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Global Carbon Pricing: A Better Climate Commitment

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Abstract

Developing countries reject meaningful emission targets (recent intensity caps are no exception), while many industrialized countries insist that developing countries accept them. This impasse has prevented the Kyoto Protocol from establishing a global price for greenhouse gas emissions.

This paper presents a solution to this dilemma—allow countries to commit to a binding global carbon-price target. This commitment could be met by cap and trade, a carbon tax, or any combination. This would allow developing countries to accept the same carbon price as the most advanced countries instead of accepting a cap that is as low as U.S. emissions in the 1800s. And it would allow the U.S. and the E.U. to keep their cap and trade schemes. The paper defines a carbon-price target, and shows how compliance could be induced using both carrots and sticks.

We also demonstrate that carbon pricing can be guaranteed to be inexpensive under a carbon-price target. A Green Fund is suggested that reinforces rather than subverts cooperation on global carbon pricing. The combined cost of a $30/ton price target and the Green Fund is only 23 cents per person per day for the United States and is negative for India. Together, these advantages should greatly increase the chance that developing countries will commit to a substantial carbon price, and this should increase the chance of cap and trade passing the U.S. Senate.

Such a policy would also reduce the world oil price. For China and the United States, this savings might well cover the full cost of the proposed initial climate agreement.

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1. Introduction

The climate policy debate takes place on two levels, national and international. This paper concerns the international level. At the national level, the debate often pits cap-and-trade against carbon taxes. National politics will continue to dominate that debate. Unfortunately, the debate spills over into the international arena where those political considerations are inappropriate and the issues are different.

The spillover of national issues has largely blocked useful discussion of the commitments and inducements that would produce an international agreement for effective action. Consequently, no such agreement is taking shape, and without one, there is little hope of slowing climate change.

Since this paper focuses on the problem of *forming* a stable and effective international climate agreement, its first challenge is to disentangle itself from the national debates. The central question at the international level is the question of commitment. An organization lacks substance unless its members have made commitments that they will keep. The issue of inducements to keep commitments is equally important, but first we will discuss what the commitments should be. It is these commitments that become entangled in the national debates.

Those who favor cap and trade typically claim an international commitment should be a commitment to accept a binding emission target, while those who favor carbon taxes advocate a commitment to implement a national carbon tax at a global tax rate. These arguments, while understandable, are damaging, because both conclusions prevent the formation of an effective international organization. As shown in Table 1, developing countries will not commit to binding emission targets. They object directly to this type of international commitment. The U.S. and E.U. are committed to their own cap-and-trade policies, so they object to national carbon taxes imposed by an international-tax commitment.

Table 1. Resolving the International Commitment Dilemma

International Commitment		National Policy Options
Binding emission targets **(Developing countries object)**	➔	Cap and trade, or Carbon tax
Binding global carbon-price target	➔	Cap and trade, or Carbon tax
Binding global tax-rate target and National carbon tax	➔	Carbon tax only **(The U.S. and E.U. object)**

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This paper provides a way around this impasse, which has deadlocked climate policy for over a decade. The solution is to adopt a commitment to a binding global carbon-price target. That commitment is the focus of this paper. This avoids the objections of developing countries to binding emission targets. But like an emission target, it allows countries to comply by implementing cap and trade, a carbon tax, or any mixture of carbon-pricing methods. This avoids a confrontation with cap-and-trade regulations.

In fact a price commitment can and will be defined so that it can be met by a pure cap and trade system, even one that issues free allowances, or by a mixture of policies. But the greatest advantage of basing an international organization on carbon-price commitments is that it will increase the breadth and depth of commitments. If China makes a binding commitment to a global price target, then the U.S. Senate can more easily commit to cap and trade with the same price target for its carbon allowances.

1.1. The Low Cost of Carbon Pricing

Carbon pricing—either with cap and trade or with carbon taxes—is the most inexpensive policy that can define commitment to an international agreement.[2] That is why carbon pricing was the goal of the Kyoto agreement, and one reason it was recommended in 1997 in the "Economists' Statement on Climate Change," signed by over 2600 economists, including nine Nobel Laureates. The OECD (2009) makes carbon pricing a central focus of a recent book, saying "if these cuts [30% in emissions by 2050] can be achieved through the global pricing of carbon, the economic cost (lost GDP) could be relatively modest."

In spite of the prominence of carbon pricing, a basic accounting of its costs is remarkably difficult to discover, perhaps because the cost under cap and trade depends on whether a country will need to trade—buy or sell permits—on the international market. If this is not necessary then cap-and-trade will cost the same as a carbon tax. That cost can be well approximated by using a formula (see Section 2) that the U.S. Environmental Protection Agency (EAP 2009, 14) uses for exactly this purpose. But if a country needs to buy permits from other countries, its costs will be higher than shown in Table 2 by the cost of the permits it purchases.

Ignoring this uncertainty with cap-and-trade costs allows us to construct a simple example of carbon-pricing abatement costs. The example also includes assistance from industrialized countries to developing countries, a policy sometimes referred to as a Green Fund. The results are shown in Table 2.

Table 2. Costs of $30-per-ton Global Carbon Pricing with a Green Fund

	Starting Emissions per Capita	Emission Abatement Cost	Green Fund Cost	Total Cost
	(tons/year)	(cents per person per day)		
India	1	0.8 ¢	−1.7 ¢	−0.9 ¢
Average Country	5	4.1 ¢	0.0 ¢	4.1 ¢
United States	20	16.4 ¢	6.6¢	23.0 ¢

Carbon pricing is assumed to reduce admissions by 20 percent from the amount shown. Note that China is quite close to being an average country in per-capita emissions.

The low costs in Table 2, given in cents per person per day, depend on three assumptions. First, the global carbon price is taken to be $30 per ton.[3] Second, the Green Fund incentive is assumed to be $2 per ton of emissions above or below the world average per-capita emissions rate. Third, the resulting reduction in emissions is taken to be 20 percent. The first two assumptions are choices of the international community. But the amount of emission reduction for a fixed carbon price cannot be

[2] Of course this should cover all greenhouse gases; "carbon" is used only as a shorthand description.
[3] Tons should be taken to mean metric tons (tonnes) of CO_2 equivalent GHGs.

controlled, and so, may differ from 20 percent.[4] But if the reduction were only 10 percent, the abatement costs would be cut in half. And if it were instead 40 percent, abatement cost would double, but the accomplishment at such a low cost would be stupendous. Hence no error in the assumption regarding the percent of emission reduction can change the results in a way that would tend to disrupt a climate agreement.

The conclusion must be that a strong climate policy can be extremely inexpensive. Even for the United States, the cost per person is less than a quarter per day ($84 per year). And this covers the cost of subsidizing low-emission countries such as India by more than double their own abatement costs. These subsidies are one-third the level that EPA estimates for international subsidies under the Waxman-Markey bill.[5] Perhaps some will argue that such low costs are still unfair to those who are poorest, yet if national policies are implemented with equal-per-person refunds, as described below, the poor will come out slightly ahead.

If the carbon price of Table 2, $30 per ton, were implemented through 2020, the cost to China would make China wait until 13 July 2020 to be as rich as it would otherwise have been on 1 July 2020.[6] The importance of such low costs for international negotiations should not be underestimated. As will be seen, commitment to a binding emission target imposes large financial risks, whether it is implemented with cap and trade or a carbon tax. But commitment to a binding carbon-price target comes with a virtual low-cost guarantee. This holds great importance for developing countries. Since cost is the principle barrier to international agreement, allowing commitment a global carbon price will greatly increase the chance of commitment by developing countries. And that will increase the chance of a significant commitment by the United States and others.

1.2. The Structure of the Design

This paper does not present a design for a national climate policy, but rather a design for an international commitment mechanism. Any country that commits under this mechanism will be free to choose its own national policy—cap and trade, taxes on fossil fuel, feebates for fuel efficiency, or any combination. The international commitment is to a global carbon-price target. As part of the commitment package, a commitment to a Green Fund is also recommended. That will encourage—but not require—a still broader range of national policies.

The price-target commitment mechanism must specify what it means to commit, and specify the inducements to keep the commitment. These include both carrots and sticks, with the carrots predominating for poor countries. The Kyoto's emission-target-commitment mechanism can provide useful guidance for the new price-target mechanism by suggesting a parallel design as follows:

Emissions-target commitment:
The country will emit no more than C or will pay others (buy allowances) to make up the difference.

Price-target commitment:
The country will price carbon at P or will pay others to make up the carbon-revenue difference.

So the first part of the commitment is to price carbon at P and that is defined by requiring countries to collect carbon revenue equal to the global carbon-price target, P^T, times the country's total emissions. Next, if the carbon revenue is under-collected there should be a way to make up the difference. That is defined by the Pricing Incentive and this equation:

$$\text{Pricing-Incentive payment} = Z \times \text{(excess carbon revenue)}$$

[4] This does not mean pricing cannot control emissions. But control of emissions requires control of the carbon price. This is discussed further in Section 6, which shows pricing can hit climate targets as well as can emission capping.

[5] The Green-Fund subsidy is $7 billion per year compared with the EPA's (2009, 14) estimate of $20 billion for foreign offsets in 2020.

[6] This is based on the U.S. DOE's International Energy Outlook 2009, and documented on www.global-energy.org.

The incentive strength is given by Z, which will be something like 10 percent. A country will have to pay only if it under-collects. As will be seen, this is fairly easy to avoid, and generally this incentive is much less risky than is the possibility of having to buy allowances on the international market under an emissions-target commitment. The incentive strength Z will need to be adjusted, but this is only a technical matter.

We recommend that the price-commitment be coupled with a commitment to participate in a Green Fund. But payments from this fund should not discourage commitment to a global carbon price, as is now the case with the Clean Development Mechanism (Stoft 2009b). Instead, payments should be made only in proportion to carbon-pricing compliance. Aside from that, contributions to and payments from this fund will be governed by the Clean Development Incentive formula:

$$\text{Clean Development Incentive payment per capita } = G \times \text{(excess emissions per capita)}$$

The Clean-Development-Incentive strength is determined by G. When $P^T = \$30/\text{ton}$, G might be something like \$2/ton. These are the values used to construct Table 2. Other than technical rules, which contain a few minor parameters, these two values are the only values the international community will need to agree on even if it has 200 member nations. It will not need to negotiate hundreds of individual emission targets. This will make start up and future adjusts far more likely to succeed.

1.3. The Effectiveness of Price

A widespread belief holds that caps are effective but prices are not. That belief is used to support cap and trade while rejecting carbon taxes. If that view were true, the proposed price-target would be dangerous since it allows either. Fortunately, the view is mistaken.

Caps cannot be even slightly more powerful than prices because they have no direct effect on emissions. They affect emissions only by creating carbon prices, which then cause emission reductions. Neither business nor consumers pay attention to the cap, which is set hundreds of millions of tons higher than their own emission level. If a business needs to emit more, it never asks how high is the cap, but only what is the carbon price?

This is not a criticism of cap and trade, it is simply an explanation. Similarly, trade has no magical effect on emissions. Its role is to equalize carbon prices among businesses and to adjust the price of emissions up and down to make sure the cap is met. Both cap and trade and carbon taxes reduce emissions only by pricing carbon.

Another belief holds that since caps work through prices neither cap and trade nor carbon taxes will be effective. Subsidies and command and control are the proposed alternative. If neither caps nor prices work, then all three international commitments discussed here are doomed to failure. In fact, since President Bush's push for strictly voluntary measures at the Bali summit, this view has quietly been gaining the upper hand. Quite possibly, the major accomplishment of the Copenhagen summit will be to enshrine a subsidy-based approach in the form of "Nationally Appropriate Mitigation Actions." Consequently it is worth looking at the evidence on carbon pricing.

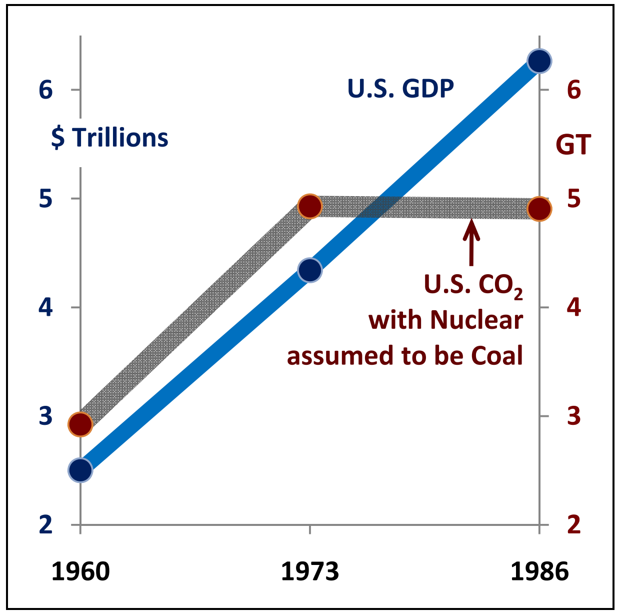
Although there is a large body of econometric evidence on the effectiveness of carbon pricing (Jorgenson 1998) there is also large-scale historical evidence on this subject. During the OPEC crisis from late 1973 through the end of 1985, world oil prices rose dramatically. Although OPEC reduced production, prices—not quantities—rationed demand.[7]

Figure 1 shows the effect of OPEC's pricing policy. It was nearly the worst form of carbon pricing both for effectiveness (because it was focused entirely on oil) and for cost (because the tax was paid to OPEC not to our own government). In spite of this, it was extraordinarily effective yet did not stop one of the strongest growth spurts in recent U.S. history.

[7] There was one exception. For a brief period, parts of the United States experienced gasoline shortages due to temporary price controls.

As the graph shows, carbon emissions grew from three billion to five billion tons per year in the thirteen years before the crisis, and declined just slightly in the thirteen years during the crisis. Actually, emissions declined about 7 percent more than shown because extra carbon emissions have been added for all nuclear plants as if they were normal coal-fired power stations. This was done to disprove the oft-repeated myth that OPEC had no effect and the decline in emissions was purely a matter of coincidence between the OPEC crisis and the birth of the nuclear industry.

Figure 1. Effect of Oil Prices on CO_2 Emissions



It is also said that what happened was not due to price, but due to energy experts and government regulations. However, the experts and regulations were themselves the result of oil prices. In fact the ups and downs of fuel efficiency standards track the ups and downs of oil prices time and again. But much, if not most, of the change in emissions was due to the direct response of inventors, business, and consumers to high energy prices. In fact, one of the biggest fuel-efficiency increases for autos took place the year before standards went into effect. Some of those changes were started in 1973, before standards were even discussed.

A different indication of effectiveness comes from an analysis of fossil-fuel subsidies by the International Energy Agency. "Eliminating all the fossil energy subsidies in the 20 largest non-OECD countries that we looked at … would drive down global carbon-dioxide emissions by 13% by 2050. … removing these subsidies could sharply reduce emissions and, at the same time, bring broader economic benefits."[8] In other words, enforcing a global carbon-price target even as low as *zero* would reduce emissions substantially and have a *negative* cost.

These observations do not show that the illustrative $30-per-ton price will reduce CO_2 enough. The point is rather that the cost of using such a price is far lower than most people imagine. Still, carbon pricing is not the only policy needed, but it is the policy that makes others easier to agree on and more effective. Our climate problems are the result of excessive climate-damaging emissions. If we are to have any hope of stopping and reversing this problem, we must address the root cause. We must put an unavoidable price on the damaging emissions. We must price carbon.

2. Verifying the Low Costs of Carbon Pricing

The fear of high costs is the single most important barrier to the adoption of an effective climate policy. In a way, this is remarkable. For example, the U.S. Department of Energy reported in 1998 that implementing the Kyoto protocol would have made the United States 0.8% poorer in 2020. But by 2005, when President George W. Bush declared that "The Kyoto treaty would have wrecked our economy," this dire view had become commonplace. The problem seems to be a coincidence of tactics. Those who want to do nothing exaggerate the costs. Those who want to take the strongest actions, avoid examining the costs because the subsidies they add on top of carbon pricing make it expensive.

If the low costs shown in Table 2 were understood and believed, it might motivate cooperation toward the design of an international agreement capable of harnessing global carbon pricing. To that end, we now take a close look at what lies behind the habitually low-cost outcomes of economic models like

[8] Dr Fatih Birol, IEA chief economist, Financial Times, ft.com/energysource, November 16, 2009.

the one used by DOE to evaluate the Kyoto Protocol. It is the same simple concept used to construct Table 2.

2.1. The EPA's Standard Cost Estimator

The real costs of carbon pricing are the costs of the activities which abate emissions. These activities impose two distinct types of cost—inconvenience costs and market costs. Putting on a sweater is an inconvenience, while installing more insulation has a market cost. But it is net costs that matter, so from these two kinds of cost, the savings from a reduced heating bill must be subtracted.

Inconvenience costs cannot be calculated directly by economists or energy auditors, so instead we use an indirect approach. People will not spend more on saving a ton of carbon than it would cost them to use the carbon and pay the price of carbon. Price carbon at $30 per ton, and no one will intentionally spend $50 to save a ton of carbon—they will just pay the price. When they choose between saving carbon and paying the price, they take account of their inconvenience, their monetary costs, and their savings from using less energy. So except for mistakes, the total net cost of saving carbon will be less than the price of carbon times the amount of carbon saved. But how much less?

Some emission-reducing actions will be cheaper than free. Many studies indicate that a large quantity of emission reductions, particularly from weather-proofing buildings, will save more by reducing energy use than the cost of implementation. But ignore such negative net costs, and simply assume that the cost of saving a ton of carbon will range uniformly from zero to the price of carbon. Then the average cost of saving a ton of carbon will be one-half the price of carbon. This gives the formula used by the U.S. Environmental Protection Agency (2009, 14):

The standard carbon-pricing cost estimator:

$$\text{Emission Abatement Costs} = \tfrac{1}{2}\,(\text{the emission reduction}) \times (\text{the price of carbon}) \qquad (1)$$

This formula was used to compute the abatement costs in Table 2. For example, an average person living in the United States causes 20 tons of emissions in one year. A 20 percent reduction would reduce emissions by four tons per year. At $30 per ton, the cost of emissions would come to $120 per year, so it would make no sense to spend more than $120 avoiding this cost. Reduction measures will range in cost from zero to $30 per ton, and the cost of the four-ton reduction would be (4 tons) x ($30/ton) / 2, or $60 per person per year. Dividing by 365 days give 16.4¢ per person per day, as found in Table 2.

2.2. Could the Estimator Be Wrong?

Since the myth of wrecking economies is so persistent, let us double check the EPA estimator that underlies our cost calculations. Could it be wrong? Of course it must be a little wrong—it is only an estimator. But it is unlikely to be far wrong because people would have to be foolish indeed to spend more for their *average* emission reduction than the cost of paying the price of carbon. Spending more would mean their best efforts to save have increased their costs. That is unreasonable, so cost cannot be more than twice as high as estimated, and that is still impressively low.

But in fact, there are several reasons to believe the estimator comes in too high. First, text-books take the view that the cost of saving a ton of carbon increases ever more rapidly the more we save. This is why nearly every analysis predicts that approaching 100 percent abatement is extremely expensive. Given the text-book view (a quadratic marginal-cost curve), the number in the approximation should be 1/3 rather than 1/2. This indicates our estimates are 50 percent too high.

Second, nearly every study of available emission-reducing activities finds quite a few activities that payback more than they cost, while the cost estimator assumes there will be none of these.

Third, studies of consumers find that they tend to err on the side of avoiding measures with long payback periods. In other words, a measure that costs $20 to save $30 in carbon taxes would be ignored, but a measure that costs, say $5 to save $30 would be adopted. Hence, the consumer-choice literature suggests that the standard cost estimator will come in too high.

Fourth, comparing the estimator to the results of a large economic model of Congressional cap-and-trade bills, used by a research group at MIT (Paltsev 2007), found that the model gave lower costs at every level of emission reduction and much lower costs at the low levels of reduction discussed here.

Many factors point toward even lower costs than those reported in Table 2. And it is virtually impossible, given the assumptions of the table, that actual cost could be more than twice as high as reported. Aside from the risks of cap and trade, carbon pricing is predictably inexpensive.

2.3. The Cost Confusion

Because of the argument just presented, economists agree that global carbon pricing is generally the most cost effective method of reducing emissions, but others are skeptical at best. The difference in view is rooted in a misunderstanding of how prices work. If a billion dollars is spent on wave power machines and nothing comes of it, a billion dollars has been wasted. If a billion dollars is paid in gasoline taxes and no one uses a drop less gasoline, nothing has been wasted. Those who favor subsidies rarely understand this point.

The misunderstanding comes from counting revenues as costs. That's understandable because, in fact, government revenues usually do become costs. Governments tax in order to spend. But the point of pricing carbon is to change behavior, and this change is not the result of spending. If a carbon cap or tax raises revenues that are not spent, the policy is equivalent to a Pigouvian tax.[9] Since the point is not to spend, once a Pigouvian tax has been collected, it has done its job—discouraging what was taxed—and the revenues can just be refunded.

That's why carbon pricing is so cheap—it's not about spending. In fact, with all the revenues refunded, it looks completely free. And if, as with the gasoline tax mentioned above, no one changes behavior, it is free. The tax is collected and refunded and nothing happens. But if people do change their behavior because of carbon pricing, the cost is exactly the cost of abatement as calculated by the standard carbon-pricing cost estimator shown above.

What if the carbon revenues are not refunded? What if they are all spent on solar-power research? Although such an expenditure may be wise, it would impose a cost on taxpayers. But that cost is not the cost of pricing carbon, it is the cost of solar-power research. So even in this case, carbon pricing itself is just as inexpensive as shown in Table 2.

But why should fully-refunded carbon pricing even work? It works because the refunds have nothing to do with the amount an individual spends on carbon. For example if the revenues are equally divided among all citizens, then riding a bike to work will save the price of carbon for the gasoline not used, but it will not reduce your refund by one cent. So the motivation to use less gas is just as strong as without a refund.[10] The Waxman-Markey bill, passed by the U.S. House, specifies that 70 percent of the permits will be auctioned and refunded after 2030, so refunds are not an idle theory. And economic models rely on this as well. Instead of modeling cap and trade, which is complex, they simply model a fully-refunded carbon tax. (Sometimes the refund is provide by reducing other taxes.) That's why economic models tell us climate policy is inexpensive. It is as cheap as shown in Table 2 provided the policy is carbon pricing and provided the revenues are not spent.

3. Comparing the Three Forms of Commitment

Table 1 lists three forms of commitment that could form the basis of an international climate agreement. The first is commitment to caps as conceived under the Kyoto Protocol and that will be our primary

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[9] Revenues collected by selling allowances can be viewed as tax revenues.

[10] While it is true that being poorer by $480 a year, without a refund, will cause people to spend slightly less on carbon (about $24 a year less), it is equally true that the non-refunded carbon tax, when spent by the government, will be spent on carbon in about the same proportion. So any impact is truly miniscule and there is no reason to think it will be in one direction or the other. Refunded carbon pricing works exactly as well as tax-and-spend pricing.

concern in this section. Because this approach has failed for 13 years, several prominent climate-policy experts have proposed the use of a commitment to a global tax as an organizing basis. This is discussed briefly, before turning to the current proposal which merges the better attributes of the first two approaches to suggest a commitment to a global price target.

3.1. Why the Kyoto, Emission-Target Commitment Fails

The purpose of the Kyoto approach was, first, to establish a price for carbon emissions by using national emission caps to create a shortage of rights to emit carbon. Second, those rights were to be traded nationally and globally to make the price of carbon uniform and to ensure efficiency in the reduction of global emissions. In theory, this approach is close to ideal. But effective emission targets have been rejected consistently by all developing countries for at least 13 years, with no significant progress toward acceptance.[11] They still have not been accepted by the United States and Australia, and have been flaunted by Canada. There relative success in the E.U. has been significantly dependent on the collapse of the Eastern European economies.

The assumption underlying this paper is that this failure is not just the result of bad actors, though there have been some and there will be more. But historical studies (Barrett 2003a) and game theory have shown that the design of an agreement has much to do with its success or failure. Examining the reasons for failure of the initial design provides useful lessons in how to revise the design to make success more likely.

Redistributing the Wealth of Nations. One obvious problem with the proposal for global cap and trade is that the proof that it is ideal is equally true no matter how the national emission targets are allocated. Reduce one country's target by a billion tons and increase another target by the same amount and the result, because of permit trading, is the same emissions from the same countries at the same price. All that changes is that one country is made poorer and the other wealthier. But nations care greatly about their wealth (Smith 1776), so the lack of any fairness standard on which to base the division of targets has been an insurmountable stumbling block.

So far the only standard for assigning targets is that "in 2007, the U.N. Intergovernmental Panel on Climate Change gave a scenario of cuts of between 25 and 40 percent by 2020" (Reuters 2009). These values (IPCC 2007, Box 13.7) are explained as follows.

> Several studies have analyzed regional emission allocations … The studies cover a broad spectrum of parameters and assumptions … the studies include very stringent requirements for developed countries … as well as less stringent requirements for developed countries and more ambitious constraints for developing countries within a plausible range.

Clearly a number of climate scientists have thought hard about what would be a good way to distribute the costs of climate change between nations. However, (1) the 25 to 40 percent range applies to the lowest of three atmospheric limits, none of which the IPCC has endorsed, (2) the IPCC has not endorsed the studies reporting the proposed emission cuts, and (3) the range of cuts applies to the entire group of Annex I (industrialized) countries as a whole but not to any country in particular. Twelve years after the Kyoto Protocol was signed, "There is no set of generally accepted principles for allocating rights to usage" (Stiglitz 2007). In fact no such principles are even on the table for discussion.

It is important to see in more detail how this problem explains the failure of negotiations over the last decade. As Stiglitz explains (2007) "Setting target levels [caps] is so contentious because allowing a country high emission levels is tantamount to giving it money—a fact that has become more obvious with

[11] China has recently accept a carbon-intensity cap for 2020 that is 40% below its 2005 intensity value. However the U.S. DOE predicted in May 2009 that under business as usual China would reduce carbon intensity by 45% during that period. During the previous 15 year period, China more than doubled emissions, exceeding all expectations, and it still reduced emissions intensity by 44.4%. Their current voluntary cap is not a meaningful commitment.

the advent of carbon trading." This is the point just made in the discussion above concerning the global allocation of targets. A lower target simply means the country must buy more emission permits, but it does not change anything else. The result is over 100 country-by-country negotiations concerning the allocation of costs with no standard of fairness to use for guidance.

Caps that Are too Low to Be Fair. An even more severe problem with negotiations is that binding emission targets for developing countries are doomed by a simple question without an answer. "By what right are the developed countries entitled to pollute more than we are, simply because they polluted more in the past? (Stiglitz 2007)" This logic carries particular force in a country like India. The United States has been asking India to accept a cap set at roughly one-half the U.S. per-capita emissions rate in 1880.

Blocking U.S. Commitment. Not only do these negotiation failures block meaningful emission targets for developing countries but indirectly they block or severely weaken a target for the States. Just over a month before the Copenhagen summit, Todd Stern, the chief U.S. climate negotiator, declared "They [the Chinese] absolutely have to cap their emissions" (Lim 2009), and then two weeks later he said "What we do *not* agree with, though, is that we should commit to implement what we promise to do, while major developing countries make no commitment at all" (AFP 2009). This is exactly the problem that caused the U.S. Senate to vote 95-to-0 in 1997 not to accept a treaty without caps for developing countries. Even Al Gore concurred, back in 1997, saying "Clearly, more work is needed [on the Kyoto Protocol]. In particular we will continue to press for meaningful participation by key developing nations" (Stevens 1997). We are still stuck in the same dilemma we faced in 1997.

Would a Trend-Line Cap Work? In an attempt to overcome these fairness issues, Stern proposes the following technical fix. "They absolutely have to cap their emissions in the sense of having them reduced significantly as compared to where their trend line is" (Lim 2009). Would that work? We cannot predict the future, so consider what would have happened if China had done this in 2000.

According to the U.S. DOE (2003), China's CO_2 emissions grew 26% between 1990 and 2000. Using that trend line to extrapolate to 2010 gives an emission level in 2010 of 3,616 tons. But that is not the cap Stern is looking for. He said China's emissions must be "reduced significantly as compared to where their trend line is." So suppose China had accepted a cap 20 percent below its trend line. That would have put the Chinese cap for 2010 at 2,892 tons.

Unfortunately for the Chinese, that cap would have turned out to be not 20 percent below business as usual, as Stern seems to expect, but 60 percent below their actual 2010 emissions (U.S. DOE 2009). And their actual emissions are already below business as usual, because the Chinese are working diligently to meet their current five-year plan, which calls for cutting CO_2 by 10 percent relative to their GDP. The unanticipated extra 40 percent cut on top of their current efforts and on top of the 20 percent cut Stern wants, would have been sheer bad luck. Neither the Chinese, the DOE, nor the IEA anticipated China's surging CO_2 emissions. As Nordhaus (2008) says, "Since the quotas are set so far in advance, the distribution of burdens across countries is as much lottery as planned and equitable redistribution."

The word "redistribution" brings us back to the point that cap and trade does not specify how costs will be distributed. What would happen when China faced its additional 40 percent cut? If it did not simply opt out of its agreement, as Canada has done, China would comply mainly by buying something over 2.5 billion tons of carbon allowances on the international market from other cap-and-trade countries. If these allowances cost $30 per ton, China would be *redistributing* $75 billion to the international community. Unlike domestic carbon pricing, this is a pure cost. China would simply be paying other countries to meet its emission target.

Now before leaving Stern's trend line proposal, note a deeper problem with the trend-line approach. Because trend lines predict the future so poorly they must be used repeatedly to set caps. But when trying to meet a cap, the country will realize that every ton it saves will lower its trend line just enough to make its next cap one ton tighter. In other words, trend-line capping punishes good behavior quite severely (Schelling 2002).

3.2. Why a Global Carbon-Tax Commitment Fails

A second form of commitment has been proposed by Joseph E. Stiglitz (2007), William D. Nordhaus (2005, 2007, 2008, 2009), and James E. Hansen (2009). Each considers a global cap-and-trade approach to be counterproductive and recommends commitments to implement a carbon tax at a global tax rate. This greatly diminishes the international negotiating problems just discussed, and it avoids the two central complaints of developing countries. However, committing to a carbon tax takes away the flexibility to choose a cap-and-trade as a national policy. This is essentially an insurmountable problem since Europe already has adopted cap and trade and is unlikely to abandon it.

In the United States, caps have political advantages, at least during the process of adoption. Carbon allowances can be used more easily than tax revenues to compensate losers by allocating free allowances to them during a transition period. Cap and trade also offers the prospect of massive emission reductions by 2050 while obscuring the costs. The United States is unlikely to adopt a carbon tax any time soon, and is close to adopting cap and trade. Hence, any feasible global-carbon-pricing policy must not discriminate against cap and trade.

3.3. Avoiding Pitfalls with a Global Carbon-Pricing Commitment

The third option is commitment to a global carbon-price target. This is designed to avoid the pitfalls of the other two approaches. Like the carbon-tax proposal, it avoids trying to force emission targets on developing countries, but like the emission-target approach is allows countries to meet their commitment with cap and trade or a mix of that with other policies. Does this succeed in avoiding the previous pitfalls?

Developing countries reject binding emission targets first because they force them to accept targets far below those of industrialized nations. Second, they reject emission targets because they jeopardize their economic growth.

Regarding their first objection, poor countries would be committing to the same carbon price as are the most advanced countries. Second, regarding the riskiness of emission targets, a price target is based on the opposite philosophy of risk. While an emission target sacrifices financial certainty to gain emission certainty, a price target does the reverse. It provides cost certainty at the expense of uncertainty of emissions. As demonstrated by the above example of a cap on China's emissions, developing countries will prefer the low-cost guarantee of Table 2, to the uncertainty of, even, trend-line caps.

Concerning the process of negotiation, global carbon pricing requires that only a single common price target be negotiated. Moreover, countries have a self interest in *raising* this target as well as an interest in lowering it. In order to gain any advantage from other countries, a positive global price is required. If each country asks itself what global target price would be best strictly from its own point of view, the answers will cluster around the answer that benefits the world most. While, if each country is given the cap that it most prefers, the resulting global carbon price would be nearly zero.

Richard N. Cooper (1998, 2000, 2007, 2008) advocates a global system of "charges on greenhouse gas emissions" that accommodates cap-and-trade systems quite well by using special exemptions and requirements. His system differs from the one described here primarily in that it does not treat caps and taxes symmetrically and does not include a Green Fund as part of the incentive system. However, his system does give countries a choice between caps and taxes, so it is a parallel proposal

3.4. Opinions on International Commitment

As mentioned at the start of this paper, the spillover of national issues has blocked useful discussion of international commitments and inducements that would facilitate an effective international organization. But a few have been discussing these international issues and it may be helpful to read what they have to say about gaining international agreement and cooperation.

With the world having invested so much in the development of the [emission] targets approach, it is understandable that there will be reluctance to abandon it. Yet there is not even a glimmer of an idea at the moment of how targets can be set that will be acceptable both to the United States and to the developing countries (Stiglitz 2007).

—Joseph E. Stiglitz, Nobel Memorial Prize, 2001

The focus has been on targets and timetables. I think this is absolutely the wrong way to go. As climatologists, it makes sense. As humans, it makes sense. But as [the basis for] an international agreement, it doesn't make any sense (Inman 2009).

—Scott Barrett, Columbia University,
Author of *Environment and Statecraft: The Strategy of Environmental Treaty-Making*

Quantity-type systems are much more susceptible to corruption than price-type regimes. … The dangers of quantity approaches compared with price approaches have been demonstrated frequently when quotas have been compared with tariffs in international trade interventions. … it would not be surprising if the carbon market became tangled in corrupt practices, undermining the legitimacy of the process (Nordhaus 2008).

—William D. Nordhaus, Sterling Professor of Economics, Yale University

With the Kyoto Protocol, commitments were made not to actions but to results that were to be measured after a decade or more. This approach has disadvantages. … A government that commits to actions at least knows what it is committed to, and its partners also know and can observe compliance. In contrast, a government that commits to the consequences of various actions on emissions can only hope that its estimates, or guesses, are on target, and so can its partners (Schelling 2002)

—Thomas C. Schelling, Nobel Memorial Prize, 2005

If it's going to be cap and trade, I'd rather nothing came out of Copenhagen. I'd rather take another year or two and get it right (ABC 2009).

—James E. Hansen, Director of NASA's
Goddard Institute for Space Studies

4. Hitting the Global Pricing Target

Flexible global carbon pricing, the policy described in this paper, consists of a Pricing Incentive and a Green-Fund Incentive. Each is governed by one key policy parameter, and these are the only values that need to be negotiated to determine the strength and equity of the policy. No individual country caps or other values need be chosen. The first key policy parameter is the global carbon pricing target, P^T. Since it is a negotiated value, we will not be concerned with it. Instead we will examine the mechanism for achieving that value, whatever the value may be. That mechanism is the Pricing Incentive, so its job is to induce countries to price carbon high enough that the global average price, P^A, equals the global target price P^T.

Since international cooperation is our primary goal it will be useful to make a flexible definition of a national carbon price so that as many legitimate carbon-pricing systems as possible can be accommodated. Fortunately, this objective gives rise to a simple definition. Definition: A country's carbon price is its total carbon revenues divided by its total carbon emissions. Carbon subsidies are counted as negative carbon revenues. Cap-and-trade revenues are defined as the market value of the carbon permits used.

The global average price of carbon, P^A, is simply the total of all national carbon revenues divided by the total of all national carbon emissions. In order to bring this average price in line with the global target, an incentive for collecting carbon revenues is applied at the national level.[12] The incentive can be expressed on a per-capita basis as follows:

$$\text{Pricing-Incentive payment } = Z \times (r - e \times P^T) \qquad (2)$$

The parameter Z is the Pricing Incentive rate, and may be, for example, 10 percent. The variable r denotes the country's per-capita carbon-pricing revenue, and e is its per-capita emissions. If e is 5 tons per year and P^T is \$30 per ton, then the country should be collecting revenues of \$150 per person per year. If instead, r is only \$120 per person per year then the Pricing-Incentive payment, with Z = 10%, works out to be 10% of (\$120 – \$150) or minus \$3 per person per year. "Minus" indicates that the country must pay, while a positive result indicates that it will be paid.

Now a penalty of \$3 for an under collection of \$30 may seem too weak, but remember that when the country collects \$30 in carbon taxes it keeps that money, and can, for example, refund it as described above. But the \$3 penalty is money that leaves the country. Few countries will want to see such an outflow of funds, so it seems likely that a small value of Z and relatively low penalties will do the trick.

Note that the Pricing Incentive functions very much like an international market for carbon permits. In the permit market, if a country over-achieves by emitting 1000 tons less than its cap, it is paid 1000 times the international permits price when it sells its excess permits. If a country collects an extra \$1000 of carbon revenue under global pricing, it is paid Z times \$1000. So Z is analogous to the price in the permit market.

The price in the permit market adjusts so that the desire to own extra permits equals the desire to sell excess permits. This is exactly what Z should do to balance the desires to over- and under-collect carbon revenues. But there is no market to adjust Z. Adjustment can still be done automatically, but with an administrative formula instead of with a market. The formula might state that if the global carbon price is 20 percent too low, then next year increase Z by 20 percent.

Just as with the international market for permits, it will be best if the Pricing Incentive payments net to zero. This can be accomplished (Stoft 2009a) with a simple modification of equation (2). With this modification, and with a simple adjustment rule for Z, the Pricing Incentive will keep P^A equal to P^T on average. If this average does not accomplish as much as desired, then the world can simply raise the target price and Z will adjust, according to its adjustment rule, and force P^A to move up to the new target level.

5. The Green Fund

The Clean Development Mechanism (CDM) was adopted when the developing countries rejected caps at the Kyoto summit. It encourages developing countries to participate in climate policy by giving them carbon credits for implementing projects that reduce their national emissions below business as usual. These credits can then be sold to companies that operate under a cap-and-trade scheme such as the EU's Emission Trading Scheme.

As explained with equation (1) above, the cost of reducing emission is, on average, half or less of the carbon price that induces the reduction. This also holds for CDM projects. Projects are paid the price of CDM carbon credits multiplied by the total emission reduction they cause. But that is twice the net cost of the abatement according to equation (1). So CDM payments are roughly half profit and half payment of

[12] There are several reasons to use an incentive rather than a rule that says, for example, that a country's carbon revenue must be within 5 percent of its target. First, we need to accommodate cap-and-trade systems which have a hard time controlling revenue. Second, with a rule, there still must be a penalty for breaking the rule and that is an incentive payment (paid by the rule breaker). Third, some countries will want to over- or under-achieve, and for the sake of cooperation, it is best to accommodate these desires, since we can do so without any harm to the system.

costs (Stoft 2009b). In fact, for the notorious HFC-23 projects, which dominated the early years of the CDM, profits were in excess of 95 percent of the payments (Wara and Victor 2008).

Because CDM projects are so profitable, they provide a significant incentive for developing countries to continue to reject Kyoto's capping approach and to reject any form of carbon pricing unless it is well subsidized (Stoft 2009b). A second, well-recognized problem with the CDM is that it is project based, and consequently misses many opportunities, such as the opportunity to encourage people to purchase more fuel-efficient cars. This makes it inefficient.

A Green Fund would provide subsidies for developing countries to participate in climate-policy. Those subsidies could replace the CDM subsidies just described. But it would be far better if the CDM could be transformed from a discouragement of global carbon pricing into an incentive for developing countries to join in global carbon pricing. Call this hypothetical new CDM the Clean Development Incentive (CDI). It would be better still if the new CDI could also serve directly as an incentive for emission reductions that are not covered by the national carbon prices described above. These include such things as nationally funded solar research and national campaigns to provide energy conservation information.

Finally it would be best if the CDI could also provide revenues for the Green Fund, and specify the fair obligations of countries providing those revenues and the proportions in which the revenues should be distributed to the recipient countries. Remarkably, all this is possible with an exceptionally simple mechanism.

5.1. Incentive Properties of Green-Fund Transfers

Any Green Fund that is not purely voluntary will have rules that determine how much countries will pay or be paid. These rules will, just by their existence, provide incentives, and these incentives may be beneficial, detrimental or meaningless. One proposed rule is that countries with high emissions, should contribute to the Green Fund according to how much they have emitted in the past. This rule provides a meaningless incentive to reduce past emissions, thereby missing an opportunity to provide a constructive incentive.

Since the goal is to determine Green-Fund transfer payments with a CDI that provides strong incentives for emission reductions, the transfer-payment rules should be based only on emissions per capita.

A basic objective of the green fund is to treat countries more fairly than does the Pricing Incentive, which simply pushes countries toward carbon taxes equal to the global carbon pricing target. If all countries meet this target, they will experience abatement costs that are approximately proportional to their emissions. This is a step toward fairness since emissions are roughly proportional to income. Nonetheless, there are good arguments for treating low-emission countries more favorably.

One of these arguments is based on the view that global warming is an example of the tragedy of the commons, with the atmosphere being the commons. The most obvious fair solution to this problem is to give every individual an equal but limited right to the commons, and allow people to use or trade their rights as they wish. Doing so would (1) provide an incentive to emit less because the rights would be costly, and (2) transfer funds from high-emission nations and individuals to low-emission nations in a fair manner. Notice that these two outcomes satisfy two objectives of the Green Fund—reducing emissions and fair transfer payments.

Also note that allocating a limited number of tradable rights is simply cap and trade with the rights being freely allocated permits. In other words this is a second form of carbon pricing. The first, described in the previous section, is harmonized national pricing, and this is truly global carbon pricing.

5.2. The Clean Development Incentive

We now have a preliminary candidate for the CDI: an equal-per-capita allocation of tradable atmospheric rights. It is an emission reducing incentive with good fairness properties. But it has two fatal flaws. It is administratively intractable and politically infeasible. First consider political feasibility.

To solve the climate problem, rights would need to be scarce enough to command a reasonable price. In the early years, if we continue with our example from Table 2, that price would be $30 per ton. Because the United States would be allocated only a world-average number of rights, it would end up spending $108 billion per year purchasing rights from outside the country. This outcome is politically infeasible.

That cost needs to be scaled down considerably, but how can individual rights be adjusted to accomplish this? As already noted, individual rights are intractable, so let us solve that problem first. Fortunately, the Green Fund does not require that individuals be paid, so simplification is just a matter of calculating the national payments that would result from individual rights and efficient trading. The formula for such payments is

$$\text{Clean Development Incentive payment } = G \times (E - e) \quad (3)$$

The variable E is the global average per-capita emission rate, and e is the per-capita emission rate of the country in question. The parameter G is the Clean Development Incentive and the second key policy parameter, after the global target price P^T. Recall that these two govern the strength and equity of our policy and are the only values requiring serious negotiations.

Note that the CDI revenues are national revenues and that the CDI is an incentive for national behavior. It provides incentives for nations to reduce emissions. For nations with low emissions per capita, $e < E$, the CDI revenue is positive, indicating the country will receive payments. Countries with $e > E$ will have negative CDI revenues, indicating they must make payments.

As shown in Table 2, this formula and the value G = $2 result in transfers to India that pay their cost of abatement twice over. This is similar to the subsidies of the CDM.

So far, the design of the CDI has achieved all of its goals except the first. It does not provide an incentive for developing countries to price carbon at the global target price. To accomplish this, add a rule that if a country with below-average emissions sets its carbon price to P^T or more, it receives full payment from the Green Fund, but if it sets its carbon price to zero, it receives no payment. Intermediate levels of carbon pricing are treated proportionally.

This completes the design of the Clean Development Incentive. It will gently induce developing countries to participate in global carbon pricing by paying them to do so. It will encourage ever country equally to reduce emissions per capita in order to reduce their obligation to the Green Fund or to increase their receipts from the Green Fund. And it determines all revenue flows into and out of that fund fairly by making them proportional to payments that would occur under a distribution of equal atmospheric rights to all citizens of the world.

6. Hitting Emission Targets

The principle argument for binding emission targets as the basis for international commitments is that caps and only caps can control the climate. If this were true, then there would be no use looking for a different form of commitment even though emission targets seem hopelessly out of reach.

In principle national caps could provide emission certainty, but they cannot provide certainty of climate. Generally, when a cap is said to hold the global temperature increase to less than, say, 2°C, it means that is the IPCC's expected increase, but there is a 50-50 chance of higher or lower temperatures with a high degree of uncertainty around the mean prediction.

But caps cannot control global emissions unless they cover all global emissions, and the chance of covering even half of all emissions seems slim for decades. But suppose 70 percent of the world's population was under perfectly controlled caps and we had to hit an emissions target in 2050. What policy would do that? It would be necessary to adjust the emissions caps of the 70 percent as we approached 2050 in order to compensate for whatever the other 30 percent of the world was doing. So for at least two reasons, caps will require multiple adjustments to hit a climate target.

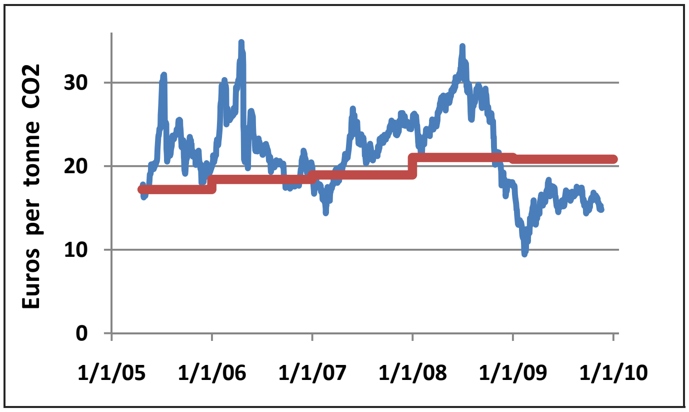
But adjustments are particularly difficult with caps because they come with no enforcement mechanism, and as discussed above they are extremely difficult to renegotiate—even if they ever could be negotiated to start with.

Fortunately, carbon pricing can be used to hit an emissions target. In fact any emission target for, say, 2050 can be hit quite accurately. In fact, carbon pricing can be used to hit global temperature target as easily as to hit a global emissions target, something pre-set caps cannot do. This only requires proper control of the global carbon price P^A, and this is tightly controlled by the global target price, which can be set as needed. So in effect, the climate authority can set P^A, and thereby control emissions. And emissions can then be adjusted as needed to hit a genuine climate target, such as global temperature.

Suppose the world decides on a target emission level for 2050. The next step is to decide the emissions path the world should take to that target. Then if the world goes above that path, P^A would be raised, and if it goes below that path, P^A would be lowered. This could be done by formula or by a technical committee.

Since the world does not change track quickly, P^A needs to be adjusted, at most, once per year. Unpredictable prices cause investment mistakes and cause investors to postpone investment decisions. So P^A should be adjusted gradually, to keep it relatively predictable. The following simple rule would guarantee a fairly direct hit on any reasonable emissions target. If emissions are off the path by more than 4 percent, adjust P^A by 4 percent, but if emissions are off the path by more than 8 percent adjust P^A by 8 percent. These should come on top of a normal three-percent-per year increase. Eleven (3+8) percent is enough to triple prices in ten years, which would allow us to hit any target we can afford to hit and some we cannot.

Figure 2. European Carbon Permit Prices (ECX 2009)



Jagged line is the EUA futures contract price for December 2012 settlement. Step function shows analogous 5 and 10% adjustments.

If such price changes seem worrisome, note that cap and trade makes the world hit its cap by allowing the permit market to set P^A. But the permit market changes its mind every day and 10-percent price changes occur frequently. The jagged price path shown in Figure 2 describes permits to be delivered in December 2012. So these represent the changing view of the future faced by investors.

But does the path of European carbon prices look like it is doing a good job of steering Europe toward a certain emission target? It may be doing the best job possible (except for its burden on investors), but in that case, the best possible is still exceptionally poor. In fact, a slow-and-steady price adjustment approach that would occur under global carbon pricing would probably steer emissions just as well, and it would not risk unexpected price spikes that could become "extremely unpopular with market participants and economic policy makers," as Nordhaus has warned may happen with caps.

The red step function in Figure 2 displays the global carbon price target under the 4-and-8 percent rule just described, where the step is taken on 2 January each year. It is assumed that the European permit price indicates whether the global carbon price target needs to go lower or higher. The steps are +8%, +3%, +13% and −2%. As can be seen, prices are far more predictable, and yet they seem to give as good if not better guidance on hitting some future target.

This section is not intended to indicate a particular design for targeting the global price or global emissions. In fact it may make more sense to simply use a steadily increasing carbon price for the first decade or until the international community is more comfortable with how the system is working. All that really matters at the start, is selecting a target price, P^T, and a CDI incentive, G, and that the system be allowed to gain members and solidify. These are the two key policy parameters, and they could simply be re-decided by a vote of the membership every five years. Even this approach would allow fairly accurate targeting of emissions over a 40 year period.

7. Enforcement and Cartels

The system presented above, flexible global carbon pricing (flexible pricing), would be mutually beneficial because of its effect on climate change. It would make all countries except Russia and the OPEC countries better off. But that does not mean it is the basis for a stable mechanism—far from it. An important lesson from game theory is that the knowledge of a mutually beneficial system is no guarantee that players will agree to and abide by that system. The "prisoner's dilemma" game illustrates this, along with a long list of other games.

Externalities produce such games. A good standard of conduct exists, which would benefit a large number of players, but the players often refuse to cooperate. This is because, for most of them, cheating is a dominant strategy. If they cheat, they are better off whether the others cooperate or not.

Consider any global climate-change policy that makes every country do "its share." For example, consider the policy advocated by the United States, that China and India must cap their emissions below business as usual. This will cost them something, but if all countries do this, the countries will all come out ahead (except for bad luck with caps). Consider China's two options: "cap" or "no cap." If the agreement falls apart, and no one else chooses "cap," then China is better off choosing "no cap." If the agreement succeeds, and everyone else chooses "cap," then China is better off choosing "no cap," because it will still gain the benefits of all the others. No matter what the others do, China is better off with "no cap."

Logically, this tells us that the U.S. approach will fail, unless the agreement to cooperate is enforced. This need for enforcement of cooperation is closely related to problems faced by a cartel such as OPEC.[13]

7.1. A Climate Cartel

The problem for a climate agreement, like the problem for a cartel, is that for each country individually, cheating is profitable. In a cartel, cheating is selling more, and under a climate agreement, cheating is emitting more. Emitting more saves money and also makes carbon-intensive export more profitable. In either case, the country that does not cooperate will benefit from the cooperation of all the others. And the country that cheats, gains from getting to emit more or sell more.

So a global climate agreement can be thought of as global climate cartel—a good cartel. Instead of supplying less of some commodity such as oil, its goal is to use less fossil fuel. So if a climate agreement operates like the Kyoto agreement, without effective enforcement, it will suffer the fate of cartels. They almost always fall apart. In fact the Kyoto agree has two aspects that make it a particularly vulnerable cartel. It has an exceptionally large number of members, and the rewards of cooperation are not immediate profits but distant and uncertain environmental benefits. Without enforcement, a climate agreement is just a cartel with more problems than usual.

The seriousness of these problems should not be underestimated. Scott Barrett (2003b), author of *Environment and Statecraft*, says "In the case of Kyoto, enforcement was added as an afterthought. My book argues that enforcement needs to be brought front and center. All of the successful treaties reviewed in my book do this, and all the failures do not." He also notes that "By using carrots in the form

[13] Although it sounds surprising, up until this last year, the OPEC cartel has been a complete failure. During the early 1980s when it seemed so successful, it was only Saudi Arabia that actually cut back on production. All the other members cheated and sold as much as they could. The result was that Saudi Arabia had to cut its output by 75 percent by 1985. At that point, it realized its failure, cut its price and recaptured as much of the market from the cheaters as it could. Only in late 2008, after the oil-price collapse, have the other OPEC members started to cooperate. But there is still much cheating and the cooperation is weak.

of side payments paid by rich countries, Montreal compensated poorer countries for participating and complying."

7.2. Enforcement

It may seem that flexible pricing has already solved the problem of enforcement and even includes carrots. The carrots are Pricing-Incentive payments to over-achievers and Green-Fund transfers to low-emission countries, and they are real. But as described so far, the enforcement is not. What is to prevent high-emission countries from under-pricing carbon and simply refusing to pay the penalty? And what is there to induce them to contribute to the Green Fund?

The penalties of flexible pricing will do their jobs only if they are backed by a real enforcement mechanism—one that does not rely on the good will of those it is supposed to control. A strong, but not harsh mechanism is required. If countries believe it will be used effectively, they will not deliberately test it, and it will almost never be needed.

This is where a climate cartel has an advantage over other cartels, and why it can succeed. As Stiglitz (2007) explains, there is an existing legal framework that can be used to enforce a climate agreement. "There is already a framework for doing this: international trade sanctions. The Montreal Protocol on ozone-depleting gases employed the threat of trade sanctions-though they never had to be used." But as he also notes, this approach has been tested in a judicial proceeding of the World Trade Organization (WTO).

The United States passed a law forbidding importation of shrimp caught in nets without U.S.-style turtle excluder devices. The WTO at first ruled against the United States because it had not applied its regulation fairly, but in this ruling it stated unequivocally, "We have not decided that sovereign states should not act together bilaterally, plurilaterally or multilaterally, either within the WTO or in other international fora, to protect endangered species or to otherwise protect the environment. Clearly, they should and do." The U.S. corrected the unfairness and the WTO ruled in its favor.

Clearly, if the United States can enforce its view of global turtle endangerment with trade sanctions, then the U.N. could enforce a climate agreement with trade sanctions. Since the poorest countries profit from compliance and most wealthy countries will likely cooperate voluntarily, such enforcement should rarely be needed. Moreover the possibility of trade sanctions will induce most countries to play it safe and comply, even if not so inclined.

8. Getting Started

Enforcement can prevent members of a group from defecting, but it cannot get an organization started. Getting started is a chicken-and-egg problem and often more difficult than holding the group together. One startup problem is simply the difficulty of the initial negotiation. This is compounded if the initial group is large and if it contains parties, such as the OPEC countries, that would rather have the process fail. For this reason, starting small is a better strategy than huge climates summits. Thomas Schelling, a Nobel economist specializing in strategic international negotiation is "pretty sure it's a mistake to try to get more than a dozen major parties to negotiate" (Inman 2009).

Clearly, the United States and China should be at the core of the initial agreement if possible. It would also be tremendously useful to have India as a representative of those countries with below-average emissions per capita. It also makes sense to include the most cooperative parties, for example the EU and Japan, but they will not likely be the ones who require hard work to bring them on board.

So the final key to successfully implementing flexible pricing is to convince the United States, China and India to adopt it and join forces. Two aspects of any such agreement are crucial for its adoption—the costs and the benefits to the founding members. For India, as shown in Table 2, there can be a clear net benefit without even counting climate benefits. So the problem of startup comes down to making sure that costs to China and the United States are reasonably low, and the benefits are as high as possible. We will begin with costs.

8.1. The Costs of Joining Are Low

China is currently emitting a bit more CO_2 per capita than the world as a whole. So, depending on other greenhouse gas emissions, China might be required to make a small contribution to the Green Fund—a possibility that China would likely reject as a starting point. One of their reasons for rejection would be that a very sizeable part of China's CO_2 emissions is embodied in exports. These emissions are more properly attributed to the importing countries. While calculating embodied emissions can be difficult, a single global value should be used for each product and agreeing on such values for a few major products should not be difficult. Taking account of these embodied emissions would likely bring China down below the average-emitter line, and allow it a small payment from the Green Fund.

In spite of this, China would still experience a net cost from adopting flexible pricing. Although this looks small on a per-capita-per-day basis, China is primarily concerned with economic growth, so we should check the long-run impact on growth. For that purpose, assume that the policy reflected in Table 2 is brought in gradually between 2010 and 2020 and that China wants to know by how much its GDP growth will have fallen behind in 2020. The answer is that it will have to wait until 13 July 2020 to have the GDP it otherwise could have had on 1 July 2020—its growth having been delayed by 12 days.

Table 3. Delayed Growth in 2020 Caused by the Climate Policy of Table 2

	Emissions	Abatement Cost	Green Fund Cost	Total Cost	Growth Rate	Delay
	(gigatons)	(billions)	(billions)	(% of GDP)	(% / year)	(days)
China	9.4	$28.2	$4.6	0.19%	5.9%	12.1
U.S.	6.0	$17.9	$7.0	0.14%	2.5%	20.1

China's emissions include emissions embodied in exports and so are likely overstated. Values are from Appendix A of the U.S. DOE's International Energy Outlook, 2009.

Costs to the United States would be somewhat lower, because its population will be four times lower. Although China's Green-Fund contribution is probably overstated in Table 3, which does not correct for emissions embodied in exports, China would, very likely, be making payments to the Green Fund by 2020. However, these would only amount to less than 3/100 of 1% of its GDP. All of this follows from the assumptions used in Table 2, and these value could be substantially altered by any agreement. In summary, however, it appears likely that the costs will not be substantial in terms of lost growth unless the climate takes an obvious turn for the worse and the world decides it needs to take the situation much more seriously. But in that case, flexible pricing would still provided excellent value.

8.2. The Benefits of Joining Are High

An overlooked benefit of a climate cartel comes from the oil market. The point of a climate cartel is to reduce the demand for fossil fuel, particularly coal and oil. But notice that reducing the demand for oil is the reverse of what OPEC does. It reduces the supply of oil in order to raise the world price of oil. The climate cartel *reduces the demand* for oil, lowering the world price of oil. This means a climate cartel is, unintentionally, an oil consumers' cartel.

In 1974, when then Secretary of State Henry Kissinger organized the International Energy Agency to be a consumers' cartel, the point was to save hundreds of billions of dollars, not to save the climate. Now the focus has shifted, but that will not stop a consumers' cartel from working to lower oil prices. In fact every analysis of global climate policy that considers the question finds that world oil prices will be reduced by a global climate agreement exactly because it acts as a consumers' cartel. This is what the U.S. DOE (1998) found when it analyzed the Kyoto Protocol and it is what a research team at MIT found when it analyzed all the cap and trade bills before Congress (Paltsev 2007, Appendix C, 66, 69). In fact the MIT report found the price of oil would be reduced 47% in 2050 by climate policy.

This is particularly important for China, which is far more concerned with oil security than with climate change. So for China, the primary benefit of joining in support of flexible pricing is that, were this adopted as a global policy, they would have a global consumers' cartel helping them holding down world oil prices. Since they will likely be importing about 80 percent of their oil by 2030, and since more oil price spikes of at least the magnitude experienced in 2008 are likely, this would indeed be a reason to join a climate organization. It will be an especially compelling reason when they realize that if they do not join, such an organization is not likely to exist.

But how much of China's $33 billion cost might be covered by the benefits of reduced oil prices? Table 4 shows that with reasonable assumptions reduced oil prices might cover $49 billion—half again more than China's climate costs—by savings from cheaper oil imports. Now, this estimate could be high, but the point is that when we are desperately in need of carrots to induce cooperation, it is unwise to ignore a carrot of this magnitude.

Because this outcome is so surprising favorable, it's worth looking at the inputs shown in Table 4. First, and most problematic, is the oil price sensitivity of 1.5, which means a 1 percent global demand reduction for oil will reduce its price by 1.5 percent. This was the lowest value discovered (See Appendix 10.4) and it comes from the IEA. But two years later, the IEA considered the possibility of a high-growth world with a tight oil market and prices rising to $87 per barrel. In that world, they found that the price sensitivity was 9—six times higher. In such a world, China's savings would be far greater.

Table 4. China's Savings on Imported Oil in 2020 from a Climate Cartel that Reduces by Demand 20%

1.5	(% oil-price change) / (% oil-demand change). From IEA's WEO 2005.
$115	Oil price in 2020. From DOE's IEO 2009, p. 23.
20%	Decrease in the climate cartel's demand for oil. From Table 2, above.
67%	Percent of oil demand controlled by the climate cartel (OECD + China + India).
13.3%	World decrease in oil demand. (67% × 20%)
$23	Decrease in world price of oil. (1.5 × 13.3% × $115)
2,146 MB/year	China's oil imports in 2020 with oil use reduced 20%. From DOE's IEO, Tables A5 and G1.
$49 B	China's Savings on oil imports in 2020. ($23 × 2,146 M)

IEA is the International Energy Agency. WEO is their World Energy Outlook. DOE is the U.S. Department of Energy. IEO is its International Energy Outlook.

The next input to Table 4 is DOE's 2009 price forecast for oil in 2020. Next is the assumptions from Table 2 of emission reductions, but extended to say that it would be the same for all three fuels. This would depend on policies. Under flexible pricing, China and the U.S. would be allowed to focus extra pricing attention on oil and they might do so. As noted in Appendix 10.2, there is a type of fuel-efficiency incentive that would receive pricing credit. But in spite of this, the global effect on the demand for oil could be less than it is on other fuels, so the estimate in Table 4 could be an over estimate—perhaps double. But even at that, and even if the low-end estimate of price sensitivity is correct, the imported oil savings still covers most of China's climate costs.

A similar calculation for the United States finds a savings on oil imports of $41 B, compared to the costs from Table 3 of $25 billion. Again the carrot is enormous. It seems clear that one of the bigger game-changers in climate negotiations would be to link them to energy security—that is, protection from high and volatile oil prices.

One reason this has not been done seems to be a common misunderstanding that runs as follows. Energy security would lower oil price, which means higher oil consumption, which means more CO_2 emissions. This logic fails to distinguish between world oil prices (which should be brought down) and domestic oil prices (which should remain high). Carbon pricing creates this differential. As long as an oil-consumers' cartel focuses on the demand side, it will necessarily act as a climate cartel, for the only way to reduce oil prices with demand is to reduce the demand for, and use of, oil. If this could be understood, then an alliance between energy-security and climate-stability interests seems possible.

9. Conclusion

Although cap and trade was originally intended to establish an efficient global price for carbon, that intention has been lost from the U.S. policy perspective. If this were not the case, U.S. negotiators, having failed to secure caps, would now offer developing countries the option of committing to a carbon tax. Instead they do not mention this possibility, but have signed agreements endorsing Nationally Appropriate Mitigation Actions. These are to be carried out in developing countries with subsidies from industrialized countries. Such subsidies, like the U.N.'s Clean Development Mechanism will only make global carbon pricing more difficult to achieve.

But the situation is even worse. The thirteen-year failed endeavor to cap the developing countries has polarized the negotiating field. Today, developing countries are demanding impossibly tight caps on industrialized countries. This is apparently a counter-attack to protect against the demands for caps on developing countries. It is also potentially lucrative, since the result of cap tightening by rich countries will be mainly to increase the value of carbon credits under the Clean Development Mechanism.

The problem has been the two forms of commitment under discussion: commit to binding national emission targets and commitment to a global carbon tax. Developing countries reject the first because the emission targets are too low and jeopardize their economic growth—their path out of poverty. The United States and most European countries reject the second as it rules out cap and trade.

This paper proposes international commitments to flexible global carbon pricing as the way to escape the above dilemma. Global carbon pricing does not impose binding targets on developing countries and it does not prevent countries from adopting cap and trade. Instead it requires that a commitment to a global pricing target be met with either cap and trade or taxes. It allows countries to over- and under-achieve the global target and makes them pay or pays them accordingly, just as happens under global cap and trade. This flexibility makes carbon pricing compatible with cap and trade.

The proposal put forward here allows for a modest start in order to solidify commitments and prove the mechanism's capabilities. It maximizes flexibility to reduce barriers to acceptance. It provides for credible enforcement, and allows generous inducements for those with little means and less responsibility for the current problems. A stable mechanism must be flexible, strong and fair to participants.

These general principles are not new ideas, but are familiar to those who study the dynamics of organizational formation and cooperation and the stability of multilateral agreements. The initial focus must be on the development of a mechanism that will lead to a stable and effective international agreement. Only with that in place can global climate targets realistically be achieved.

10. Appendix

10.1. Summary of the Flexible-Global-Carbon-Pricing Mechanism

Flexible global carbon pricing is governed by two key parameters, the global carbon target price, P^T, and the Clean Development Incentive (CDI) rate, G. These are the key values to be negotiated. National Pricing-Incentive payments guide the global average carbon price toward P^T, and are described by equation (2). CDI payments comprise a Green Fund, and are defined by equation (3).

$$\text{Pricing-Incentive payment } = Z \times (r - e \times P^T) \tag{2}$$

$$\text{Clean Development Incentive payment } = G \times (E - e) \tag{3}$$

r = national carbon revenues per capita

e = national emissions per capita

E = global emissions per capita

Z = the Pricing Incentive strength

Besides these two basic incentives, several more technical rules are needed, as well as a method for adjusting P^T and G.

First, a rule is needed for raising Z when the global average carbon price, P^A, is less than the target, P^T, and for lowering Z when $P^A > P^T$. The rule might be, raise Z by C% when P^A is C% below its target.

Next there is a rule that countries will receive full CDI payments only if they price carbon at the target or higher and will receive proportionally less if they price below the global target.

Some rule about the form of CDI payments will be required, and backstop enforcement of the two types of payments is provided with trade sanctions when necessary.

Finally there must be a rule for adjusting P^T. This could be an agreement to have it increase at a predetermined rate until it is voted on again, or it could be an agreement to adjust it to force emissions to follow a certain path to a climate or emissions target.

10.2. Fuel Efficiency Standards as Carbon Pricing

Standards can be useful and efficient when applied to consumer choices for which consumers exhibit an irrationally high discount rate. Examples of this are said to include cars, homes and electric appliances. Suppose that consumers take into account one-half of the future cost of gasoline when purchasing a car, and the cost of gasoline is $3.00 per gallon. Instead of complex standards, the government could levy a fee on new cars equal to $1.50 times a standard auto lifetime mileages (say 100,000) divided by the car's miles per gallon. This would make consumers take into account the full value of fuel efficiency when purchasing the car.

The revenues could then be refunded to the car companies in proportion to the number of cars sold. This would not interfere with the energy incentive but would make it cheaper to sell cars, so the refund would be passed through to consumers, who as a group, would experience no net cost.

The revenue collected with such a fee is one more form of carbon pricing (once the carbon content of the fuel is taken into account). In this way countries can be given credit for a policy that is superior to fuel efficiency standards.

10.3. International Transfers as Shopping Credits

There is sure to be opposition in some industrialized countries to even the modest international transfers used in the examples of this paper. First it will be said that money should not be given without proper oversight of its use. But in fact the proposal is that the payment be made only in return for carbon pricing. This means the country must levy taxes or implement cap and trade. As can be seen by observing the U.S. Congress, this is no easy feat even for an advanced industrial nation. So the Green Fund transfers are definitely being given only in return for well-monitored, verifiable actions that are sure to have real effects.

Nonetheless, the Green Fund transfers could be shopping credits for green goods and services, good only in the country of origin. It should also be noted that the U.S. Green Fund payments are $7 billion per year in 2020 as shown in Table 3, while the U.S. EPA estimates that foreign payments for offsets will be $20 billion per year in 2020 under the Waxman-Markey bill.

10.4. The Sensitivity of the World Oil Price to Demand

The most difficult value to estimate in the calculation of oil price reduction is the sensitivity of world oil price to the world's demand for oil [(percent change in price)/(percent change in demand)]. Fortunately, published results from a number of major climate-change models reveal their implicit estimate of oil-price sensitivity. These values are listed in Table 5 below, and more information is given at www.global-energy.org.

Table 5. Sensitivity of World Oil Price to Changes in World Oil Demand

Sensitivity	Model
4.5	U.S. DOE's 1998 report on the effect of the Kyoto Protocol
3.5	Wharton Economic Forecasting Associates' model of the Kyoto Protocol, 1998.
4.5	Electric Power Research Institute's (EPRI) model of the Kyoto Protocol, 1998.
1.5	International Energy Agency: *World Energy Outlook 2005*
8.9	International Energy Agency: *World Energy Outlook 2007* (high demand scenario)
1.6	U.S. DOE's "Analysis of Crude Oil Production in the Arctic National Wildlife Refuge." May 2008. (Shifting the supply curve has the same price effect as shifting the demand curve.)
----	MIT's study of seven cap and trade bills before Congress, (Paltsev 2007) found these bills together with similar programs (delayed in developing countries) would reduce world oil demand 34—47% by 2050 (from $90 to $48/bbl for the stricter cap-and-trade bills).

The Wharton and EPRI results were reported in U.S. DOE's 1998 model of the Kyoto Protocol.

To be cautious, the lowest of these values, 1.5, was used in Section 8, above. This value is from the International Energy Agency's *World Energy Outlook: 2005*. This report includes both a "reference scenario" and an "alternative policy scenario" that assumes reduced fossil energy use. This is the IEA's prediction of the change in demand for oil in the alternative policy scenario:

> Demand for oil in the Alternative Policy Scenario rises to just under 5000 million tons in 2030, 580 million tons, or 10%, lower than in the Reference Scenario.

This 10 percent decrease in the use of oil relative to the IEA's reference scenario would reduce the price of oil, and the IEA tells us:

> The oil price averages $33 per barrel in the Alternative Policy Scenario. This is $6, or 15%, lower than in the Reference Scenario, because lower demand depresses prices.

But the IEA's *WEO 2007* report may be more relevant to conditions we are now facing. It considers a "high-growth" scenario in which demand for energy is high. Higher oil demand pushes the price of oil up and the IEA tells us "international oil prices reach $87 per barrel in year-2006 dollars in 2030, 40% higher than in the Reference Scenario." In spite of that, the global demand for oil is only 3 percent higher than in the reference scenario. If climate policy reversed the high-demand scenario, it would cause a 29% price drop from $87 back to $62. This indicates a price sensitivity of 8.9, six-times higher than the one used in this paper.

Although the recent tightening of the oil market seems to be as much caused by supply reduction as increased demand, these two causes should have a similar effect on the oil-price sensitivity. The DOE (2009) is now predicting an oil price of $130 in 2030. When that is compared to the IEA's high-demand scenario that reaches only $87 in 2030, it seems clear that we have entered a world of higher oil-price sensitivity than the IEA imagined for its high-demand scenario back in 2007.

10.5. U.S. Compliance with Global Pricing

Quite likely, a global pricing target would not start at $30/ton, but would instead start at a lower value and ramp up. This would give governments and economies time to adjust while still sending essentially a full $30 price signal to long-term investors. But to simplify, and to confront the full problem, let us assume the global carbon pricing target is $30/ton. How could that be met in the United States?

The greatest advantage of meeting a carbon pricing commitment would be that the United States would be matching efforts by other countries that would be (aside from the Green Fund) demonstrably comparable to the U.S. commitment. This would eliminate the roadblock that derailed cap-and-trade in the Senate in late 2009 and that caused the 95-to-zero vote against Kyoto-like Protocols in the Senate in 1997.

To put the various policy choices in perspective, note that with a population of 300 million emitting 20 tons/capita and a carbon price of $30/ton, the U.S. carbon revenue requirement would be $180 billion. This revenue requirement could be met under cap and trade even if all permits were distributed for free. They would be counted at their market price when used toward pricing revenue. Also the purchase and retirement of offsets and of permits from other countries under cap and trade would be counted. Under cap and trade with a price floor set at $20 per ton, at worst, the United States would under-collect by $60 billion. But counting offsets, the under-collection would likely be much less, even if the price of allowances is $20/ton. Even an under-collection of $60 billion would likely result in a Pricing Incentive payment to the climate authority of something on the order of $6 billion. Over collection would be equally possible and would earn a similar payment *from* the climate authority.

A modification of CAFE standards would allow the strength of the cap to be roughly cut in half. To get credit for the fuel efficiency incentive, an auto-mileage feebate could be added to the standard. By making the feebate an addition to rather than a replacement of the standard, environmentalists would be reassured. The two incentives would not be additive but would form a system of belts and suspenders.

Assuming, with the NHTSA, that car buyers ignore roughly half the future cost of gasoline, a feebate that corrected for this myopia would contribute roughly $90 billion in carbon revenue—all of which would be refunded to auto-makers on a per-vehicle basis. That would leave only $90 billion to be collected with cap and trade.

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