The Kyoto Protocol: a cost-effective strategy for meeting environmental objective?: discussion

Zhang, ZhongXiang
University of Groningen, The Netherlands

May 1999

May 1999

The Kyoto Protocol: A Cost-Effective Strategy for Meeting Environmental Objective?: Discussion[1]

ZhongXiang Zhang
Faculty of Economics and Faculty of Law
University of Groningen
P.O. Box 716
9700 AS Groningen
The Netherlands
Tel: +31 50 3636882
Fax: +31 50 3637101
Email: Z.X.Zhang@Rechten.RUG.NL
Web: http://www.eco.rug.nl/medewerk/zhang/

1. Introduction

Prof. Alan Manne and Dr. Richard Richels have made many valuable contributions in modelling the economic costs of mitigating greenhouse gas emissions, and this paper (Manne and Richels, 1999) is one of these contributions. It first examines a "Kyoto Forever" scenario in which the Kyoto constraints on Annex I countries are maintained throughout the 21st century. Next, the paper calculates what the economic implications of limiting the purchase of carbon emission rights are. It shows that in case Annex I buyers are allowed to meet only one-third of their obligation through trading of carbon rights, the annual GDP losses in 2010 in the US are two and one-half to three times the case in which full global trading is assumed. Then, the paper examines the potential of carbon leakage through international fuel markets and through the migration of energy-intensive industries from Annex I countries to non-Annex I countries. Finally, the paper evaluates the Kyoto Protocol in the context of the longer-term goal of the Framework Convention.

Reading this very interesting paper suggests four issues or questions to me. The first issue is about distributional realities of the international climate change negotiations. The second issue is about

[1] Invited discussion at the Intergovernmental Panel on Climate Change Working Group III Expert Meeting on the Economic Impacts of Annex I Mitigation Policies on Non-Annex I Countries, The Hague, 27-28 May 1999. The views expressed here are those of the author. The author bears sole responsibility for any errors and omissions that may remain.

correspondence between geopolitical regional aggregates in MERGE and Annex B countries. The third issue is about implications of the autonomous energy efficiency improvement rates assumed in MERGE on the income elasticity of energy consumption. And fourth issue is about market power in an international greenhouse gas emissions trading scheme.

2. Modelling distributional realities of the international climate change negotiations

First of all, I agree with the broad conclusion of the paper (Manne and Richels, 1999) that a long-term climate strategy should be designed to facilitate achieving the Framework Convention's ultimate objective of stabilizing greenhouse gas concentrations in the atmosphere at the lowest possible abatement and transaction costs. One might wonder why keeping down the costs of compliance matters. It is often heard that the high cost of compliance is just what polluters should suffer so that polluters are taught a lesson. From a political perspective, the more costly the compliance, the less likely it is that those who bear the high costs will be willing to commit to stringent emissions targets in the future. Given the fact that no emissions targets beyond 2012 have been set, increasing the overall costs of compliance thus makes it even more difficult to set stringent emissions targets for some Annex B countries, if not all, for the subsequent commitment periods beyond 2012 in order to achieve the Climate Convention's ultimate objective.[2] It is the lack of the targets of post-2012 that is seen as a threat to the pace of technical innovation needed to make more stringent future emissions targets affordable. The lack of such long-term commitments also restricts the choice of the compliance mechanisms and tools and creates some divergence of views in assigning liability in an international greenhouse gas emissions trading scheme (Zhang, forthcoming).

There are many paths to a longer-term stabilization concentration target. The path of offering great *when flexibility*, namely, the path that would begin gradually and leave the more drastic cuts in emissions in later periods, receives increased attention in the literature on economic and environmental implications of reaching a specific atmospheric concentration target (see, for example, Richels and Edmonds, 1995;

[2] Stavins (1998) points out that the adoption of the US SO_2 allowance trading program is largely attributed to strong support from the Environmental Defense Fund that was able to make powerful arguments for tradeable permits on the grounds that the use of a cost-effective instrument would make it politically feasible

Wigley, Richels and Edmonds, 1996; Manne and Richels, 1998; Yang and Jacoby, 1999). However, as Jacoby *et al*. point out, although these studies are instructive, their emphasis on global cost-effectiveness tends to underplay important distributional realities of the international climate change negotiations, and how they might be worked out over time. With the successful conclusion of the Montreal Protocol that sets percentage reduction targets for CFC emissions, it is not surprising that calls for limiting greenhouse gas emissions have focused on a similar strategy since the June 1988 Toronto Conference, which has recommended a 20% reduction by 2005 and a 50% reduction by 2025 in global CO_2 emissions relative to the 1988 levels (Zhang, 1997). Although it is the accumulated concentration of greenhouse gases in the atmosphere, not the annual emissions, that influences climate change, as at Kyoto, negotiations will continue to be about emissions levels in the near term, not about emission trajectories over several decades. In my review, the main reason is that, in the absence of dramatic and forceful changes from the business-as-usual trends, negotiators, particularly from developing countries, believe that private firms and consumers alike will not change their production and consumption patterns and will not take seriously the need to reduce greenhouse gas emissions.[3] The question then arises: how can one connect negotiations about near-term emissions reductions with a long-term stabilization objective? With the belief that in any fair regime substantial differences in per capita income will translate into substantial differences in emissions control obligations, Jacoby *et al.* (1999), for example, propose that accession of developing countries and burden sharing should be based on ability of pay. Although it is not my intention to recommend the approach as the sole determinant of incremental emissions control obligations, it might be worthwhile pursuing this kind of thought in assuming national commitments in MERGE towards the lowest cost path to the longer-term stabilization concentration target. This would enrich the policy relevance of this study to the ongoing climate change negotiations.

3. Correspondence between geopolitical regional aggregates in MERGE and Annex B countries

---

to achieve greater reductions in SO_2 emissions than would otherwise be possible. I believe that the arguments also hold for setting the post-2012 greenhouse gas emissions targets.

[3] Negotiating the appropriate size and shape of percentage emissions reductions would be not that easy. On the one hand, whatever a target is agreed on should be large enough to signal a decisive change from the business-as-usual trends. On the other hand, it should not be so large that governments would dismiss it as unrealistic.

It is unclear whether the correspondence between geopolitical regional aggregates in MERGE and Annex B countries is exact. It seems to me that Annex B countries modelled in MERGE constitute all the OECD countries and Eastern Europe and the Former Soviet Union (EEFSU). As such, they include Turkey as an OECD country and the Central Asian Republics as part of the EEFSU. But Turkey and the Central Asian Republics are not Annex B parties to the Kyoto Protocol. Although such a distinction does not have a fundamental impact on the results of the paper, from a climate change negotiator perspective it would be very useful to separate these non-Annex B countries from the Annex B parties aggregates in MERGE.

4. Implications of the choice of autonomous energy efficiency improvement rates on the income elasticity of energy consumption

One of the possibilities of decoupling energy consumption and CO_2 emissions from GDP growth in integrated assessment models, such as MERGE, is represented by the autonomous energy efficiency improvement (AEEI) parameter. The parameter accounts for all but energy price-induced energy conservation. Energy conservation of this type is available at zero or negative net cost, and is taking place regardless of the development of energy prices. It may be brought out by regulations. It may also occur as a result of "good housekeeping" or of a shift in the economic structure away from energy-intensive heavy manufacturing towards services. In the case where the parameter lowers the rate of growth of CO_2 emissions over time and therefore decreases the amount by which CO_2 emissions need to be constrained, the economic impacts of a given carbon constraint will also be lower.

In MERGE, the AEEI value is taken to be 40% of the rate of GDP growth. This implies that energy consumption grows at 60% of the rate of GDP growth. If price-induced energy conservation is taken into account, then energy consumption grows at a rate even lower than 60% of the rate of GDP growth. This leads to an income elasticity of energy consumption of less than 0.6. Comparing the implicitly assumed elasticity with what has been derived from the World Bank (1996), as given in Table 1, we can see that the assumed elasticities are backed from conventional wisdom for the OECD countries and China, but are much lower than what were observed for low-income economie and upper-middle-income economies over the period 1980-1994, which include four geopolitical regions modelled in MERGE, such as, Eastern

Europe and the Former Soviet Union (EEFSU), India, Mexico and OPEC (MOPEC), and the rest of world (ROW). Given the implications of the assumed AEEI values, and the fact that the AEEI values have a crucial influence on the estimates of economic costs of a given carbon constraint, what AEEI values are considered reasonable for the countries and regions considered in MERGE are worthy of further investigation.

Table 1 Growth Rates of GDP and Energy Consumption, and the Income Elasticity of Energy Consumption among Different Economies, 1980-1994

	Annual growth of GDP (%)	Annual growth of energy consumption (%)	Income elasticity of energy consumption
Low-income economies *	2.5	3.3	1.32
China	11.0	4.5	0.41
India	5.2	6.3	1.21
Upper-middle-income economies	2.5	3.9	1.56
High-income economies	2.8	1.1	0.39

* Excluding China and India.

Source: Calculated based on data from the World Bank (1996).

5. The issue of market power in an international greenhouse gas emissions trading scheme

The paper investigates the impact of market power. It indicates that the international price of permits depends on who resides in market power. With a buyer's market, buyers exert sufficient market power to hold the international price to the marginal cost of abatement in the selling countries. As such, the international price of permits is much lower than those in the absence of market power. Conversely, when market power resides with the sellers, the international price of permits is much higher than those in the absence of market power. This would lead to high economic losses for the buying countries, such as the

US. This raises an important question: is market power a real issue in an international greenhouse gas emissions trading?

In my view, monopoly power in permits market eventually depends on how an international greenhouse gas emissions trading scheme will take shape. Emissions trading modelled in MERGE operates as if governments retain the sole right to trade. As such, emissions trading takes place on a government-to-government basis. Under this trading model, there are few players on the market. So market power could likely be an issue, particularly when the majority of inexpensive emissions permits are concentrated among a few Eastern Europe and the Former Soviet Union countries.

If Annex B governments elect to allocate the assigned amounts to individual sub-national entities, and authorize them to trade on the international emissions permits market, any effectuated trades take place on a source- to-source basis (See Zhang (1998, forthcoming) for a detailed discussion on inter-governmental emissions trading and inter-source trading). Incorporating sub-national entities into an international emissions trading scheme would potentially increase the total amount of transactions in the international scheme. Increasing the number of trades would help to improve market liquidity and reduce the potential for abuse of market power. Hargrave (1998) shows that if an upstream trading system, which targets fossil fuel producers and importers as regulated entities,[4] would be implemented in the US, the total number of allowance holders would be restricted to about 1900, as shown in Table 2. Even with such a relatively small number of regulated sources, market power would not be an issue. In the above upstream system for the US, the largest firm has only a 5.6 percent market allowance share. Firms, with each having less than one percent share, would hold the lion's share of allowances (Cramton and Kerr, 1998). Even if market power would not be an issue under the domestic emissions trading scheme, it is hard to imagine a market power problem, if trading is broadened beyond the national boundary and provided that requisite international institutions supporting trading are available. So, in my review, the results as estimated by

[4] In contrast, a downstream trading system would be applied at the point of emissions. As such, a large number of diverse energy users are included. See Zhang (1998, forthcoming) for a detailed discussion on upstream, downstream and hybrid emissions trading systems.

MERGE under the assumption of market power should be regarded as an upper bound on the price of carbon permits and the GDP losses.

Table 2 Number of Regulated Entities in an Upstream Trading System in the US

Industry	Point of regulation	Number of regulated entities
Oil	Refinery	175
Oil	Refined product importers	200
Natural gas	Pipeline	150
Natural gas liquids	Processing plant	725
Coal	Preparation plant	550
Coal	Mine	100*
Total		1900

* Although there are approximately 2100 mines in the US, the number of mines actually required to hold allowance probably would be less than 100. This is because mines would be required to hold allowances only for coal not sent to preparation plants. This occurs at a relatively small number of mines, principally located in the West.

Source: Hargrave (1998).

However, collusive behaviour might occur under the CDM, because both host and investor governments do play the role in approving CDM projects, whereas, under inter-source trading, the governments are limited to setting the rules rather than undertaking emissions trading themselves. This raises the question that how developing countries can limit the supply of CDM credits and maximize the revenues of selling CDM credits. Figure 1 shows an aggregated downward-sloping demand curve of Annex I countries and an aggregated upward-sloping supply curve of non-Annex I countries to supply the total quantity of CDM credits at various price levels (for simplicity, I draw linear demand and supply curves here). The point E^o

where the two curves labelled as *Demand* and $Supply^o$ cross gives the market cleaning price of CDM credits P^o and the total quantity of CDM credits traded Q^o. The area OE^oP^o represents the net gain to non-Annex I countries. Then, how to increase the net gain to non-Annex I countries? As shown in Figure 1, this could be achieved by shifting supply curve upward from $Supply^o$ to *Supply**. At the new equilibrium *E** where the new supply curve *Supply** crosses the same demand curve *Demand*, although the total quantity of CDM credits traded drops to *Q**, the net gain *OE*P** is greater than OE^oP^o because the market clearing price *P** rises faster than the quantity falls. This has a very important policy implication, as it suggests that if the market clearing price could be held up to the reasonable level, relatively costly CDM projects could be undertaken early with international partners. This would leave low-cost abatement options (the so-called low-hanging fruits) available for later use of their own if developing countries would be subsequently required to reduce their own emissions.

The question then arises: how can the market price of CDM credits could be raised? One *tacit* collusive strategy is that developing countries could insist on restriction on the use of flexibility mechanisms to meet Annex I countries' Kyoto commitments in the name of promoting technical innovation needed to make more stringent future emissions targets affordable and thus kick off the ball to Annex I countries' court. Another way is to prevent trading in hot air, although in practice it is very difficult to distinguish real reduction from hot air.[5] Because hot air is available at zero abatement cost, allowing hot air to be traded tends to push down the overall market clearing price because it reduces Annex I countries' demand for CDM credits. It has dawned on many developing countries and environmental NGOs that the US is counting on breathing Russian hot air to comply with its reduction target set in the Kyoto Protocol, rather than taking abatement actions at home. In this regard, it would be very helpful to clear up the doubt about this, if MERGE could provide the estimated amount of hot air and estimate the economic implications of excluding trading in hot air on the US economy.

---

[5] When emissions trading were allowed, a country whose legally binding greenhouse gas emissions limits set by the Kyoto Protocol exceed its actual or anticipated emissions requirements would be able to trade these excess emissions, thus creating the hot air that would otherwise have not occurred. The hot air problem would be particularly acute in Russia whose emissions are not expected to rise to its 1990 level until 2010 (UNFCCC, 1997).

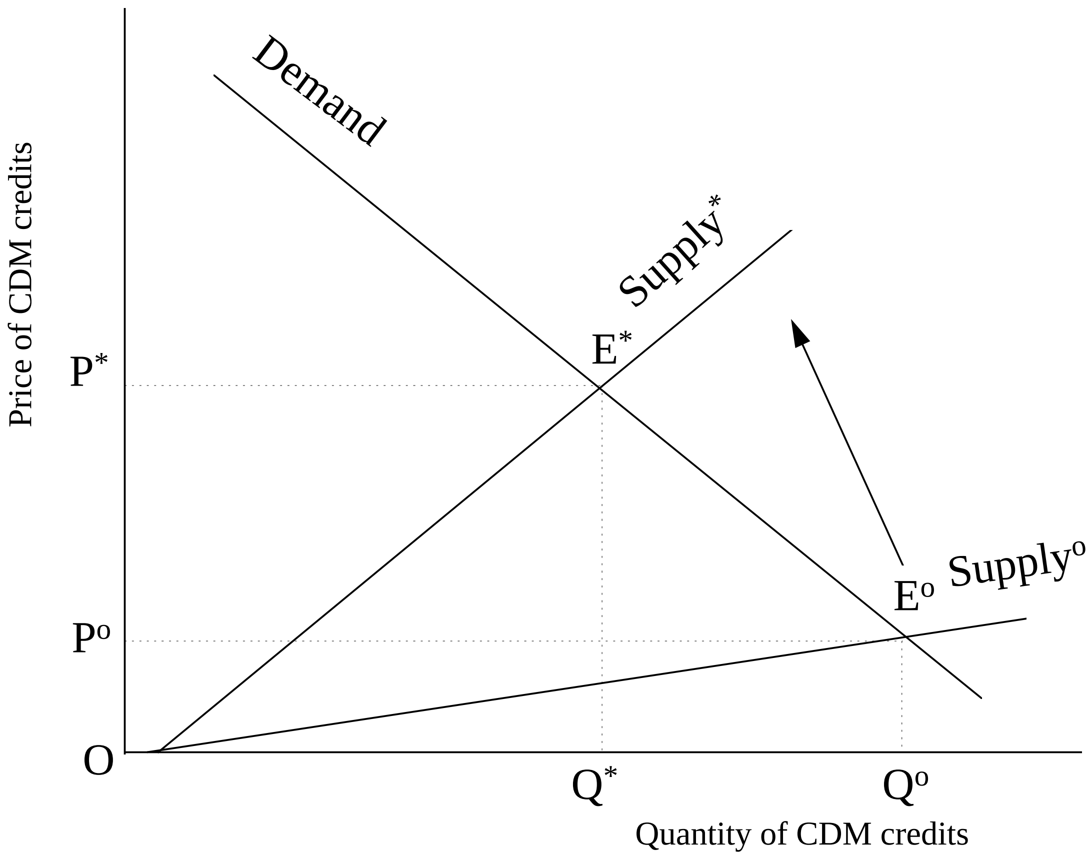

Figure 1 Aggregated Demand and Supply Curves of CDM Credits

References

Cramton, P. and S. Kerr (1998), Tradeable Carbon Allowance Auctions: How and Why to Auction, University of Maryland at College Park.

Hargrave, T. (1998), US Carbon Emissions Trading: Description of an Upstream Approach, Center for Clear Air Policy, Washington, DC.

Jacoby, H.D., Schmalensee, R. and I.S. Wing (1999), Toward a Useful Architecture for Climate Change Negotiations, MIT Joint Program on the Science and Policy of Global Change, Report No. 49, Massachusetts Institute of Technology.

Manne, A. and R. Richels (1997), On Stabilizing CO_2 Concentrations: Cost-Effective Emission Reduction Strategies, *Environmental Modeling and Assessment*, Vol. 2, No. 4, pp. 251-265.

Manne, A. and R. Richels (1999), The Kyoto Protocol: A Cost-Effective Strategy for Meeting Environmental Objective?, Presented at the Intergovernmental Panel on Climate Change Working Group III Expert Meeting on the Economic Impacts of Annex I Mitigation Policies on Non-Annex I Countries, The Hague, 27-28 May.

Richels, R. and J. Edmonds (1995), The Economics of Stabilizing atmospheric CO_2 Concentrations, *Energy Policy*, Vol. 23, Nos. 4/5, pp. 373-378.

Stavins, R.N. (1998), What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading, *Journal of Economic Perspective,* Vol. 12, No. 3, pp. 69-88.

UNFCCC (1997), Summary of the Report of the In-Depth Review of the National Communication of Russian Federation, United Nations Framework Convention on Climate Change (UNFCCC), FCCC/IDR.1(SUM)/RUS, Bonn.

Wigley, T.M.L., Richels, R. and J.A. Edmonds (1996), Economic and Environmental Choices in the Stabilization of atmospheric CO_2 Concentrations, *Nature*, Vol. 379, No. 6562, pp. 240-243.

World Bank (1996), *World Development Report 1996*, Oxford University Press, New York.

Yang, Z. and H.D. Jacoby (1999), Necessary Conditions for Stabilization Agreements, in C. Carraro (ed.), *International Environments on climate Change*, Kluwer, Dordrecht.

Zhang, Z.X. (1997), *The Economics of Energy Policy in China: Implications for Global Climate Change*, New Horizons in Environmental Economics Series, Edward Elgar, England.

Zhang, Z.X. (1998), Greenhouse Gas Emissions Trading and the World Trading Systems, *Journal of World Trade*, Vol. 32, No. 5, pp. 219-239.

Zhang, Z.X. (forthcoming), The Design and Implementation of an International Scheme for Greenhouse Gas Emissions, *Environment and Planning C: Government and Policy*.