

A “Greenprint” for International Cooperation on Climate Change

Aaditya Mattoo
Arvind Subramanian

The World Bank
Development Research Group
Trade and Integration Team
May 2013



Abstract

International negotiations on climate change have been dogged by mutual recriminations between rich and poor countries, constricted by the zero-sum arithmetic of a shrinking global carbon budget, and overtaken by shifts in economic power between industrialized and developing countries. To overcome these “narrative,” “adding-up,” and “new world” problems, respectively, this paper proposes a new Greenprint for cooperation. First, the large dynamic emerging economies—China, India, Brazil, and Indonesia—must assume the mantle of leadership, offering contributions of their own and prodding the reluctant industrial countries into action. This role reversal would be consistent with the greater stakes for the dynamic emerging economies. Second, the emphasis must be on technology generation. This would allow greater consumption and production possibilities for all countries while respecting the

global emissions budget that is dictated by the climate change goal of keeping average temperature rise below 2 degrees centigrade. Third, instead of the old cash-for-cuts approach—which relies on the industrial countries offering cash (which they do not have) to the dynamic emerging economies for cuts (that they are unwilling to make)—all major emitters must make contributions. With a view to galvanizing a technology revolution, industrial countries would take early action to raise carbon prices. The dynamic emerging economies would in turn eliminate fossil fuel subsidies, commit to matching carbon price increases in the future, allow limited border taxes against their own exports, and strengthen protection of intellectual property for green technologies. This would directly and indirectly facilitate such a technological revolution.

This paper is a product of the Trade and Integration Team, Development Research Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The authors may be contacted at amattoo@worldbank.org and asubramanian@piie.com.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

A “Greenprint” for International Cooperation on Climate Change

Aaditya Mattoo
(World Bank)

and

Arvind Subramanian
(Peterson Institute for International Economics and Center for Global Development)

Keywords: environment, climate change, international cooperation

JEL code: F13, F18, H23, Q56

This paper is based on, and updates, the overview chapter of our recent book, *Greenprint: A New Approach to Cooperation on Climate Change*. We are grateful to colleagues (too numerous to list individually) at the Center for Global Development, Peterson Institute for International Economics and the World Bank for helpful comments and discussions. The views represent those of the authors and not of the institutions to which the authors are affiliated.

The difficulty lies not so much in developing new ideas as in escaping from old ones.

---John Maynard Keynes, *The General Theory of Employment, Interest, and Money*

I. Introduction

International negotiations on climate change have been dogged by mutual recriminations between rich and poor countries, constricted by the zero-sum arithmetic of a shrinking global carbon budget, and overtaken by shifts in economic and hence bargaining power between industrialized and developing countries. We call these three factors, respectively, the “narrative,” “adding-up,” and “new world” problems. Given these factors, the wonder is not the current impasse. It is rather the idea that progress might be possible at all.

But there is a way forward. It requires a radical change in the approach to cooperation on climate change. We propose a “Greenprint for cooperation” that calls for a major role reversal between the developed and developing countries, a shift in emphasis from emissions reduction to technology generation, and a radical reconfiguring of contributions by individual countries.

First, instead of waiting for the industrial countries to lead, the large “dynamic emerging economies”---China, India, Brazil, and Indonesia, hereafter referred to as DEEs---must assume that mantle, offering contributions of their own and prodding the reluctant West, especially the United States, into action. This role reversal would be consistent with the fact that the stakes in the near to medium term are much greater for the DEEs than for today’s rich countries.

Second, instead of focusing exclusively on emissions cuts by all, which would imply either unacceptable cuts in consumption in rich countries or poor countries’ having to forgo the rudiments of modernity, the emphasis must be on technology generation. This would allow greater consumption and production possibilities for all countries while respecting the global emissions budget, about 750

gigatons of carbon dioxide over the next forty years, that is dictated by the climate change goal of keeping average temperature rise below 2 degrees centigrade.

Third, instead of basing cooperation on the old “cash-for-cuts” approach---not feasible today because the economically enfeebled rich are in no position to offer meaningful compensation to poorer countries in return for cuts in their carbon emissions---all major emitters, the rich and the dynamic poor alike, must make contributions, calibrated in magnitude and form to development levels and prospects. “From each, according to its ability, and to each, the common good of planetary survival” might be a characterization of contribution and reward in this new approach.

In this paper, we begin by describing, in Section II, the formidable challenge of meeting climate change goals and, in Section III, how little has been accomplished so far through the feeble efforts at international cooperation. We present, in Section IV, our diagnosis of why the current approach to cooperation will not work, and, in Section V, our proposal for an alternative approach. Sections VI and VII lay out the specific elements of the proposed Greenprint, and Section VIII reflects on the plausibility of the Greenprint as a basis for progress.

II. The Challenge

Is the world making progress on climate change? In a 2011 OECD report on climate change, Virginie Marchal and colleagues strike a hopeful note, reporting that emissions were growing more slowly than GDP in both the high-income and developing countries, including China.¹ This decoupling of emissions and growth, if true, would be good news indeed, since it would suggest that the world can

¹ Marchal et al. (2011).

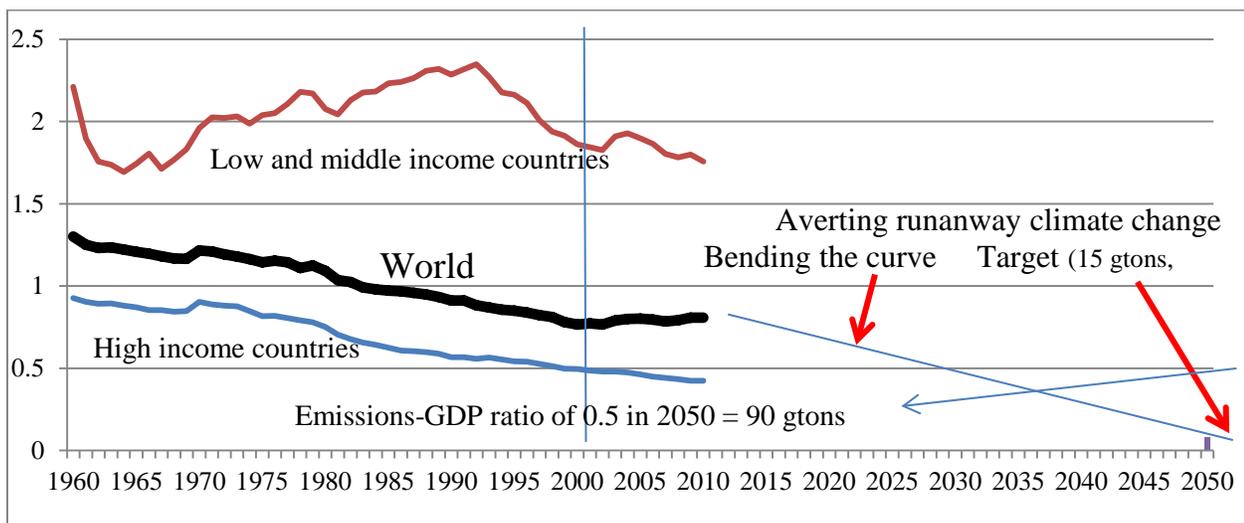
cut emissions without hurting the economic growth needed to lift hundreds of millions of people out of poverty.

But what matters is global emissions. And while it is true that global emissions grew slower than GDP between 1960 and 2000, since then decoupling has stalled and global emissions have grown as fast—or even faster—than global GDP. Figure 1 shows that the emissions/GDP ratio declined in high income and developing countries until the late 1990s but since then the global emissions/GDP ratio has been climbing. How can this be?

The answer is that fast-growing countries such as China and India account for an increasing share of global GDP, and these fast-growing countries have higher emissions/GDP ratios than the slower growing high income countries. So even though these countries’ emissions/GDP ratio is falling, as they account for a larger share of the global economy, the global emissions/GDP ratio is rising.

Figure 1. Global Emissions as share of Global GDP

(kilograms per dollar of GDP, measured in US dollars at 2000 prices)



Source: World Bank's World Development Indicators, and IEA's [Emissions data](#) (2012). Data for 1960-2009 are from the World Bank and data for 2010 are extrapolated using the International Energy Agency's most recent data for emissions.

Focusing on global emissions is important because that is what matters for the atmosphere. Similarly focusing on global GDP is important to recognize the role played by energy demand in driving global emissions. As global GDP rises, demand for energy will rise in high-income countries less than proportionately. But there will be much greater increases in energy use from developing countries. These increases from very low current levels are not only unavoidable but arguably a moral imperative, since increased energy use will be crucial to lifting vast numbers of people out of extreme poverty.

How should this play out? One can ask what needs to happen by 2050 for the world to have a fighting chance of limiting temperature increases to below 2 degrees centigrade. Put more precisely, how much does the global emissions/GDP ratio need to fall to avert runaway climate change? Suppose global GDP-per-capita growth were to average 3 percent over the next four decades, which is less than seen in recent years and assumes some under-performance by low-income countries; and global population growth to average about 0.8 percent. These assumptions, combined with the goal of limiting emissions in 2050 to about 15 gigatons of CO₂ emissions, which climate scientists say is near the upper end of what might be safe, imply that the emissions/GDP ratio must fall from the current level of 0.8 to about 0.08—that is, a ten-fold decline.

In Figure 1, the barely visible bar at 2050 is the amount of emissions that the atmosphere just might be able to tolerate without rapidly overheating. For all practical purposes, we need to be in a zero-emissions world by 2050 to avert catastrophe. Note that the drop between now and 2050 will have to be dramatically steeper than anything we have witnessed in history. The basic assumptions can be altered but they will not change the basic fact of how much the emissions-GDP curve needs to be bent. If, on the other hand, the emission-GDP curve heads anywhere close to the current trajectory, we are looking at emission levels of about 90-100 gigatons (2050 GDP is about \$185 trillion, at 2000 prices),

orders of magnitude larger than the target for 2050 of about 15 gigatons. Clearly we need an entirely different approach to climate change.

III. The Cancun, Copenhagen, Durban, and Doha “Deals”

These seem unusually inauspicious times to discuss, let alone yearn for, international cooperation to address the problem of climate change. After all, the four most recent summits held under the UN Framework Convention on Climate Change (UNFCCC)---Copenhagen in 2009, Cancun in 2010, Durban in 2011 and Doha in 2012---have come and gone. They, especially Durban, offered only a thin reed of hope based on nothing more than promises to make more meaningful promises later, rather than on concrete commitments to act now.

To the glass-half-fullers, the Copenhagen summit had notable successes:

- It moved climate change up to the top of the political agenda.
- It took several significant steps, including spelling out the goal of limiting global warming to 2 degrees centigrade.
- It called for arrangements to mobilize \$100 billion a year by 2020 to help developing countries adapt to climate change, that is, to adjust to the warming that does occur despite mitigation efforts.
- It established an advisory group to look at financing options.

But to the glass-half-emptyers, the meeting was notable for what did not happen:

- There was no agreement on binding emissions cuts and only promises of best efforts at the national level; indeed, no aggregate emissions target was set, not even for 2050.
- There was no commitment to provide public resources to the poorest, only broad statements of intent to provide international assistance.
- There was no agreement on international monitoring, reporting, and verification, but some willingness to countenance international consultation.

- There was no mechanism for reducing emissions from deforestation and forest degradation, although there was some recognition of the “need” for the “immediate establishment of a mechanism.”
- And there was no discussion of international trade in emissions rights.

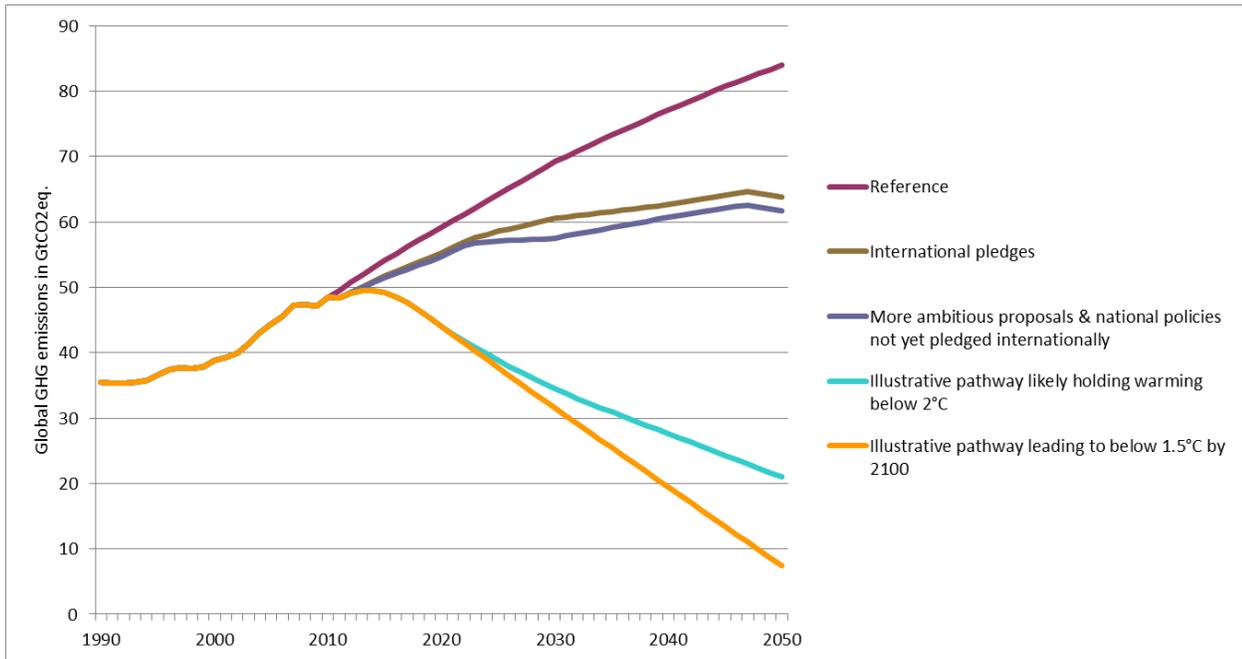
In Cancun a year later, expectations were so low that what did occur was an upside surprise. Although there was still no agreement on binding emissions reductions, the Cancun summit did lead to emissions reduction pledges from both developed and developing countries, involving all of the major economies and the largest emitters---China, the United States, the European Union, India, and Brazil. The agreements included a mechanism to track countries’ progress in meeting those commitments, and a review of the adequacy of the commitments in meeting long-term global emissions reduction goals. And they established a number of mechanisms and institutions to help accelerate emissions cuts and protect vulnerable countries, such as a Green Climate Fund (managed by the World Bank), a global network of climate-related technology experts, an adaptation framework, and a strategy for tackling deforestation.²

The big problem with the pledges made by the major countries to cut emissions is that they are inadequate compared to what the scientific community says is necessary to keep climate change to manageable levels. As Figure 2 shows, a group of MIT scientists who maintain an interactive real-time scoreboard calculate that even if all countries keep their pledges, the likely temperature rise by 2050 will be 3.2 degrees centigrade (5.8 degrees Fahrenheit). Although this would be better than the predicted temperature rise of 4.8 degrees centigrade (8.6 degrees Fahrenheit) under a “business-as-usual” scenario, it would still fall far short of the goal of limiting temperature rise to 2 degrees centigrade (3.6 degrees Fahrenheit) and emissions to below 450 ppm (parts per million). So, even on the most generous interpretation, the insurance policy against catastrophe was weak.

2. Houser (2010).

Figure 2: Projected GHG Emissions Under Different Scenarios

(Gigatons of CO₂)



Source: Climate Action Tracker (climateactiontracker.com), © 2009 Ecofys and Climate Analytics.

One year later, in Durban, the headline outcome was the agreement to start talks on a post-2020 climate accord. A new working group was given a mandate “to develop a protocol, another legal instrument or an agreed outcome with legal force under the United Nations Framework Convention on Climate Change (1992) applicable to all Parties.” The job is to be completed by the end of 2015 to enable the agreement to go into effect and be implemented in 2020. The noteworthy and new part of this

wording is that all countries are supposed to be legally bound, including the big developing-country emitters and the United States.³

Optimism has to be tempered by the fact that neither the magnitude nor the timing of commitments was specified, so it is not certain that the depressing emissions trajectory shown in figure 2 will be improved upon. Further clouding the outlook was the absence of details on the Green Climate Fund: who will contribute, how much, public funding or private, and if private, would it be via trade in emissions allocations?

The Rio+20 summit, held in June 2012, was never meant specifically to tackle or revive international cooperation on climate change. And it lived up to that expectation by producing a document of fifty-three pages of fine print described scathingly by a *New York Times* blogger as “283 paragraphs of kumbaya.”⁴ The final document contained some potentially useful ideas and promises. One was a commitment to devise new environmentally friendly development benchmarks in areas such as renewable energy and food security. It also gave a small boost to scrapping fossil-fuel subsidies, but even here the draft agreement merely invited governments to “consider rationalising inefficient fossil fuel subsidies . . . in a manner that protects the poor and the affected communities.”

At the Doha conference, progress was slow and frustrating. It is now portrayed as a way-station to a major effort slated for 2015.

IV. Why the Old Approach Will Not Work

It is abundantly clear that the approach that has been used for climate change discussions over the past twenty years hasn't worked and won't work because of the three problems that we have labeled the “narrative” problem, the “adding-up” problem, and “new world” problem. We consider each in turn.

3. Von der Goltz (2011).

4 . McDonald (2012).

A. The Narrative Problem

Climate change talks have not taken place in a historical vacuum. They have in fact been characterized by contentious and competing ethical and moral perspectives. Developing countries look at recent history and argue that the rich world has been responsible for the bulk of emissions, and, having “colonized” emissions space, has preempted the growth and development prospects for developing countries. Relying on a broad ethical notion that all citizens of the world have equal access to the atmosphere’s capacity as a carbon sink, they contend that their development opportunities should not be constrained.

Further, they are outraged that rich countries demand that they reduce their emissions, given that the difference in per capita energy use between rich and developing nations is so vast and that rich countries, especially the United States, have yet to seriously initiate the process of emissions reductions. They invoke the fact that U.S. emissions have actually increased since the 1997 Kyoto Protocol on emissions reductions (despite reductions since 2007), and find it galling that a nation of gas guzzlers, reluctant to give up its profligate ways, should be asking them to forgo the rudiments of modernity such as access to basic energy services. They also complain that rich countries have not shown enough generosity by way of financial and technology transfers to poor countries.

This narrative of recrimination has not gone unchallenged. At one extreme, Richard Cooper argues that “optimal decisions generally require [that] bygones . . . be ignored. To focus on equity, and thus the alleged retrospective wrongs of the remote past, is to assure inaction.”⁵ Vijay Joshi (2009), too, argues that the notion of historic responsibility is “a persuasive claim but it runs up against some powerful moral intuitions. The advanced countries did not expropriate knowingly. They acted in the

5. Cooper (2008, p. 20).

belief, universally held until quite recently, that the atmosphere was an infinite resource. Moreover, the expropriators are mostly dead and gone. Their descendants, even if they could be identified, cannot be held responsible for actions they did not themselves commit.”⁶ For example, if only individuals can be responsible, then calculations from the Climate Analysis Indicator Tool (CAIT) suggest that just 8 percent of the 2000 emissions stock can be traced to the flow of emissions from individuals who are still alive and might be held responsible.⁷

The rich countries have their own narrative of recalcitrance. They blame the major developing-country emitters such as China and India for not cooperating adequately and for being unwilling even to consider emissions cuts. Furthermore, claim some in the rich world, if we are responsible for pollution, then the developing world should be responsible for its large population. And if we are to be blamed for the “bads” such as emissions, then we should get credit for the “goods” that we have provided in the form of technology and research (such as those that led to the green revolution.)

B. The Adding-Up Problem

The adding-up problem is the brutal arithmetic that for the planet to survive in some habitable form, the world has to live within a fixed carbon budget of about 750 gigatons of CO₂ emissions between now and 2050. More allocations for one country mean less for another. The adding up problem arises because, contrary to popular conception and the assumption underlying much of the climate negotiations, the atmosphere is already saturated with carbon: there is no more “space” to allocate to additional emissions if humans want to preserve a climate that resembles the one in which civilization arose. The cold, hard fact is that a drastic reduction in aggregate emissions is required if we are to achieve a reasonable probability of keeping temperatures at livable levels. But the exercise is even more

6. Joshi (2009, pp. 130-131).

7. Posner and Weisbach, table 5.1 (2011).

difficult than allocating a fixed carbon budget. Any attempt at allocation is a moving target because the carbon budget is actually shrinking relative to the growing needs of developing countries.

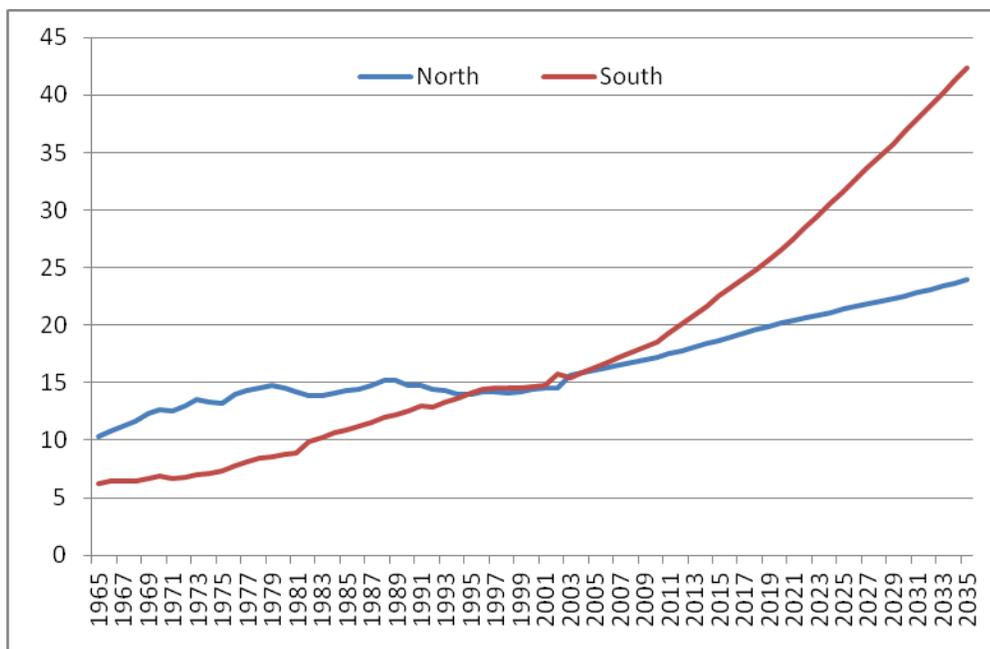
At this point, the high-income countries, with one-sixth of the world's population, are responsible for nearly two-thirds of the greenhouse gases (GHGs) in the atmosphere, and they account for about 60 percent of current emissions. But China, India, and other developing-country emitters such as Brazil, Mexico, South Korea, Indonesia, South Africa, and Iran will progressively account for a larger share of total GHG emissions, meaning that without significant cuts from them, global targets cannot be met by actions by industrial countries alone.⁸ In fact, the flows of CO₂ emissions by developing countries (the global South) have already exceeded those of the industrial countries (the global North). Even on a cumulative basis, developing-country emissions will exceed those of the industrial countries by around 2030.⁹ Not much later, developing-country CO₂ emissions in a business-as-usual scenario (if no reductions are made and everyone continues on the current trajectory) will greatly exceed the level of those consistent with keeping temperatures at reasonably safe levels (see figures 3a and 3b).

Moreover, given current rates of technological progress, the available carbon capacity is not even adequate to sustain business-as-usual growth rates for developing countries, let alone for the world as a whole. One striking calculation is that if the pace of technological change does not accelerate and if poorer countries preserve their development opportunities, rich countries will have to reduce their emissions by 270 percent! This means that they need to significantly *add* to the capacity of the atmosphere as a carbon sink---for example, by financing reforestation---for the overall carbon budget constraint to be met.

8. Joshi (2009).

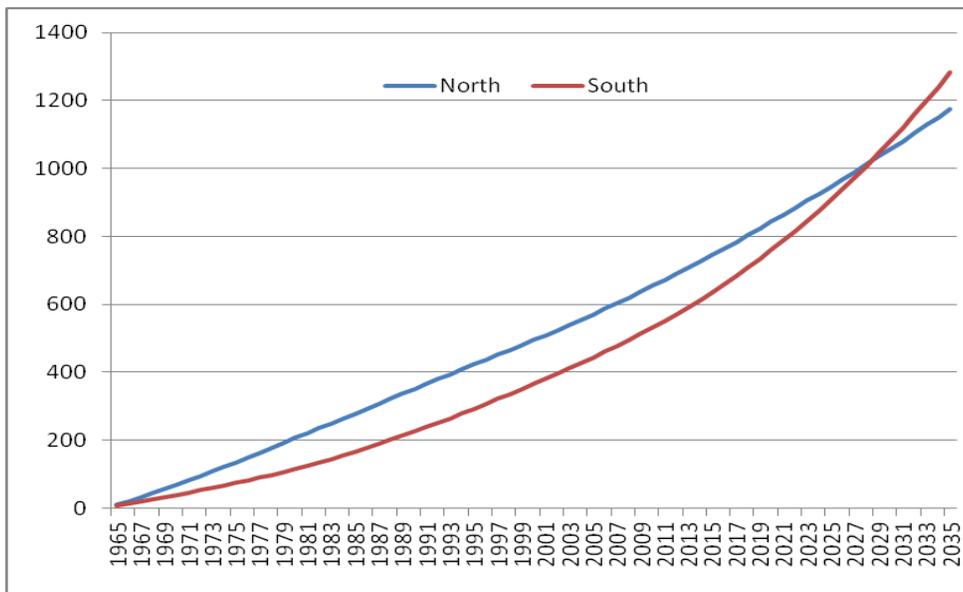
9. Wheeler and Ummel (2007).

Figure 3a. Annual CO₂ Emissions (gigatons), 1965--2035



Source: Wheeler and Ummel (2007, p. 17).

Figure 3b. Cumulative CO₂ Emissions (gigatons), 1965–2035



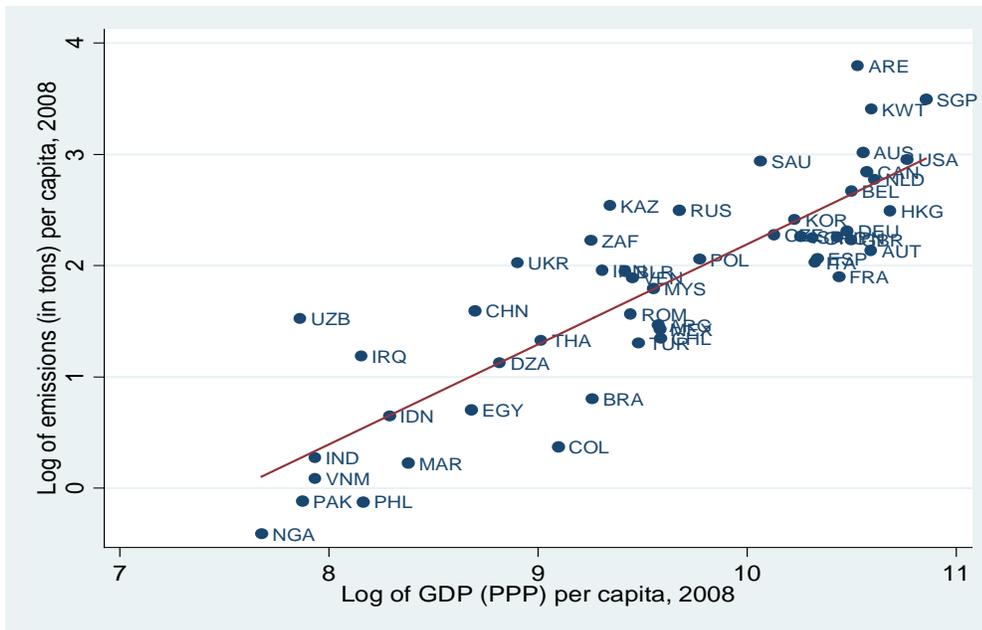
Source: Ummel and Wheeler (2007, p.17).

But could developing countries contribute to the atmosphere's carbon-sink capacity by cutting back emissions and ensuring safe global levels of CO₂? Unfortunately, emissions reductions for the foreseeable future would entail significant economic costs, given these countries' need for massive expansions in energy, transport, urban systems, and agricultural production for development. Current emissions are inequitably distributed across the world, with per capita emissions of developing countries a fraction of those of high-income countries (see figure 4). The implication is that any emissions cuts will reduce energy use and income even further beyond already low levels. Moreover, many of the large developing-country emitters are those with the better prospects for growing faster in the future, and emissions cuts would jeopardize these prospects. In short, given current technologies, growth and climate change goals are irreconcilable.¹⁰

Figure 4. International Distribution of Emissions, 2008

10. Birdsall, Subramanian, Hammer and Ummel (2009).

(Log of emissions in tons)



Source: Authors' calculations, based on data from the World Bank's World Development Indicators.

Any commitments by developing countries to reduce emissions will lead to an increase in the price of energy and hence implicitly in the price of carbon, which is embodied in fossil fuel-based energy products. This price rise will affect not just the overall economy but also the composition of production and the distribution of consumption. On the production side, manufacturing tends to be far more energy- and carbon-intensive than agriculture and services, so any increase in the carbon price is likely to lead to a contraction of manufacturing. In India, for example, the carbon intensity of manufacturing was about 518 tons per million U.S. dollars in 2004, much more than the 301 tons in agriculture and 231 tons in services. Of course, there are big differences within manufacturing, with certain energy-intensive manufacturing sectors emitting more than twice as much carbon as others.

In an international system of trading emissions rights, developing countries might have to cope with even higher carbon prices than if emission rights were not tradable. The reason is that if industrial countries undertake greater emissions cuts than developing countries and rights are not tradable, there will be international differences in carbon prices, with lower prices in developing countries than in industrial countries. But tradability---which is likely to involve producers in industrial countries'

purchasing emission rights to discharge CO₂ in poorer countries---will lead to an international equalization of carbon prices, with prices in poorer countries rising by more than that entailed by their emissions cuts alone. Higher carbon prices could lead to the contraction of dynamic industries in developing countries, which would affect growth adversely.

The sales of emissions rights will lead to large capital flows into developing countries, and this can create the same types of complications as large aid flows or natural resource revenues. Unless the money can be effectively managed or prudently invested, they could lead to a contraction of the dynamic export sectors as the economy becomes uncompetitive through foreign exchange appreciation. For instance, we find that a plausible combination of carbon price increases and transfers generated through emissions trading could lead to a decline in India's manufacturing output by over 5 percent and in manufacturing exports by over 10 percent.

On the consumption side, higher carbon prices could hurt consumers of energy, including the very poor. The conventional view is that these distributional consequences can be addressed domestically through appropriate taxation and redistribution. But it is almost a condition of underdevelopment that politics and administrative capacity will impede such actions. The experience with industrial policies and "picking winners" has highlighted the demanding and often unfulfilled requirements for successfully doing so. Identifying and assisting the poor may be even harder, as dramatically illustrated in India, where the inability to target transfers has led to carbon-inefficient subsidies for power and kerosene that mostly benefit the non-poor.

Mahatma Gandhi may have been morally astute in lamenting that the planet can survive mankind's need but not his greed. But the adding-up problem suggests that given current technologies, even fairly meeting the reasonable needs of a growing world population will have dire planetary consequences. This problem can only be solved by shifting the focus away from emissions cuts to technology generation.

C. The “New World” Problem

When the first major climate change talks took place, resulting in the 1997 Kyoto Protocol, there were, broadly, two sets of countries: large emitters that were, on average, rich, and medium to large emitters that were, on average, poor. Since then there have been significant shifts in economic power, and it is now estimated that nonindustrialized countries will account for 70 percent of world GDP by 2030 (measured in terms of purchasing power parity) and nearly 80 percent of incremental growth over the next twenty years.¹¹ China alone might account for 15 percent of world trade and 20 percent of GDP by 2030. And by then, China, India, and Brazil will rank among the five largest countries in the world in terms of their purchasing power parity.

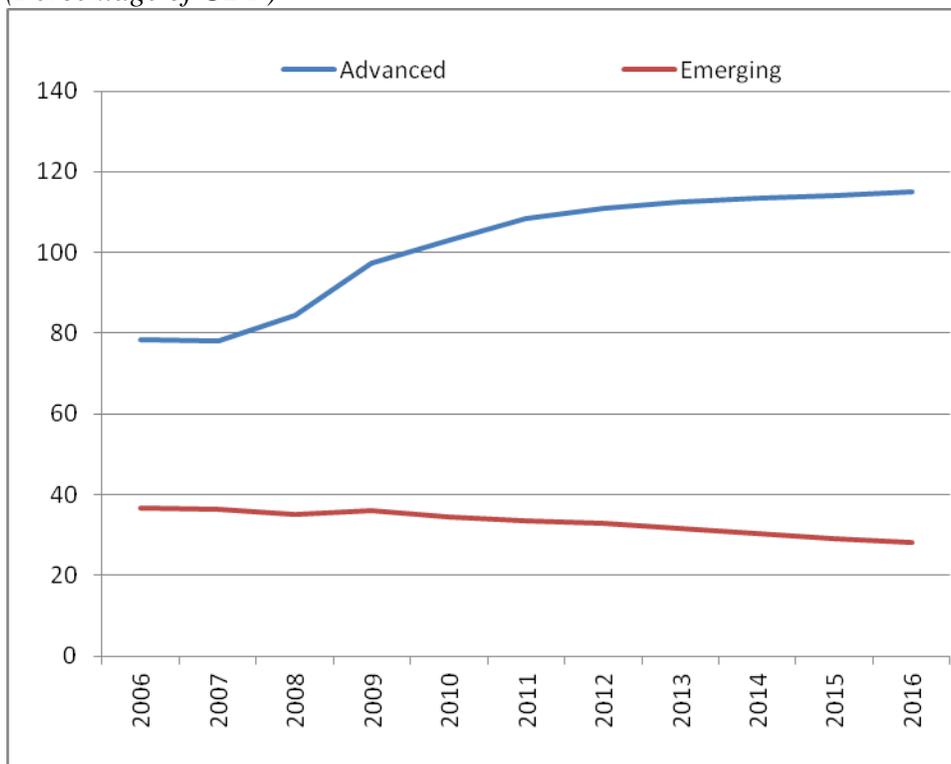
Some of the most dramatic changes are likely to occur on the fiscal front. The public sector balance sheet of advanced economies has become extremely fragile, because of rising entitlements, aging populations, the global financial crises that began in 2008, and the contingent liabilities in their financial systems. The time bomb of fiscal unsustainability is ticking not just in the United States but also, perhaps even more furiously, in Europe. Whereas debt ratios for emerging-market Group of Twenty (G-20) countries are expected to remain steady at about 40 percent of GDP, those of advanced economies are expected to rise from close to 80 percent of GDP today to 120 percent by 2015 (see figure 5).¹² These ratios for industrial countries are not expected to reach reasonable levels until well into the future---if, that is, large fiscal adjustments are undertaken.

11. Subramanian (2011). These projections assume relatively optimistic growth prospects for the United States and Europe.

12. These projections by the IMF are based on its assessment of current policies. In some ways, restricting the time horizon to 2015 understates U.S. and European fiscal problems. In the United States, the real challenges related to entitlements, especially health care, will emerge after 2020.

Figure 5. General Government Debt Ratios, 2000--14

(Percentage of GDP)



Source: International Monetary Fund 2009. P15.

These numbers illustrate the obvious: the United States and Europe are no longer economically preeminent and must now deal with the new rising powers, including and especially China, India, Brazil,

and Indonesia. These countries are large emitters---China is number 1 and India is number 3 in the emission rankings---and are now significant players in the world economic system and will have a significant say in the design of any international agreement. These new circumstances have implications for rich countries' being able to offer "carrots" such as financial transfers and wield "sticks," the threat of trade sanctions, as a way of inducing cooperative action.

Sticks-and-carrots tactics worked well in some situations. In the Uruguay Round of multilateral trade negotiations held between 1986 and 1994, which led to the establishment of the World Trade Organization (WTO), many developing countries were disinclined to change their intellectual property laws (IP). The United States and Europe threatened trade retaliation against a number of developing countries unless they changed their domestic intellectual property (IP) laws. They also offered market access under bilateral free trade agreements, to Chile and Mexico, and multilaterally, in textiles and agricultural sectors (Subramanian 2011). That the use of sticks and carrots succeeded was reflected in the Agreement on Trade-Related Aspects of Intellectual Property Rights, which created new and substantially higher standards for IP protection around the world.

But a good example of the limits to carrots and sticks relates to China and its exchange rate policy: China keeps the value of the yuan low, which promotes higher exports. The United States wants China to revalue the yuan to a higher value vis-à-vis the U.S. dollar. Despite repeated U.S. cajoling and wielding of threats, China has not substantially changed its exchange rate, a policy that no doubt reflects its growing economic footprint, its huge market, and its pool of cash. In short, its international clout. If Niall Ferguson's famous term "Chimerica" to describe the intertwining of the United States and China means anything, it is that China has become so important and powerful a player that it is no longer easy to elicit cooperation from the outside.¹³ Threats of trade and other sanctions are unlikely to work

13. Ferguson and Schularick (2007).

because China can retaliate---for example, by dumping its vast holdings of U.S. treasury paper---and cause disruption in Western markets.

In the context of climate change, the bargaining dynamic between the United States and large developing countries has been dominated by discussions of financial transfers to developing countries. How much money are we talking about? It is estimated that full compensation to developing countries for cutting current emissions by 30 percent would entail net financial transfers by the rich countries of about \$430 billion in 2020, about 1.5 percent of their GDP, and about \$3.3 trillion by 2050. Most of these flows would go to the four largest emitters. China and India would receive about \$75 and \$50 billion, respectively, in 2020 and about \$600 billion and \$175 billion, respectively, in 2050 (Jacoby and others 2008)---an event that is hard to imagine from a political point of view, especially given that in recent years, China has in effect been writing checks to the U.S. government by financing its deficits.

If financial compensation in the form of public transfers from today's rich to poor is ruled out, what about private capital flows to developing countries? An article of faith in climate change discussions is that private resource flows to developing countries from the trading of emissions allocations can alleviate the costs to developing countries from emissions reductions (Stern 2009). As the *Financial Times* editorialized, "In the actual world, a global scheme of tradable emissions quotas is the best solution" because trade in these quotas would automatically generate the transfers that could offset the costs imposed on developing countries.¹⁴

When all countries take on binding commitments to reduce emissions, capital flows will be generated through international trading of emissions allocations. How much countries gain is determined entirely by their emissions allocation. For large financial transfers to materialize, countries such as China and India would need to receive large allocations of emissions rights. Yet the heart of the climate

14. *Financial Times* (2010).

change divide is precisely that these large allocations to big developing countries are strongly resisted by rich countries. There may be a kind of “transfer illusion” based on the notion that it is harder to make public financial transfers than generous allocations of emissions rights---after all, it is this illusion that favors cap-and-trade over taxes in a domestic context. But it seems unlikely that this transfer illusion or obfuscation can overcome the fundamental economic and political realities that transfers will be large and hence economically unaffordable; and the potential recipient of transfers or emissions allocations will be the economically dynamic countries China and India.

V. Cooperation in the New World

Any prospect for success going forward will need to address each of the three problems we have identified.

A. New Narrative

Narratives matter. Not just for creating and sustaining nationhood, as Isaiah Berlin famously argued, but also, critically, in international negotiations. In the climate change talks, the old narrative must give way to a new one. In our view, the key shift will have to come from the DEEs, with China, India, Brazil, and Indonesia proactively leading the charge for action on climate change. But is this credible or plausible? We believe it is, for two reasons.

First, it is increasingly recognized that the stakes in the near to medium term are much greater for the developing countries than for today’s rich countries. They are either in or much closer to the tropics, where rising average temperatures will more quickly reduce agricultural productivity. They have much higher population densities, and therefore much narrower margins for survival as natural systems, especially water, come under stress. And they have much lower per capita incomes, making it harder to

cope with coming disruptions by making major infrastructure investments such as building sea walls or extending irrigation systems.

William R. Cline (2007) estimates the costs for agriculture. In the event of a 2.5 percent temperature increase India's long-term agricultural productivity will decline by about 38 percent, as compared with a U.S. decline of 6 percent. Overall, India and sub-Saharan Africa will suffer losses of as much as 4 to 5 percent of their GDP from a 2.5 percent temperature increase, compared with less than 0.5 percent of GDP for the United States and Japan.

More recently, William Nordhaus (2011) has calculated the social cost of carbon in terms of the change in long-run consumption due to an additional unit of emissions. He estimates that this social cost is significantly greater for China, India, and other developing countries than it is for the United States or Europe. For example, the social cost of carbon for China is about three times that of the United States and nearly four times that of Europe. For India it is about two times that of the United States and three times that of Europe. These greater costs for China and India result from these countries' greater growth prospects, which would be negatively affected by climate change, and their greater vulnerability to damage from climate change.

Hamilton (2011) captures the relative benefits and costs of mitigation for developing and industrial countries well. Using one of the standard integrated assessment models (IAMs,) he finds that the mean benefit-cost ratio for developing countries to do their efficient share of mitigation is 3.8, while this ratio if they finance all mitigation (including that in OECD countries) is still 2.7. For OECD countries the mean benefit/cost ratio for financing all mitigation (including that in developing countries) is an unattractive 0.5. Setting ethics and politics aside, the stark bottom line is that it is strongly in the

interest of developing countries to mitigate climate change -- much more so than is the case for OECD countries.¹⁵

Indeed, the alarming prospect for the DEEs is not that they will be asked to contribute too much but that the rich countries might ask too little. The rich countries, reluctant to cut emissions, may opt to interpret inaction by the DEEs as justification for attempting to adapt to climate change instead of taking aggressive actions to avert it. If the rich make this strategic choice, the consequence could be catastrophic for all parties. As the writer Simon Kuper put it, “We in the West have recently made an unspoken bet: we’re going to wing it, run the risk of climate catastrophe, and hope that it is mostly faraway people in poor countries who will suffer.”¹⁶ The large and vulnerable developing countries must go on a war footing to campaign for action, including by today’s rich countries, to avert catastrophic climate change.

A second reason why DEEs will be obliged to take the lead is because industrialized countries are increasingly incapable of doing so. The political consensus for serious action is fraying, especially in the United States. Regarding President Barack Obama’s position, the political columnist Hendrik Hertzberg noted that there is a gulf between Candidate Obama’s passionate embrace of climate change as humanity’s and his top concern and President Obama’s token allusion to climate change in his 2011 State of the Union Address, in the context of energy efficiency.¹⁷ One explanation for Obama’s inaction may be the combination of economic problems---high unemployment, low growth, and diminishing prospects for the middle class---that increasingly preoccupy American policymakers. No doubt this tension between the economy and the environment is reflected in the administration’s ambivalence

¹⁵ Indeed, developing countries must act early because delayed action on mitigation by developing countries drives up total mitigation costs for achieving a climate target very sharply, not least because a number of low-cost options are taken 'off the table' as a result of this delay.

16. Kuper(2011).

17. Hertzberg (2011).

toward the Keystone XL oil pipeline from Canada to the Gulf of Mexico. Then, too, the U.S. political and intellectual environment---characterized by the rise of those who don't accept the science of climate change and the rise of the fuel-funded lobby actively opposed to action on climate change---offers little encouragement.

In the past, the DEEs, especially China and India, were accused of being recalcitrants because they were apparently unwilling to assume their "fair" share of the responsibility for climate change action. Now, the growing political acceptance in these countries of the need to act on climate change is creating a serious possibility of a role reversal. But for China and India to articulate the new narrative, to credibly become the new *demandeurs*, they must back up their rhetoric with real contributions to the long-term solution.

B. New Arithmetic

If large transfers are off the table, developing countries can meet climate change goals without sacrificing their economic dynamism if they spew less CO₂ for the same amount of activity. This is only possible through rapid technological change---indeed, through radical, historically unprecedented technological breakthroughs.

How radical would this breakthrough have to be? In *Greenprint*, we discuss the magnitude of technology improvement and energy conservation needed to ensure that climate change objectives are met without developing countries' having to sacrifice their growth and energy-use goals. Changes of the required magnitude in consumers' energy use and producers' efficiency in the use of carbon were not observed even after the oil shocks of the 1970s, which led to an increase in the price of energy far greater than that contemplated under any of the current proposals on emissions mitigations. At that time, efficiency in the use of carbon increased only by about one-third of what it will take in the future to meet climate change goals.

C. New World Focus

But how can countries cooperate to generate the required technological progress? The key will be for the industrial countries to recognize that premature cuts in carbon emissions by developing countries would threaten these countries' economic dynamism. At the same time, the DEEs must focus on what they need to contribute, consistent with their new dynamism, to get the industrialized countries to undertake ambitious emission cuts. Rather than seeing these emission cuts as payback for historic sins, they should view these cuts as an investment to help all parties in generating technology, thereby helping to reduce the future cost of their own emissions cuts.

The framing of the issue, at least in the ongoing dialogue, would shift from "cash from industrial countries for cuts by developing countries" to "contributions from developing countries for cuts by industrial countries." Such a change in substance and attitude by developing countries could set in motion a mutually reinforcing dynamic of cooperation. Thus, the formula, informed fully by basic notions of equity, would be "To developing countries according to their growth needs; from developing countries commensurate with their growth dynamism, and to all the common good of planetary survival." This would be the basis for a "Greenprint" for international cooperation.

VI. The Logic of the "Greenprint"

What does our proposed Greenprint look like? The new approach will not look like the old one. The contrast between the old and new approaches is one of moving from a backward-looking narrative--the rich are to blame---to a forward-looking one in which emerging markets will suffer more and hence these countries must take the lead (see Table 1). The changed narrative enables a new focus, approach, and set of actions that lead to different results. Here it should be noted that the set of actions that we are proposing for the two major groups of economies, today's rich industrial economies and the dynamic emerging ones, should be seen as one possible selection from among a broad menu of options. Our aim

is to highlight that any plausible plan for cooperation would have to be vastly different from the current one.¹⁸

Table 1 Contrast between old Approach and “Greenprint for Cooperation”

Old Approach	New “Greenprint for Cooperation”
<i>Narrative</i>	
<i>Backward looking</i> – Industrial countries are to blame	<i>Forward looking</i> – Emerging-market countries are more vulnerable to consequences of climate change and thus must take the lead.
<i>Focus</i>	
<i>On emissions cuts</i> , because required cuts are considered attainable at acceptable costs	<i>On technological progress</i> , because required emissions cuts are not attainable at acceptable cost with current technologies (the “adding up” problem”).
<i>Distribution of Burden</i>	
<i>Industrial countries</i> must bear nearly all costs.	<i>All countries</i> must contribute to a solution, consistent with their economic situation.
<i>Actions</i>	

18. It is an open question as to whether cooperation should follow the current paradigm of seeking one grand agreement or involve a variety of loosely coordinated smaller-scale agreements (Barrett and Toman 2010).

Industrial and emerging-market countries both cut emissions.	Industrial countries make early emissions cuts.
Industrial countries compensate emerging market countries for losses caused by the latter's emissions cuts.	Emerging market countries take actions to support the industrial countries' cuts: <ul style="list-style-type: none"> - carbon price-related actions - trade-related actions - technology development-related actions
<i>Results</i>	
Aggregate emissions cuts consistent with climate change goals	Aggregate emissions cuts consistent with climate change goals but attained at lower developmental costs because of technological progress

These contributions would be in lieu of their own cuts and a quid pro quo for significant emissions cuts by industrial countries. Not all developing countries would be expected to make contributions---they would be expected from only a subset of developing countries whose economic dynamism has enabled them to attain a certain development threshold and contributions would be calibrated to relative economic strength. The threshold would be more or less defined by the countries in the IMF's emerging economies group. Countries below this threshold would be exempt and remain net recipients of finance and technology. Contributions could come from both what countries actually do (such as providing contributions to current economic conditions. To this end, we propose the following two suites of actions:

The rich countries would commit to a time path for an early increase in the price of carbon, targeting a steady-state price of carbon consistent finance and technology) and what they forgo (the right to seek compensation, to acquire technology at less than market cost, and to preserve existing access to foreign markets).

- Central to our proposal is providing incentives to generate technology that addresses the adding-up problem and to calibrate with creating a path of emissions reductions that would

bring emissions per capita down from just about twenty tons now to two tons in all industrialized countries by 2050---in keeping with a 80 percent reduction from 2005 levels.¹⁹

This carbon price would be the key price signal to galvanize the green technology revolution.

- The large developing countries would complement and facilitate this industrial-country action in three key areas: carbon price, trade and technology. These would either directly help reduce emissions (when they reduce consumer subsidies for energy), directly help technology generation (when they raise IP protection for green technologies, subsidize green technologies, or contribute to a technology fund) or indirectly help technology generation by facilitating industrial country action (when they agree to allow industrial countries to impose border taxes on carbon).

If all parties implement these actions, we would expect green technological change to be galvanized and better technologies to start flowing. At that stage, it would become easier for the DEEs to take on emissions reductions obligations, which would be triggered when certain technology thresholds are met, such as the price of renewables' falling sufficiently relative to fossil fuels. Specifying these thresholds, and calibrating individual countries' emissions obligations to these thresholds and other economic circumstances, would need to be carefully discussed and perhaps would need to be legal commitments.

VII. Elaborating on the Actions by the Dynamic Emerging Economies

In this section we present and discuss a menu of specific contribution that DEEs could choose to adopt (summarized in Table 2).

19. The carbon price that can achieve the emissions reductions objective will of course be intensely debated because it will depend on a host of economic, technological, and ethical factors.

Table 2 Generating a technological revolution – shared but divergent responsibilities

<i>Industrialized countries' responsibility</i>		<i>Emerging-market countries' responsibilities</i>
Raise the price of carbon to make Early and significant emission cuts	Carbon price- related actions	Progressively eliminate fossil fuel subsidies Commit to commit “for every one dollar increase in carbon price by industrial countries at date t, we will raise carbon price by \$X by date t+Y”
	Trade-related actions	Allow limited border tax adjustments by countries that raise the price of carbon Support reform of trade rules that allows greater scope for green subsidies Eliminate local content requirements which raise costs in green industries
	Technology- related actions	Contribute to global technology fund Strengthen protection of IPRs related to green energy and technology

A. Carbon Prices

i. Progressively eliminating fossil fuel subsidies

Developing countries could directly contribute to climate change mitigation by committing to phase out subsidies for fossil fuel consumption, which impose large economic costs within these countries, especially because they encourage profligacy in the use of water for agriculture. These water-related costs will only increase in the presence of climate change and growing water scarcity. Of course,

there could even be a quid pro quo, with the DEEs demanding a reciprocal elimination of tax breaks for the fossil fuel industry in rich countries.

The OECD estimates that the removal of energy subsidies in all non-OECD countries would lead to a substantial decline in emissions from fossil fuel consumption, amounting to a 10 percent decline in global GHG emissions in 2050 compared to business as usual. China's emissions would be reduced by over 10 percent, India's by close to 25 percent, and Russia's and other oil-exporting countries' by around 30 percent.

ii. Committing to future emissions reductions

Lord Nicholas Stern has argued that developing countries should "conditionally commit to commit."²⁰ By this he means that the key conditions for them to cut their emissions would be ambitious emissions reductions by the industrial countries and the delivery of financial assistance. Ambitious emissions reductions by industrialized nations would still be a key condition because that is the sine qua non for incentivizing technological progress. However, the Stern condition on financial assistance is now politically infeasible, at least for India and China, as discussed earlier.

The reason for developing countries to commit to emissions reductions is to strengthen the incentives for technology creation in the long run by assuring innovators of a bigger market that would include the large developing countries. But this commitment is only credible if technological progress mitigates the costs to developing countries of emissions reductions.

Accordingly, developing country emissions reductions could be made conditional on, or triggered by, technology improvements in key areas such as carbon capture and storage; car battery; fuel efficiency, and so forth.²¹ Future discussions should establish how these technology triggers could work

²⁰ Stern (2008).

²¹ Patel (2010).

in practice. This approach is consistent with developing countries' willingness, expressed at Durban, to take on legally binding commitments in the future.

One possibility consistent with the role reversal inherent in the logic of our Greenprint might be the following, especially to prod the West into action. For example, China can do so by offering the following deal to the United States: any action by the United States today to place a high price on carbon would be matched by China according to a precisely specified, and even legally binding, timetable. Thus, for every \$10 increase in the price of CO₂ implemented by the United States now, China would increase carbon prices by, say, \$5 in 15 years and it would match fully the US carbon price by 2040. This assurance would facilitate US action and also guarantee high long-term returns to private sector investment in green technologies.

B. Trade

i. Promoting green subsidies

Consider certain episodes from last year. In late 2012, the United States sanctioned not only the use of anti-dumping duties from 18 to 250 percent against Chinese exports of solar panels on the grounds that Chinese manufacturers were “dumping” (selling below cost) solar panels, but also imposed anti-subsidy or countervailing duties of around 15 percent in response to state support for solar panels. Moreover, in the US Presidential debates, Mitt Romney put President Obama on the defensive by trying to tar him with the “failed industrial policy” brush in relation to government support for clean energy and Solyndra.

The European Union has also launched two investigations against Chinese solar panel exports, alleging dumping in one and subsidization in the other. Rulings in these cases are expected soon. These examples illustrate how international rules and ideology (which underlie the former) could come in the way of efforts to tackle climate change.

As mentioned above, under current WTO rules, economy-wide subsidies for clean energy would be permissible because they are not specific to an industry. However, any form of export subsidies

including those involving clean energy and/or green technologies is prohibited (see Part II of the WTO Agreement on Subsidies and Countervailing Measures (SCM) and Pauwelyn 2009). Domestic subsidies for specific industries for the development and production of green products are not prohibited but actionable by partner countries if the latter believe that their domestic production or exports are adversely affected (See Part III of the WTO's SCM Agreement and Green 2006).

Partner countries can take two types of actions: Where they are affected in third markets, they can contest the subsidies through the WTO dispute settlement mechanism, asking for them to be curtailed or removed; and where they are affected in their own markets they can, in addition, impose countervailing duties on products benefitting from such subsidies, subject to a number of conditions, including demonstration of injury to a domestic industry (see part V of the WTO's SCM Agreement). Until 2000, some environmental subsidies were deemed non-actionable but that exemption has not been renewed. Thus, under the current regime, such subsidies are potentially in the actionable category.

On the face of it, these rules are an example of how trade negotiations can produce disciplines that are good for global welfare. In principle, any benefits of subsidies—such as enhancing the competitiveness of domestic producers—are outweighed by their costs to the granting government. Nevertheless, politically influential producer groups (think agriculture and aircraft makers) can sometimes extract subsidies from a government, which can in turn provoke retaliatory subsidies from other governments and lead to a wasteful subsidy war. WTO rules which prohibit export subsidies and render production subsidies actionable are meant to prevent precisely such a non-cooperative outcome. In relation to climate change, however, these rules curtail three important benefits of subsidies. First of all, any subsidy that promotes clean energy and green products at home confers a benefit also to partner countries. If China generates less CO₂, that is partly a benefit for the United States. So the calculus of costs and benefits gets altered because of the global spillovers from such subsidies.

Second, a country also makes available cheaper green products and technologies to other countries, and that encourages their use. If these products generate positive environmental spillovers,

then they are likely to be underused at normal market prices, and subsidies can take us closer to the social optimum. Retailers and solar installation companies in the United States, which benefited from cheap Chinese solar panels, argued vehemently, but in vain, against curtailing competition from China. European action may cause the solar energy market to shrink, studies suggest. Any increase in domestic production and employment due to higher prices of Chinese products would be outweighed by decreases suffered by upstream and downstream firms.

Third, there is an arguably bigger political economy benefit. Prospects for climate change action in the United States in the form of a carbon tax or cap-and-trade do not seem bright. President Obama's acknowledgement of climate change as a priority in his State of the Union Speech is unlikely to be matched by bold action because of the lack of bipartisan support in Congress. This state of affairs reflects a combination of factors—climate change denial, the strength of the carbon energy industries, and weak economic prospects. Thus, the United States is unable or unwilling either to raise the price of carbon or to subsidize cleaner fuels and technologies. One development may galvanize action in the United States: the threat that green technology leadership will be captured by China. In other words, the United States needs a Sputnik moment of collective alarm at the loss of US economic and technological ascendancy.

China and other countries are today being straitjacketed by the subsidies-are-bad ideology. The global battle against climate change is thus being fought with a depleted arsenal (see, for example, Acemoglu et al. 2011). Countries that have the financial means to do so should be allowed to deploy industrial policy to promote clean energy and green technologies. What the world needs is unbridled competition or even a race initiated by a change in global trade rules to facilitate large scale support for the development and production of the currently under-supplied green goods. The United States would be forced to respond. Fiscal weakness might prevent the grant of retaliatory subsidies by the United States. But that might force the United States into the best possible reaction: increasing the price of carbon as a way of re-gaining the technological edge on climate change.

This logic applies also to export subsidies. They may also confer environmental benefits, but they are likely to inflict greater damage on partner countries in terms of trade displacement and are blatantly mercantilist instruments. It may be harder to agree on greater permissiveness vis-à-vis such instruments and their use may generate a stronger political backlash in importing countries.

In light of the above, we would propose altering current rules in the following manner. Production subsidies for specific green products and technologies should be permissible. Partner countries should not be able to take action unilaterally or through WTO dispute settlement against them. Export subsidies related to green products and technologies should not be prohibited. However, since they carry greater risks of mercantilist abuse, they should be regulated more strictly than production subsidies. That is, depending on certain thresholds—in terms of the magnitude of subsidies and the damage to partner country trade—which could be specified in the future, they should be actionable either through multilateral dispute settlement or through countervailing action. In the language of current WTO subsidy rules, we would be shifting the treatment of subsidies one notch in the degree of greater permissiveness: Specific green subsidies that are currently actionable would be permitted; and current export subsidies that are prohibited would be made actionable.

We would not change existing rules for subsidies contingent upon the use of domestic over imported goods. Local-content promoting subsidies have been implemented in China, India, and Canada and several countries, and contested by the United States and others (in fact China stopped providing such subsidies to its solar power companies in response to trade action by the United States). These subsidies do not have the environmental benefits of other subsidies because they merely induce the substitution of more costly domestic inputs for cheaper foreign alternatives, and therefore do not further—they may even hinder attaining—environmental objectives.

We can speculate on how WTO law might view trade interventions to address global spillovers such as those from granting production and export subsidies for green goods which have a beggar-thy-neighbor aspect but which help address the problem of climate change. In the famous shrimp-turtle case

the WTO Appellate Body declared legitimate a US import ban on shrimp caught using a production process that was harmful to an endangered species of turtles.

By allowing a ban based on the process of production and not the product itself, the WTO acknowledged that members were permitted, under some conditions, to take trade measures to protect the global public good even when the damaging action was taking place outside the territory of the member. If negative interventions such as bans can be justified in this manner, surely it would make sense also to legitimize or be more permissive toward positive actions such as production and export subsidies when they serve to protect the global environment by encouraging more climate-friendly production and consumption outside a member's territory.

ii. Allowing border tax adjustments

With notable exceptions, countries around the world have shown great reluctance to raise directly the domestic price of carbon. Countries that are inclined to raise carbon prices may favor additional border taxes, for two reasons: to offset the competitiveness disadvantage to their firms, and to prevent the "leakage" of carbon emissions in the form of increased production in countries with lower carbon prices. Other countries are wary of border taxes because of the "slippery slope" problem, i.e., once allowed, they could serve protectionist goals.

As Table 3 shows, there is a range of actions/approaches that have been proposed, which vary in terms of their trade and environmental friendliness and also in the manner and extent to which they address underlying political economy problems. At one end, there is the recent Australian carbon tax that was implemented unilaterally whose key feature is that the tax is not applied on imports. Instead, the government removes some of the carbon tax burden on domestic firms in the energy-intensive and

trade-exposed sectors over time.²² This tax can thus be seen as very trade-friendly because it is not imposed on imported goods. By the same token, it exposes domestic industry to greater competition from imports from countries that do not impose similar carbon taxes as Australia.

Table 3 Possible border tax adjustments

<i>Pro-Trade ←</i>		<i>→Pro-environment (substantive + political economy)</i>	
Australian carbon tax	Carbon safeguard mechanism	Carbon embodied in domestic production	Carbon embodied in imports (various US legislative proposals)
Export taxes levied on carbon-intensive exports			

At the other end of the spectrum are border tax adjustments imposed on imports based on the carbon embodied in them. In the climate change bill introduced in the US Senate by Senators Boxer and Sanders in February 2013, there was a provision for a “carbon equivalency fee” on imports of carbon pollution-intensive goods. In the European Union, no clear policy initiatives have so far been taken in relation to border tax adjustments except in relation to carbon taxes on domestic and foreign airlines. But in the past, then French President Nicolas Sarkozy, among others, called for countries in the European Union to adopt carbon taxes and to impose adjustments at the border for these taxes.

Can border taxes be designed in a way that addresses these conflicting concerns?

From a trade perspective, border tax adjustments applied symmetrically to imports and exports essentially transform production-based taxes into consumption-based taxes (Grossman 1982). Such adjustments do not alter the incentives within a country to produce exports or importables. From an environmental perspective, border tax adjustments are aimed at ensuring that the emissions reductions achieved within a country through a tax are not totally offset by the increase in emissions that occurs in partner countries by virtue of expanded trade.

²² Moore (2013).

What would be the status of different forms of BTAs under existing trade rules? WTO law and jurisprudence are evolving and not completely clear on what types of actions would be legitimate (see Hufbauer et al. 2009; Pauwelyn 2009, Bhagwati and Mavroidis 2007, UNEP and WTO 2009, and Horn and Mavroidis 2011, among others for a thoughtful examination of the legal implications of possible trade actions). The WTO issue on border tax adjustments relates to the basic national treatment principle in Article III of GATT (1994). This article clearly permits the imposition on imports of domestic indirect taxes provided the taxes on imports are no higher than the taxes levied on like domestic products.

Under the GATT panel ruling in the Superfund case, indirect taxes levied on domestic inputs could also be imposed on imports provided these inputs were embodied in the final product (see UNEP and WTO 2009). However, there is no WTO jurisprudence on whether such adjustments are permissible for inputs (such as energy) that are used in production but are not themselves incorporated in the final product. Even if border tax adjustment is permitted on inputs that are consumed but not incorporated in the final product, it is not clear whether it should be based on the carbon content of domestic production or foreign production. The ruling in the Superfund case suggested that the border tax adjustment could be based on the amount of input embedded in the import, so there is a presumption in favor of the latter interpretation.

We show in Greenprint that BTAs based on carbon content in imports would have drastic trade consequences. There is also a serious practical problem with BTAs based on inputs that are consumed in the process of producing the output. Implementing carbon taxes based on the direct and indirect carbon content in imports would require data not only on production methods in all source countries but also information on the origin of each input. Different imports from one country could have different carbon content depending on where the inputs used in production were sourced: US imports of car A from Malaysia that used steel from, say, Brazil would face a different kind of border tax adjustment than car B also from Malaysia that used steel from China. In a world of internationally fragmented

production, establishing the precise carbon content of any particular product would be nearly impossible. These daunting informational requirements could allow considerable scope for rent-seeking behavior as firms try to manipulate information to influence the taxes imposed on particular goods from particular countries.

These considerations suggest that a possible compromise between no border tax adjustments (as in the case of the Australian carbon tax), which is best from a trade perspective, and adjustment based on carbon content of imports (as in various US legislative proposals), which is attractive from an environmental perspective, could be adjustment based on the carbon content in domestic production. Countries could accept this principle as a pragmatic and negotiated compromise between not just trade and environmental concerns, but also between the interests of different countries.

The case for such adjustment is strengthened by our finding that unilateral emission reductions by industrial countries lead primarily to a loss in industrial competitiveness rather than to significant “leakage” of emissions. Adjustment based on carbon content in domestic production addresses competitiveness concerns in industrial countries without inflicting undue pain on developing countries.

An alternative to import taxes would be for the exporting country to impose taxes on exports, which could be designed to have the same environmental consequences as the import-based border taxes. The big difference would be that the tax revenues would be collected by the exporting countries rather than the importing countries. Such taxes could in principle be implemented unilaterally without the need for any change in trade rules. But international cooperation, in the form of coordination and information-sharing between importing and exporting countries (but also more broadly in the form of clarifying existing rules) would help walk the narrow path between carbon tax avoidance (if the exporting country under-taxes) and double taxation of carbon (if the importing country taxes what has already been taxed).

C. Technology

i. Strengthening IPR protection for green technologies

The WTO's TRIPs agreement requires countries to provide patent protection for all fields of technologies (Article 27.1). TRIPs provisions would therefore apply to new technologies and products related to climate change as well. However, what TRIPs gives technology creators with one hand, it partially claws back with another hand, through fairly permissive compulsory licensing provisions. Countries can grant compulsory licenses (licenses granted without the authorization of the patent owner) without specifying the reasons, provided they fulfill certain conditions. Two important conditions are: providing due process and ensuring "adequate compensation" for the patent holder (Article 31 (h)).

Now, developing countries have been using compulsory licenses, especially in the area of pharmaceuticals, to dilute the patent right and lower prices of medicines in order to achieve health goals (Brazil and India being recent examples). Some of the rhetoric surrounding environmental technologies suggests that developing countries may favor weaker intellectual property rights to facilitate dissemination of such technologies.

If, however, these countries come to believe that (i) the stakes in preventing climate change are high for them (as we argue in our book, *Greenprint*); (ii) technology generation is key to preventing or mitigating the effects of climate change; and (iii) because they are large emitters of greenhouse gases and because their markets for green technologies are large, technology generation will be materially affected by the property rights protection that they provide, then their incentives for strengthening intellectual property rights (IPR) protection will be enhanced. In this case, rules on IPRs could be strengthened.

One way of doing this would be to tighten the compulsory license provisions at least for the large emerging market economies such as China, India, Brazil, Indonesia, Russia, and South Africa. One possibility, for example, would be to change Article 31 (h) of the TRIPs agreement to say that where compulsory licenses are granted for green technologies, the right holder shall be paid remuneration

related to the fixed cost of inventing them (suitably apportioned across the large markets). Another way could be to make stronger commitments to enforce IPR laws in relation to green technologies.

ii. Creating a global technology fund

Large developing countries continue to see themselves as recipients of financial inflows. The new reality, however, is that industrial countries simply cannot afford to provide financial compensation for action on climate change. DEEs could make a virtue of this new reality. One option would be simply to declare, as China has implicitly done, that they would not be claimants for international transfers related to climate change. A more ambitious option would be to help set up and even contribute to an international fund for technology generation and dissemination.

Such a fund could have two objectives: first, to provide incentives for creating a public “commons” of green technologies, with the clear understanding that any such technologies would be freely available because they would not have been privately funded. This part of the fund could be set up as advance market commitments, financial commitments to subsidize future purchases of a product or service up to predetermined prices and volumes. Michael Kremer and Rachel Glennerster (2004) have shown how such a structure could be applied to developing a pneumococcal vaccine in a pilot project by the GAVI Alliance and the World Bank (see also Berndt and others 2007). A coordinated technology fund could overcome problems of fragmentation and insufficient incentives that might arise from purely national efforts. A second objective would be to finance the transfer of green technologies, especially those created in the private sector, to countries that might not be able to afford them.

This new fund could be the first postwar and post-G-20 international institution with a governance structure reflecting the economic importance of large developing countries. Contributions could be based on two criteria, ability to pay and potential benefits, which would differentiate these countries on a simple, fair, and transparent basis. If twenty-two emerging market countries contributed about 0.2 percent of their GDP annually over fifteen years, their contribution alone to the global technology fund would be about half a trillion dollars.

D. New Carrots and Sticks

Note that in the old approach, the rich countries were wielding the carrots of financial transfers to induce emission cuts by the poor countries and the stick of trade action as the penalty for not undertaking such cuts. Here we suggest replacing the current approach to climate change cooperation, which relies on the West offering cash (which it does not have) to developing countries for cuts (that they are anyway unwilling to make). It is China, and eventually other developing countries, that must offer inducements.

Radical role reversal is central to our approach to climate change cooperation, reflecting the broader shift in economic dominance from America to China.

In the Greenprint we envisage some significant role reversal as to who brandishes the sticks and who offers the carrots, reflecting these shifts. The DEEs would implicitly be offering carrots if, consistent with their fiscal strength, they were to make financial contributions to the Green Technology Fund that would benefit all countries, and if, to facilitate emission cuts, they were to allow rich countries to take trade actions against the exports of DEEs.

Could the DEEs also wield sticks against any failure of the rich to contribute to climate change prevention? One possibility would be for the DEEs to threaten to take trade action against the exports of rich countries---or at least their energy-intensive exports---if they failed to undertake the early emissions cuts that, according to the Greenprint, are critical to unleash technological innovation.

The DEEs could even enact legislation according to which they could take trade-restrictive action against all countries that exceeded a target level of per capita emissions (say, five tons) by 2025. Such a stick would be a natural complement to the carrot of constructive engagement that they would offer. The stick would also implicitly help set an international standard of equity and fairness on emissions targets that is an alternative to the current one, advanced by industrial countries, of reductions in absolute emissions.

Such a dramatic role reversal could play a part in breaking the policy paralysis on climate change in the rich countries, especially the United States. If, for example, the DEEs target U.S. manufacturing exports, these industries could be galvanized into putting pressure on the carbon-based sectors to loosen their grip on climate change policy.

For a dramatic role reversal whereby the DEEs wield sticks against the rich for noncooperation to have credibility, it might be necessary for the DEEs to either take or commit to some serious actions that put serious pressure on rich countries. One possibility might be for the DEEs to eliminate fossil-fuel subsidies, or to commit to achieving that goal within, say, five years, and set a path for future carbon prices. They could then more credibly threaten trade action if the rich countries do not undertake emissions cuts.

VIII. Is the New Approach Plausible?

What are the odds that our proposed Greenprint would be embraced by either the large developing-country emitters or the rich countries, especially the United States?

There is reason for optimism regarding the large developing-country emitters because they are already following the same approach domestically. To preserve its existing comparative advantage, China is not confronting traditional manufacturers with higher carbon prices. Instead, it is providing incentives for green technologies to help its comparative advantage evolve in new directions. It plans to generate 15 percent of its energy from renewable sources by 2020. In 2007 China invested \$12 billion in renewable energy, which placed it second in the world in absolute dollars spent, just behind Germany. Over the next decade it plans to spend between \$440 billion and \$660 billion on new energy development, made doable by its economic dynamism and strong fiscal picture.

India and other large developing-country emitters such as South Africa are acting similarly: instead of raising the price of carbon, they are paying much higher prices for renewable energy sources. India has begun reducing fuel subsidies and deregulating the pricing of some petroleum products; it

intends to generate 15 percent of its total power from renewable sources by 2020. David Wheeler and Saurabh Shome (2009) estimate that this policy is equivalent to a total CO₂ charge of about \$80 billion for emissions from new coal-fired power facilities between 2010 and 2020. The relative price changes induced in this manner may have a less disruptive effect on downstream users of energy than an increase in carbon prices, with the government absorbing the dislocation costs that would otherwise be imposed on the private sector.

More broadly, this strategy is resulting in large developing countries' taking the lead in shifting to low-carbon energy development. For example, Wheeler (2009) estimates that 68 percent of the increase in low-carbon energy generation---including biomass, solar, wind, geothermal, hydro, and nuclear---during the period from 2002 to 2008 has been in developing countries.

Are we asking too much of developing countries? We do not think so. First, our approach reflects the key equity principle of preserving full development opportunities for the poorer countries; that is why they would not be required to make any emissions cuts. Second, consistent with this equity principle, it is industrialized countries that would be required to make ambitious (large in magnitude and front-loaded) emissions cuts. Third, many of the contributions we suggest merely internationalize actions that the DEEs are already pursuing domestically. Fourth, our proposed contributions are a menu of options rather than a must-do package.

As for rich countries, amid the generally gloomy political climate, there may be some spurs for action. Just as the melting of the Himalayan glaciers has aroused a new sense of urgency in India, so the repeated forest fires in the western United States, coinciding with nine of the ten hottest years ever recorded, can shake the United States out of its torpor.

Second, the United States faces a medium-term fiscal crisis of unprecedented proportions. The arithmetic is such that new sources of revenue will have to be found to bridge the deficit, and taxes on carbon or the auctioning of any carbon caps could feature prominently as part of the solution to the fiscal crisis. Action on climate change could thus be forced by fiscal rather than scientific or moral

imperatives. In 2011, Professor Alan Blinder made a case for a U.S. carbon tax of 8 cents on every gallon of gasoline in 2013, rising to 26 cents by 2015, to kick in after the current recovery takes hold.²³ He argues that such a tax not only would address the U.S. fiscal problem but also would be good for the environment, stimulate innovation in green technologies, and reduce fuel dependence.

Third, the shale gas revolution has made available a cleaner source of energy, which will make it easier for the United States to meet given emission targets. Put differently, the carbon tax that will need to be imposed by the United States in this post--shale gas world will likely be lower than previously, even though some of the emission benefits may be diluted because of the reduced incentives to develop even cleaner sources of energy such as solar and wind.

In addition, the United States might be motivated by a desire to avoid a trade conflict with Europe, which notwithstanding its ongoing economic difficulties, has a durable interest in climate change policy. If Europe takes further action on this front, it will want to safeguard the competitiveness of its energy-intensive industries from those not similarly encumbered by carbon taxes. In air transport, the EU is already insisting that foreign airlines operating in Europe buy emissions quotas just as European airlines will be obliged to do. The irony is that the United States, which has considered wielding the trade instrument against recalcitrant developing countries, might find itself the target of such instruments.²⁴

Then, too, the United States might be roused into action by the growing technological threat from China. Already, U.S. business has been alarmed at China's attempts to develop technology in other areas

23. Blinder (2011).

24. The implications for emissions reductions of the Fukushima tragedy in Japan remain unclear. Germany, for example, announced a policy to phase out nuclear power plants. Whether such reactions signal just a shift away from nuclear energy or a renewed interest in other sources with a clear impetus toward reduced GHG emissions remains to be seen.

through government support and obtaining technologies from abroad. The thought that China could easily replicate these actions in the new green areas is weighing heavily on U.S. business and government.

IX. Conclusion

Reducing greenhouse gas emissions to prevent catastrophic climate change needs a new Greenprint for international cooperation. The pre-Copenhagen formula of “cash for cuts” was predicated on a division of the world into rich and poor. The recent financial crisis and the longer-term forces of economic convergence have combined to put that world behind us. Now, an economically enfeebled industrial world must engage with a financially strong and economically confident developing world on the basis of a new assessment of strengths and constraints.

Will cooperation on climate change be easy? Almost certainly not. But we are confident that the current approach will not work, as Keynes reminded us. That is why in writing this paper we have attempted to provide ammunition to escape the stranglehold of the old approach, characterized by a narrative of recrimination and recalcitrance. Developing countries focus on the past, when rich countries “colonized” the carbon space, and seek contributions commensurate with historic responsibility. In contrast, industrial countries focus on the hypothetical future, when the dynamic developing countries will be large emitters, and complain that the future despoilers are unwilling to begin making contributions now.

We urgently need a new narrative, one characterized by leadership and innovation. In particular, developing countries must recognize their immense stakes in averting climate change, stakes that are even greater than those for the rich world, which will be affected less and have more resources to adapt. They must now take the lead and prod an increasingly reluctant West, especially the United States, to act. By making meaningful contributions of their own, they can claim the mantle of leadership. This means bringing into play policy instruments beyond carbon pricing, redefining the categories of rich and

poor, and modifying the roles of financiers and recipients of funds. Our Greenprint suggests a way to help efface humanity's potentially catastrophic carbon footprint.

References

- Acemoglu, Daron, Philippe Aghion, Leonardo Bursztyn, and David Hemous. 2011. The Environment and Directed Technical Change. *American Economic Review* 102, no. 1: 131–166.
- Barrett, Scott, and Michael Toman. 2010. “Contrasting Future Paths for an Evolving Global Climate Regime.” Policy Research Working Paper No. 5164. Washington: World Bank.
- Berndt, Ernst R., Rachel Glennerster, Michael R. Kremer, Jean Lee, Ruth Levine, Georg Weizsäcker, and Heidi Williams. 2007. “Advance Market Commitments for Vaccines Against Neglected Diseases: Estimating Costs and Effectiveness.” *Health Economics* 16, no. 3: 491--511.
- Bhagwati, Jagdish, and Petros C. Mavroidis. 2007. “Is Action Against US Exports for Failure to Sign the Kyoto Protocol WTO-Legal?” *World Trade Review* 6, no. 2: 299--310
- Birdsall, Nancy, Arvind Subramanian, Dan Hammer, and Kevin Ummel. 2009. “Energy Needs and Efficiency, Not Emissions: Re-Framing the Climate Change Narrative.” CGD Working Paper 187. Washington: Center for Global Development, November.
- Blinder, Alan S. “The Carbon Tax Miracle Cure,” *Wall Street Journal*, January 31, 2011.
- Cline, William R. 2007. “Global Warming and Agriculture: Impact Estimates by Country.” Washington: Center for Global Development and Peterson Institute for International Economics.
- Cooper, Richard N. 2008. “The Case for Charges on Greenhouse Gas Emissions.” Harvard University, Kennedy School of Government, Belfer Center for Science and International Affairs, Harvard Project on International Climate Agreements, October.
- Ferguson, Niall, and Moritz Schularick. 2007. “‘Chimerica’ and the Global Asset Market Boom.” *International Finance* 10, no. 3: 215--39.
- Green, A. 2006. Trade rules and Climate Change Subsidies. *World Trade Review* 5, no. 3: 377–414.

- Grossman, Gene, 1982, "Border Tax Adjustment," *Journal of Inter-national Economics*, vol. 10, no. 1, February 1980.
- Hamilton, Kirk, 2011, "Benefit-cost ratios for climate mitigation: PAGE2002 simulations," note prepared for World Development Report.
- Hertzberg, Henrik, "Cooling on Warming," *The New Yorker*, February 7, 2011.
- Horn, Henrik and Petros C. Mavroidis. 2011. To B(TA) or not to B(TA)? On the Legality and Desirability of Border Tax Adjustments from a Trade Perspective. *World Economy*.
- Houser, Trevor. 2010. "Copenhagen, the Accord, and the Way Forward." PIIE Policy Brief No. 10-5. Washington: Peterson Institute for International Economics.
- Hufbauer, Gary Clyde, Steve Charnovitz, and Jisun Kim. 2009. "Global Warming and the World Trading System." Washington: Peterson Institute for International Economics.
- International Energy Agency, 2012 "CO₂ Emissions from Fuel Combustion Highlights."
- International Monetary Fund, "The State of Public Finances Cross-Country: Fiscal Monitor, November 2009" (Washington: IMF, November 3), p. 15
- Jacoby, Henry D., Mustafa H. Babiker, Sergey Paltsev, and John M. Reilly. 2008. "Sharing the Burden of GHG Reductions." Report no. 167. Massachusetts Institute of Technology, Joint Program on the Science and Policy of Global Change.
- Joshi, Vijay, 2009. "Comments on Climate Change and India: Implications and Policy Options." India Policy Forum 2009/10 - Volume 6 , The Brookings Institution and National Council of Applied Economic Research.

- Kremer, Michael, and Rachel Glennerster. 2004. *Strong Medicine: Creating Incentives for Pharmaceutical Research on Neglected Diseases*. Princeton University Press.
- Kuper, Simon, "Climate Change: Who Cares Anymore?," *FT Magazine* (blog), September 17, 2011.
- Mark McDonald, "U.N. Report from Rio on Environment a 'Suicide Note,'" *IHT Rendezvous* (blog), June 24, 2012.
- Marchal, Virginie, Rob Dellink, Detlef Van Vuuren, Christa Clapp, Jean Château, Eliza Lanzi, Bertrand Magné, and Jasper van Vliet, 2011 "OECD Environmental Outlook to 2050, Chapter 3: Climate Change."
- Moore, Michael. O. 2013. Embedding Climate Change Mitigation Efforts in the Multilateral Trading System. Paper presented at the George Washington University Conference on the multilateral trading system.
- Nordhaus, William D. 2011. "Estimates of the Social Cost of Carbon: Background and Results from the RICE-2011 Model." Cowles Foundation Discussion Paper No. 1826. Yale University, Cowles Foundation for Research on Economics: October.
- Patel, Urjit R. 2010. "Decarbonisation Strategies: How Much, How, Where and Who Pays For $\Delta \leq 2^{\circ}\text{C}$?" Working paper 39. Brookings, March.
- Pauwelyn, Joost. 2009. "Statement of Joost Pauwelyn . . . Testimony before the Subcommittee on Trade of the House Committee on Ways and Means, March 24, 2009" (<http://waysandmeans.house.gov/media/pdf/111/pauw.pdf>).
- Posner, Eric, and David Weisbach. 2010. *Climate Change Justice*. Princeton University Press.

Stern, Nicholas, 2008. "Towards a Global Deal on Climate Change." Third Annual Richard H. Sabot Lecture, Center for Global Development (Washington, June 26).

Stern, Nicholas. 2009b. *The Global Deal: Climate Change and the Creation of a New Era of Progress and Prosperity*. New York: PublicAffairs.

Subramanian, Arvind. 2011. *Eclipse: Living in the Shadow of China's Economic Dominance*. Washington: Peterson Institute for International Economics.

UNEP and WTO (United Nations Environment Program and the World Trade Organization). 2009. Trade and Climate Change: A Report by the United Nations Environment Program and the World Trade Organization. Geneva.

Von der Goltz, Jan. 2011. "Durban Climate Deal: What a Great Result This Would Have Been Some Ten Years Ago!" *Global Development: Views from the Center* (blog). December 13.

"We Cannot Gamble with the Planet," editorial, *Financial Times*, November 28, 2010.

Wheeler, David, and Saurabh Shome. 2009. "Less Smoke, More Mirrors: Where India Really Stands on Solar Power and Other Renewables." CGD Working Paper 204. Washington: Center for Global Development.

Wheeler, David, and Kevin Ummel. 2007. "Another Inconvenient Truth: A Carbon-Intensive South Faces Environmental Disaster, No Matter What the North Does." CGD Working Paper 134. Washington: Center for Global Development.

Wheeler, David, and Saurabh Shome. 2009. "Less Smoke, More Mirrors: Where India Really Stands on Solar Power and Other Renewables." CGD Working Paper 204. Washington: Center for Global Development.