PRACTICAL PROBLEMS CONFRONTING A CARBON TAX OR PERMIT TREATY

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INTRODUCTION

In another paper, Seidman and Lewis (2009) estimated the potential cost saving to the world economy of getting low-income countries to help reduce carbon emissions, then considered how compensation under an international treaty might induce low-income countries to help, and investigated whether high-income countries might benefit despite collectively compensating low-income countries under the treaty. That study considered two alternative ways to reduce emissions: a harmonized carbon tax, and a cap and trade international permit system. Each way would roughly equalize the carbon price facing all emitters and tend to minimize the world cost of achieving a given world emissions reduction target. To illustrate the potential of a carbon treaty, that paper made a number of simplifications and ignored practical difficulties. In this paper we re-examine these simplifications and address the practical problems that would face the international treaty board that implements the policy.

AN INTERNATIONAL CARBON TREATY

This section summarizes our earlier paper. The simulations in that paper used actual 2004 data on carbon emissions (Energy Information Administration, 2004) and per capita GDP from 178 countries (International Monetary Fund, 2004) to provide an estimate of how much better off high-income countries might be if they get help from low-income countries in reducing carbon emissions rather than doing it themselves, even if they collectively compensate low-income countries through an international carbon treaty. That paper provided a numerical illustration of how an international carbon treaty administered by a "Treaty Board" might work.

Under the treaty each high-income country would make a contribution to the Treaty Board, not to any particular low-income country, according to a formula prescribed by the treaty that applies objectively to all high-income countries; and each low-income country would correspondingly receive compensation from the Treaty Board according to a formula.

We made the plausible assumption that if only a subset of countries reduce their own emissions, a subset country would have a marginal cost for the last unit it abates that is greater than the marginal cost would be for the first unit of a nonparticipating country, implying that it would be possible to reduce the total world cost of reducing emissions by inducing nonparticipating countries to help.[1]

Under the compensation formula specified in the treaty, each low-income country's per capita compensation depends on both its cost of emission reduction, and on its per capita GDP. Under the contribution formula specified in the treaty, each high-income country's per capita contribution depends on both the cost saving it achieves from the participation of low-income countries in emission reduction, and on its per capita GDP.

With a harmonized carbon tax,[2] each country agrees to levy a carbon tax at the uniform magnitude specified by the Treaty Board for all countries (for example, $100 per ton). Each country's government levies and administers its carbon tax, collects and keeps its carbon tax revenue, and decides how to use the revenue. Each high-income country government decides how to finance its contribution to the Treaty Board, and each low-income country government decides how to use its compensation from the Board. The Board's contribution formula prescribes the amount each high-income country must pay, and the Board's compensation formula prescribes the amount the Board must pay to each low-income country.

With marketable permits,[3] compensations and contributions are implemented indirectly by a formula used by the Treaty Board to distribute permits to countries under the treaty. Each low-income country government is given more permits than the Treaty Board expects its firms to use; the Board's intention is to enable each low-income country to become a net seller of permits and thereby receive compensation through its sales. Each high-income country government is given fewer permits than the Board expects its firms to use; the Board's intention is have each high-income country become a net buyer of permits and thereby make a contribution through its purchases. Each

country government could either sell all its permits, or distribute some or all of its permits for free to its own firms.

In round numbers, here is what we found using 2004 data for emissions and per capita income. World emissions would have been 7 billion tons. Suppose the objective is to reduce emissions 1 billion tons. If all 200 countries (both high- and low-income) participate, a tax of $100 per ton induces the cutback of 1 billion, and the cost of this emissions reduction to the world economy is $50 billion: a cost of $25 billion is incurred by the 50 higher-income countries (per capita GDP greater than $12,000) due to their emissions reduction, and a cost of $25 billion is incurred by the 150 lower-income countries (per capita GDP less than $12,000) due to their emissions reduction. If the 50 higher-income countries alone cut 1 billion, the tax required to induce them to cut 1 billion is $200 per ton and the cost to these countries is $100 billion. Thus, the cost saving to the 50 higher-income countries of getting the 150 lower-income countries to help is $75 billion. To compensate the 150 lower-income countries 100 percent of their cost of emissions reduction requires that they be given $25 billion. If the 50 high-income countries contribute $25 billion to the get the lower-income countries to help cut 1 billion tons, the higher-income countries are $50 ($75-$25) billion better off than if they had cut 1 billion tons by themselves.

The percentage compensation needs to be phased down gradually, rather than abruptly, from 100 percent to 0 percent. For illustration, we consider 100 percent compensation for $y < \underline{y} = \$6{,}000$ and a smooth phase-down of the compensation percentage from 100 percent to 0 percent as y increases from $6,000 to $y^* = \$12{,}000$. For example, for one large low-income country with $y < \$6{,}000$, the compensation formula yielded a per capita compensation of $7.

Consider a formula by which the per capita contribution of a high-income country, x, varies with its per capita income above y^*, Δy (where $\Delta y = y - y^*$), and its per capita cost saving, Δc, so $x = h(\Delta y)^v(\Delta c)^w$, where $\Delta y \equiv y - y^*$. A v of 1 yields a proportional contribution formula while a v of 2 yields a progressive contribution formula. If w=1, the high-income country's per capita contribution is proportion to its cost saving due to the help of low-income countries. If w=0, a country's per capita contribution depends only on its per capita income. Each year the Board sets the numerical value for h that Board technicians estimate will raise an amount of total funds from the high-income countries equal to the total funds promised by formula to the low-income countries.

With this contribution formula we found (using 2004 data) that one very high-income country would contribute $40 per capita under the proportional formula (v=1) and $50 per capita under the progressive formula, while one moderately high-income country would contribute $15 per capita under the proportional formula and $10 per capita under the progressive formula.

Practical Problems in Implementing the Treaty

The political and operational aspects of the treaty and the Treaty Board would be challenging. Should the Treaty Board be a newly formed agency or a division of a current international agency? How many votes would each country have? Obviously these aspects of an international carbon treaty would be extremely controversial. Similar problems arise in other international agreements concerning, for example, international trade, and the Treaty Board would need to adapt these methods to a carbon treaty.

Should low-income countries with y below $\underline{y}$ receive compensation that is greater than, equal to, or less than 100 percent of their cost of cutting emissions?

The Treaty Board technicians need to develop a cost formula that yields an estimate of the cost of emissions reduction so that the Treaty Board can assign the per capita compensation to each low-income country and the per capita contribution from each high-income country. What problems can arise with the Treaty Board's cost formula? What variables, parameters, and functional form should be in the cost formula? Should the cost formula be the same for every country?

Suppose the cost formula states that a low-income country's estimated cost of emissions reduction is proportional to E, its estimated emissions in the absence of the treaty, and therefore, that its compensation would vary directly with E. This raises two issues. First, as the Treaty is being debated, would a low-income country have an incentive to expand its emissions so that it can receive larger compensation once the Treaty goes into effect? This can be prevented by making the Treaty retroactive: As the Treaty is being debated, it would be announced that E will be based on historical, not current, emissions.

Second, however, is the issue of fairness. Should a low-income country receive higher compensation because it has a higher E? If so, then would the treaty be rewarding low-income countries that had historically contributed more to the problem? If this is viewed as objectionable, it would be possible to base per capita compensation solely on per capita income so that a country's compensation would not vary with its historical or its current emissions. The total compensation for low-income countries that participate in the treaty could be based on an estimate of the total cost to these low-income countries. For example, total compensation could be set at X percent of the estimated total cost where X percent would be set by the Treaty Board; X percent could be set greater than, equal to, or less than 100 percent (e.g., if X percent were set at 100% percent and 150 low-income countries participate, then according to Table 1, these 150 countries would receive a total compensation of $25 billion). This $25 billion would be allocated to each low-income country solely according to its per capita income, not according to an estimate of its particular cost of cutback.

Recall that in our earlier paper a high-income country's per capita contribution *x* varied with its per capita income in excess of *y**, and might also vary with the high-income country's per capita cost saving due to the participation of low-income countries. If a high-income country's contribution depends on its cost saving, then the cost estimation

Table 1
Overview of the International Carbon Treaty

An Estimate of How Much Better Off High-Income Countries Might Be if They Get Help from Low-Income Countries in Reducing Total World Emissions by 1 Billion Metric Tons, Rather Than Doing It Themselves

2004 EIA Data on Carbon Emissions and IMF Data on Per-Capita GDP (y) for 178 Countries ($ entries in billions – Numbers are Rounded)

	50 High-Income Countries $y>\$12{,}000$	*150 Low-Income Countries* $y\leq\$12{,}000$	*World*
Cost of Emissions Reduction When a Subset of 50 High-Income Countries Reduce Emissions 1b Tons (With a Carbon Tax of $200/Ton).	$100b	$0b	$100b
Cost of Emissions Reduction When All 200 Countries Participate to Reduce Emissions 1b Tons (Carbon Tax of $100/Ton).*,**	$25b	$25b	$50b
Cost Saving Due to 150 Countries Helping in the Emissions Reduction.	$75b	-$25b	$50b
Cost Saving Due to 150 Countries Helping along with 100% Collective Compensation to the 150 Low-Income Countries from the 50 High-Income Countries through the Treaty Board.	$50b	$0b	$50b

* Assume that if only a subset of countries reduce their own emissions, a subset country would have a marginal cost for the last unit it abates that is > the marginal cost for the first unit of emissions reduction by a non-participating country.

**Based on Dinan and Rogers' (2002) review of empirical studies for the United States. We use the very rough, simplifying assumption that a price of $100 would reduce emissions by 15 percent (1b tons is roughly 15 percent of the 2004 World emissions of 7b tons).

problems noted above for low-income countries would also apply to high-income countries.

The Treaty Board technicians must be able to measure each country's per capita GDP in a common currency so that the Treaty Board can assign a low-income country's compensation and a high-income country's contribution. Recall that in our earlier study we assumed for illustration that the treaty must specify the per capita GDP values for $\underline{y}$ and y^* (where $\underline{y} < y^*$): low-income countries with y below $\underline{y}$ would receive full compensation, countries with y greater than $\underline{y}$ but less than y^* would receive partial compensation, and countries with y greater than y^* would make contributions. In our earlier paper we used the IMF's estimate of per capita GDP for each country in 2004. Measuring per capita GDP in a common currency is difficult and controversial, and much research effort has been devoted to this task.

The treaty must specify not only the initial values for $\underline{y}$ and y^*, but must also indicate how the values for $\underline{y}$ and y^* will evolve over time: Will the values be adjusted annually by a vote of the Treaty Board, or will the Treaty Board specify a formula that links $\underline{y}$ and y^* to world GDP per capita?

Under the treaty, the per capita contribution of each high-income country would depend on its per capita income. The treaty would need to specify whether the contribution formula should be progressive, proportional, or regressive.

An issue of fairness might be raised: Should a high-income country that has historically emitted a large quantity of carbon over an extended time period be required to make a larger per capita contribution? If so, then an additional variable—cumulative emissions—should be included in the contribution formula. Introducing this variable raises several practical problems including choosing the historical time period over which to measure cumulative emissions, and the availability and quality of data on past emissions.

Should an attempt be made to estimate the future benefit to each country from reducing carbon emissions, and should this estimate be used to adjust the country's compensation or contribution? For example, a country with a large population in a coastal flood zone might benefit substantially in the future. It might be difficult to provide estimates of per capita future benefits for individual countries and to get diplomats to accept such estimates.[4]

Problems with a Tax Treaty

If the treaty utilizes a tax, then a country participates in the treaty if it levies the tax prescribed by the Treaty Board. Must country X levy the $100 carbon tax on top of its $4 gasoline tax? Or can it levy a smaller carbon tax such that the sum of its carbon tax and gasoline tax is "equivalent" to a $100 carbon tax? If so, how would "equivalence" be measured? Is it permissible for the country to terminate its gasoline tax when it adopts the $100 carbon tax? If country Y provides a subsidy to its coal industry of $20 per ton, must it eliminate this coal subsidy when it institutes its $100 per ton carbon tax? Or must it levy a carbon tax larger than $100 such that the carbon tax minus the coal subsidy is "equivalent" to a $100 carbon tax?

Suppose country Z already subsidizes alternative non-carbon energy (nuclear, solar, wind). Would Z be permitted to count its subsidies for non-carbon energy as "equivalent" to a tax on carbon so that it can comply with the treaty by levying a carbon tax that is less than $100? Or suppose country Z already uses regulation. Would Z be permitted to count its regulation to limit carbon energy or mandate non-carbon energy as "equivalent" to a tax on carbon?

What degree of compliance and enforcement would be required by the Board of each country under a carbon tax treaty? For example, a country government might state that it is imposing a $100 carbon tax but fail to monitor compliance or penalize firms that ignore the tax. Similar problems arise in many international agreements concerning, for example, international trade, and the Treaty Board would need to adapt these methods to a carbon tax treaty.

Problems with a Permit Treaty

If the treaty utilizes a permit system, then a country participating in the treaty must require its own firms to possess a quantity of permits equal to its quantity of carbon emissions. If country X already has its own domestic permit system, must it replace it with the new international permit system? If country Y has a $20 per ton coal subsidy, must it eliminate it to join the treaty? If country Z has subsidies or mandates for non-carbon energy, should it be rewarded with more permits? A country government might pledge to require its firms to possess a permit for each ton of carbon the firm emits, but the government may fail to monitor compliance or penalize firms that ignore the permit requirement.

Under a permit system, achieving the intended compensation or contribution for each country is less direct than for a carbon tax. Recall that under a permit system, compensation to a low-income country is implemented by giving that country a quantity of permits that the Treaty Board expects will be greater than the country's emissions so that the country will become a net seller of permits. Similarly, a contribution is imposed on a high-income country by giving that country a quantity of permits that the Treaty Board expects will be less than the country's emissions so that the country must become a net buyer of permits.

An example is useful. Suppose the aim is to cut emissions from 7 to 6 billion. Then the Treaty Board would distribute 6 billion permits. For each low-income country, the Treaty Board would forecast its emissions for the coming year under the permit system and give the country more permits than the Board expects that country to use so that the country would become a net seller of permits. Suppose the Treaty Board forecasts that low-income countries would emit 3 billion under the permit system. Then the Treaty Board would give low-income countries 3.25 billion permits, so that if they emitted 3 billion, they would be able to sell 0.25 billion. If the Treaty Board forecasts that the fluctuating world permit price over the coming year will on average equal $100 per ton, then this net sale of 0.25 billion permits by low-income countries would yield them revenue of $25 billion.

For each high-income country, the Treaty Board would forecast its emissions for the coming year under the permit system and give the country less permits than the Board expects the country to use so that the country would become a net buyer of permits. Suppose the Treaty Board forecasts that high-income countries would emit 3 billion tons under the permit system. Then the Treaty Board would give high-income countries 2.75 billion permits so that, if they emitted 3 billion, they would have to buy 0.25 billion. If the fluctuating permit price averages $100 per ton over the coming year, this purchase of permits would contribute revenue of $25 billion. Thus, the Treaty Board would give each country a quantity of permits based on its forecast of what the average permit price will be over the coming year, and its forecast of how many tons of carbon the country's firms will emit.

The problem, of course, is that the Treaty Board's forecasts may well be inaccurate. A low-income country may end up emitting more than its permit allocation from the Board, forcing it to be a net buyer of permits; similarly, a high-income country may end up emitting less than its permit allocation from the Board, enabling it to be a net seller of permits. What then?

It might be possible for the Board to make annual readjustment of compensations and contributions. One way to implement the readjustment might be to require year-end cash payments from some country governments and to make year-end cash payments to other country governments to undo the unintended consequences of the initial distribution of permits. Another way might be to alter next year's allocation of permits.

The functioning of an international permit market would pose administrative challenges for the Treaty Board. A carbon permit market would tend to behave like the markets for stocks, bonds, commodities, and currencies. The problems that arise in regulating and intervening in these markets would be relevant to an international permit market. What regulations should the Board impose and what interventions should it undertake? Would there be any restrictions concerning who is allowed to participate in the carbon permit market? Would any requirements or restrictions be imposed on the behavior of participants or the financial instruments that participants develop?

If there is a sharp spike in the world permit price, should the Board intervene by selling permits? If there is a sharp plunge in the world permit price, should the Board intervene by buying permits? Should the treaty specify whether, when, and how the Board should intervene, or should intervention be left to the discretion of Board members?

CONCLUSION

In an earlier paper which ignored practical difficulties, we outlined how an international treaty might be implemented by a Treaty Board using a compensation formula for low-income countries and a contribution formula for high-income countries. Using a set of simplifying assumptions, we showed the potential cost saving to the world economy, and to high-income countries, of getting low-income countries to help reduce carbon emissions, even if this required high-income countries to collectively compensate low-income countries. In this paper we examined in detail the set of practical difficulties that would arise under such a treaty.

Notes

[1] The role of increased participation in reducing the world cost is emphasized in several studies: Frankel (2007), Olmstead and Stavins (2006), Pizer (2006), Zhang (2004), Aldy, Barrett, and Stavins (2003).

[2] Nordhaus (2006), Cooper (1998); analysis of the design of a carbon tax within each country is given by Metcalf (2007), Goulder (1992), and Poterba (1991).

[3] Permit plans are analyzed in Stavins (2007), and Olmstead and Stavins (2006).

[4] Benefits as well as costs are weighed in Nordhaus (2007), and Lewis and Seidman (1996).

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