

The increasing number of existing, planned, and proposed regional, national, and subnational cap-and-trade policies for CO_2 emissions reduction suggests that the linkage of these systems may be a significant element of a future international climate policy architecture. In this context, linkage refers to the recognition of the allowances (permits) from one system for use in meeting the compliance requirements of another. The potential benefits of such linkage include cost savings from increasing the scope of the market, greater market liquidity, reduced price volatility, lessened market power, and reduced carbon leakage (Jaffe, Ranson, and Stavins 2010).

Such linkage of domestic cap-and-trade systems could be initiated by bilateral or multilateral agreements among governments. However, it would lead to trading not among governments but among firms within the respective countries. This would circumvent the problems (mentioned earlier) that are inherent in international emissions trading under Article 17 of the Kyoto Protocol (Hahn and Stavins 1999).

Domestic cap-and-trade programs could be linked directly, either unilaterally or bilaterally. With a direct bilateral linkage, a pair of domestic cap-and-trade policies would recognize allowances from the other system. Under unilateral linkage, one system recognizes allowances from the other system, but the recognition is not reciprocal. Allowance prices would converge with both direct bilateral linkage, as long as there were no constraints on intersystem trades, and unilateral linkage, as long as the buying system's price was higher than the selling system's price: no trading would take place if the opposite were true (Jaffe, Ranson, and Stavins 2010).

A potential problem with this approach is that direct linkage of cap-and-trade systems will lead to the automatic transmission of cost-containment elements—banking, borrowing, safety valves, and price collars—from one system to the other. This raises concerns for some countries because of the possible loss of control of their domestic systems, and it raises the possibility that systems would need to be harmonized in advance of any linkage.

The need for prior harmonization can be avoided through the substitution of indirect links for direct ones. If each cap-and-trade system were linked with a sufficiently robust common emissions-reduction credit system, then all of the cap-and-trade systems would be linked (indirectly), achieving the benefits of cost reduction, greater market liquidity, reduced price volatility, lessened market power, and reduced carbon leakage but with greatly reduced transmission of cost-containment mechanisms from one system to another. This would reduce, if not eliminate, the need for prior harmonization. With a sufficient supply of credits, prices in all systems would converge, although this might not occur if binding constraints were imposed on the use of credits and allowances from other systems.

This is a rather good characterization of what appears to be evolving, that is, the emergence of regional and national cap-and-trade systems in the industrialized world, each of which allows offsets to some degree from the CDM, the emissions-reduction credit system in developing countries established under the Kyoto Protocol. Under the CDM, certified emissions reductions (CERs) are awarded for voluntary emission reduction projects in those developing

[14]See Deborah Seligsohn, Report from Cancun: China's climate progress since Copenhagen World Resources Institute, November 30, 2010. http://www.wri.org/stories/2010/11/report-cancun-chinas-climate-progress-copenhagen.

countries that ratified the Kyoto Protocol but are not among the countries subject to emissions limitations. The industrialized countries that took on emissions targets under the Protocol can use CERs to meet their commitments. By the end of 2012, the CDM will have generated more than 2.7 billion (tons of) CERs, the vast majority of them for projects in China, India, and Brazil (Jaffe, Ranson, and Stavins 2010).

A potential concern associated with linking cap-and-trade systems through a common emissions-reduction credit system is additionality, because credit systems, including the CDM, have been plagued by questions about the actual emissions reductions represented by credits because of the difficulty of establishing a baseline against which reductions can be measured. Linking credit systems with a cap-and-trade system shifts this concern to the latter system, where the issue of additionality would otherwise not be a significant concern. Thus there is a trade-off between the potential economic and environmental gains of such a bottom-up system of global indirect linkage and the potential economic and environmental losses that linkage can bring about if additionality problems are severe.

The Role of Emissions Trading in a Future International Climate Policy Architecture

One of the key concerns raised about the viability of a post-2012 international climate policy architecture that includes international emissions trading as a core element is that industrialized countries will not support such a policy once the cross-border financial flows implied by trading allocations, which favor developing countries (to prompt their accession to the agreement), become apparent (Cooper 1998; Victor 2007).[15] However, despite the significant variation in per capita income across EU ETS member states, this has not turned out to be a point of controversy (Ellerman 2010). This may be due to the fact that, although trading is active, financial flows from emissions trading represent a very small portion of total imports and exports. For example, the United Kingdom is the largest emissions allowance importer in the EU ETS, importing 14 percent of its verified emissions, worth about £350 million. But this still represents a very small portion, less than a tenth of 1 percent, of its total imports of goods and services (Ellerman 2010). Furthermore, it is important to keep in mind that any viable alternative that engages the major developing countries in an international climate policy architecture will likely involve some form of financial transfers from industrialized to developing countries.

The experience of the EU ETS and the support for international emissions trading voiced by other countries represent important political arguments for this element of a future international climate policy architecture. Thus international permit trading—not among countries per se but among firms within and across countries—remains a promising approach to achieving global emissions targets. Potential problems and challenges abound, and it is probably fair to say that the more one studies international tradable permit systems to address global climate change, the more one concludes that this is the worst possible approach—that is, of course, until one examines all of the other possible approaches.

[15]This is related to the broader point that linking bottom-up approaches may be more politically feasible than the establishment of a top-down international emissions trading system (Flachsland, Marschinski, and Edenhofer 2009).

Incorporating Linkage among a More Heterogeneous Set of National Policies

Although in many parts of the industrialized world, cap-and-trade systems currently appear to be the preferred approach for achieving meaningful GHG emission reductions, it also appears likely that some countries, perhaps a sizable share, will use other approaches, ranging from other market-based instruments, particularly carbon taxes, to more conventional types of regulatory instruments, such as performance standards and technology standards. This raises questions about whether bottom-up linkage among a heterogeneous set of national policies is feasible and at what cost.

The short answer is that although bilateral allowance recognition between cap-and-trade systems is the simplest and easiest form of linkage, it is also possible to link carbon tax systems with cap-and-trade systems. For that matter, some types of regulatory standards can also be linked (Hahn and Stavins 1999; Metcalf and Weisbach 2011). Direct linkages and, more likely, indirect linkages through a common emission-reduction credit system, are possible among a fairly broad but not unlimited set of national policy instruments. Problems arise with some types of linkages, but some of these can be addressed through *ex ante* harmonization. Rather than going into more detail here, we direct the reader's attention to Metcalf and Weisbach (2011), which focuses on these very issues.

Summary and Conclusions

This article has identified and assessed three elements that are likely to be essential aspects of a future global climate change policy architecture that is meaningful and feasible, and that can serve in some sense as a successor to the Kyoto Protocol. These three elements will be key regardless of whether the ultimate architecture is achieved through a centralized top-down agreement, a set of harmonized national policies, or a decentralized bottom-up approach.

To summarize these elements, first, key nations have to be involved, including major emerging economies, through the use of economic trigger mechanisms such as growth targets. Second, cost-effective time paths for emissions targets are required: firm but moderate in the short term, and much more stringent and flexible in the long term. Third, to keep costs down, market-based policy instruments—whether emissions trading, carbon taxes, or hybrids of the two—need to be part of the architecture. International linkage of regional, national, and even subnational market-based instruments will most likely be the means through which this third element is implemented.

The overall structure proposed here can be designed to be scientifically sound, economically rational, and perhaps even politically pragmatic. The agreements emerging from the 2010 Conference of the Parties to the UNFCCC in Cancun are roughly consistent with the three key elements emphasized here: (a) the distinctions between the Kyoto Protocol's Annex I and non–Annex I countries have been blurred, in that all countries will take on responsibilities post-2012; (b) although the focus is on 2020, aspirational targets stretch to 2050; and (c) market mechanisms are explicitly endorsed (over the objections of a handful of dissenting countries).

Although there is no denying that the successful implementation of this climate policy architecture faces significant challenges, they need not be insurmountable. Moreover, these challenges are no greater than those facing other approaches aimed at addressing the threat of global climate change.

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Abstract

This article describes three essential elements of an effective post-2012 international climate policy architecture: a framework to ensure that key industrialized and developing nations are involved in differentiated but meaningful ways, an emphasis on an extended time path for emissions targets, and the inclusion of flexible market-based policy instruments to keep costs down and facilitate international equity. This overall architecture is consistent with fundamental aspects of the science, economics, and politics of global climate change; addresses specific shortcomings of the Kyoto Protocol; and builds on the foundation of the United Nations Framework Convention on Climate Change. (*JEL*: Q54, Q58, Q48, Q39)