MIT Joint Program on the Science and Policy of Global Change

The Evolution of a Climate Regime: *Kyoto to Marrakech*

Mustafa H. Babiker, Henry D. Jacoby, John M. Reilly and David M. Reiner

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Abstract

At meetings in Bonn and Marrakech in 2001, the Conference of the Parties to the Framework Convention on Climate Change broke through an impasse on the detailed provisions needed to allow the Kyoto Protocol to enter into force. Key ingredients in the breakthrough included U.S. withdrawal from the process, an effective relaxation of emissions targets for Japan, Canada, and Russia, and provision of access to unrestricted emissions trading. We analyze the costs of implementation and the environmental effectiveness of the Bonn-Marrakech agreement, and its effect on the relative roles of CO_2 *vs*. non-CO_2 greenhouse gases. The ability of the major sellers of permits, notably Russia and Ukraine, to restrict access to permits, and the ability to trade across all greenhouse gases controlled under the Protocol, are both found to have a significant effect for both costs and effectiveness. Finally, the implications of the agreement for the future evolution of the climate regime are explored.

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1. INTRODUCTION

In November 2000, at The Hague, the sixth Conference of the Parties (COP-6) to the United Nations Framework Convention on Climate Change (FCCC) dissolved in an acrimonious dispute—between the European Union and a group that included the United States, Japan, Russia, Canada, and others—over the terms for implementing the Kyoto Protocol. The following July, at a resumed COP-6 *bis* held in Bonn, a political agreement was reached that in principle resolved the issues that had led to the earlier breakdown. The way was thus paved for the drafting of the technical language needed to allow ratification and implementation of the agreement, a process completed at COP-7 in November 2001 in Marrakech. What had changed between The Hague and Bonn that allowed the Protocol to move forward? What seemed to help was the fact that the world's largest emitter of greenhouse gases was sitting on the sidelines. In March 2001, and again in July, the new U.S. administration had declared the Protocol fatally flawed, and said it was unwilling to consider ratification or even to negotiate further on its terms.

To be sure, several steps remain before the Protocol can enter into force, but the Bonn-Marrakech agreement was a substantial and, to these observers at least, surprising accomplishment considering the earlier difficulties. Next must come ratification by the requisite combination of parties: 55 nations, including sufficient nations to amount to 55% of Annex I carbon dioxide emissions in 1990 (Annex I consists of the OECD as of 1992, Eastern and Central Europe, Russia and Ukraine). Since the Protocol has, of this writing, been ratified by 46 nations (UNFCCC, 2001a), and the fifteen member states of the E.U. have indicated their commitment to ratify it in 2002, the key obstacle to entry into force is the percentage target. Since the U.S. by itself accounted for 36% of 1990 emissions, Japan or Russia alone is large enough to constitute an effective veto. The leverage this fact gives to them, and to other smaller developed nations such as Canada, helps explain the dramatic shift between The Hague and Bonn.

In addition to entry into force, a number of key issues remain to be resolved that could substantially undermine the environmental effectiveness of the Protocol. These include resolution of compliance issues deferred to the first Meeting of the Parties (MOP) after entry into force, establishment of the boards and committees needed to administer various provisions of the protocol, and negotiation of commitments for a second commitment period.

Perhaps more important than the negotiated international agreement is what transpires domestically. The parties accepting the Protocol will need to implement domestic polices to bring them into compliance, carry out the specified procedure for expert review of performance and certification, and (if needed) impose any penalties agreed for parties failing to meet their obligations. The international agreement simply reviews the achievements of a party and potentially penalizes it for non-compliance. Actual emissions result from the activities of firms and individuals within a country. Domestic implementation thus requires each party to develop a regulatory compliance and review mechanism consistent with its political, judicial, and regulatory structures that actually brings about the needed reductions.

There is a chance, of course, that failure of ratification or deadlock on compliance issues may still derail the Protocol. Also, further interpretation of the agreement may substantially change the nature of each party's commitments, as we understand them now. Some of us outside the negotiations have also been surprised by the wide range of interpretations of what at first seemed straightforward Protocol language. We have, however, made our best attempt to interpret the text as it now stands (UNFCCC, 2001b), and we seek here to assess its economic and environmental implications, assuming that the resolve shown by the Parties in Bonn and Marrakech will propel them forward to ratification and entry into force.

We address several questions. What are the environmental and economic implications of the agreement? That is, what level of emissions reductions does it require, and what level of effort would be needed to achieve them? We also take up the challenge posed by the glaring hole in the agreement, namely, what are the implications for possible future efforts to seek convergence between the Kyoto regime and whatever approach the United States may ultimately take?

2. EVENTS ON THE ROAD TO MARRAKECH

2.1 The Original Kyoto Plan

Perhaps it is foolhardy to attempt to reconstruct the Kyoto Protocol as agreed in 1997, particularly considering the four years of conflict over its interpretation that followed.[1] What is clear is that the Kyoto Protocol established national emissions reduction targets, for a single five-year averaging period, 2008-2012, for nations listed in Annex B to the Protocol, offered the beginnings of the accounting procedures needed to establish compliance and provided a general description of various mechanisms to allow flexibility intended to reduce the overall cost of compliance. These mechanisms included "bubbles" within which several countries could meet their obligations jointly, a facility for crediting emissions reducing projects in other Annex B nations (Joint Implementation or JI), a Clean Development Mechanism (CDM) to generate credits for investing in projects in developing nations that had not assumed constraints under Annex B, and a system of trading in emissions permits among Annex B nations. Six categories of gases were specified, and at the same session the parties agreed to the100-year IPCC Global Warming Potentials (GWPs) for their comparison and aggregation, allowing larger reductions in one category to offset lesser reductions in another. Less clear were provisions that were added to allow sinks from forests and possibly agricultural soils to offset the emissions reductions agreed. Negotiations leading up to Kyoto had called for agreement on policies and measures (*i.e.*, not just targets to be met but specific actions to be taken), but these did not survive, significantly on opposition from the U.S.

Having set national targets and a timetable, and inserted these other features, the negotiators returned home declaring victory in the establishment of an international climate control regime. The expectation was that, if put into force, the first commitment period would see the Annex B parties reduce their emissions to roughly 5% below 1990 levels. Unfortunately, though it was possible to pick the reduction percentages and outline flexibility mechanisms, it was more difficult to define what they might mean in practice. A number of contentious issues were left for subsequent negotiation under a Buenos Aires Plan of Action negotiated in COP-4 in 1998. The key battles centered on whether there would be limits on the use of the mechanisms, and what other restrictions might be imposed in selecting projects or in the details of trading across sources or among gases. The concept behind JI and CDM was clear enough, but important details, such as what types of projects would be admissible, were not. Sinks had been added into the text in two articles: Article 3.3 which covered land use and forestry projects initiated since 1990, and Article 3.4 which introduced pre-existing biological sinks. These articles were written in such a way that conflicted parties could interpret the language in widely differing ways (Schlamdinger and Marland, 2000). In the final hours, after a fierce debate, the United States and

[1] For a description written before COP-6 and the Bonn-Marrakech agreements, see Grubb *et al.* (1999). We focus here on the national targets and timetables and their implementation although there are, of course, many other features—such as reporting requirements, adaptation aid and other compensation, capacity building, and technology transfer—that are significant parts of the larger agreement, but are not of concern in this assessment.

its allies managed to secure the inclusion of emissions trading in the face of widespread skepticism or outright hostility towards the concept.

Although the U.S. and the larger Umbrella Group[2] argued strenuously for a generous interpretation of sinks and emissions trading to alleviate burdens, the dominant view within Europe was that their use should be limited. This led to a contentious battle over Article 3.4 sinks and over "supplementarity"—*i.e.*, the limits on the degree to which a party's reduction commitment could be met through the various flexibility mechanisms (Ellerman and Sue Wing, 2000).

Finally, the 1997 text delayed consideration of compliance, only specifying the need to develop an "indicative list" of consequences at the MOP, and that the Protocol ultimately would need to be amended to provide "binding consequences" for non-compliance.

2.2 Changes On the Way to Marrakech

In the negotiations under the Buenos Aires Plan of Action, many issues not emphasized here were dealt with, but the parties remained deadlocked on the difficult questions of CDM, sinks, supplementarity, and compliance. COP-6 in The Hague began with some 250 pages of bracketed text. The plan was for the diplomats to clean up that text during the first week, leaving only the key political choices to be decided by the ministers, due to arrive in the second week. As in the lead-up negotiations, the lower-level diplomats did not have the authority to remove the brackets, and the negotiations bogged down. To quote one observer, the problem in The Hague was that, "The first week was too political for the technicians, and the second week was then too technical for the politicians." Toward the end of the session, the President of the Conference, Dutch Environment Minister Jan Pronk, put forth a short compromise document, attempting to close the gap on the major political questions. In the final 36 hours of bargaining, negotiations among the more than 150 parties represented there boiled down to a deadlock between the United States (supported by the Umbrella Group) and the European Union. At the point of collapse in disagreement and recrimination the main deal breakers were the same ones it had been impossible to resolve in Kyoto three years earlier: supplementarity and sinks. Not wanting to admit defeat, the meeting was "suspended" rather than adjourned. A meeting to resolve the differences was held in Ottawa immediately following the debacle in The Hague, but it quickly dissolved in conflict as well.

With the new U.S. administration's refusal to negotiate, the environment shifted dramatically. Ironically, removal of the U.S. from the process both increased the commitment of the remaining parties to reach agreement, and freed up the negotiators to accept provisions they had opposed when the U.S. was viewed as the principal beneficiary. COP-6 *bis* in July 2001 started from an updated version of the earlier Pronk memo. In the subsequent negotiations, any requirement of supplementarity was dropped completely. Moreover, Article 3.4 sinks, earlier sought by the United States and others in the Umbrella Group and opposed so strenuously by the E.U., were

[2] The Umbrella Group was a loose coalition that included the U.S., Japan, Canada, Australia, Norway and New Zealand, and later came to include Russia and Ukraine.

freely allocated to Canada, Japan, and Russia. The quantities given in the Bonn compromise (detailed in Table 2 below) totaled 54 million metric tons of carbon (MMtC). In effect, these countries were allowed to reduce their Kyoto targets using this mechanism, a move bitterly criticized when the U.S. tried to introduce these credits in The Hague.

In addition to the resolution of a number of nettlesome technical details, the final text reached in Marrakech included agreement to a request by Russia for another 15.4 MMtC of Article 3.4 sinks, adding to the substantial quantity of hot air already available in the first commitment period. As in Bonn, countries such as Russia and Japan, and to a lesser extent Canada, were in a strong bargaining position in relation to the E.U. and others who had opposed these "do nothing" sinks. Finally, COP-7 agreed to a compliance penalty involving suspension of eligibility to use the flexibility mechanisms and a deduction of any first-period shortfall from the (still to be negotiated) allocation for the second commitment period, using a multiplier of 1.3. It is, in effect, a borrowing provision with an interest rate of just over 5 percent per annum. On the insistence of Japan and others, provisions were included for reinstatement of eligibility, and the legal text on compliance was delayed, to be taken up by the MOP after the Protocol has entered into force.

3. COMPUTING THE EFFECTS OF CHANGING PROVISIONS

3.1 The MIT EPPA Model

To evaluate the implications of these changing features of the Protocol we apply the MIT Emissions Prediction and Policy Analysis (EPPA) model. It is a recursive-dynamic multi-regional general equilibrium model of the world economy developed for analysis of climate change policy (Babiker *et al.*, 2001a). The version of EPPA used here is built on a comprehensive energy-economy data set (GTAP4-E) that accommodates a consistent representation of energy markets in physical units as well as detailed accounts of regional production and bilateral trade flows (Hertel, 1997).[3] The base year for the model is 1995 and it is solved recursively at 5-year intervals. In the reporting of results below, the year 2010 is used to represent the 2008-2012 commitment period.

For purposes of this assessment, a significant feature of the model is the inclusion of the cost of abatement of non-CO_2 greenhouse gas emissions (CH_4, N_2O, HFCs, PFCs and SF_6) as described by Hyman (2001). Calculations shown below take account of these gases, using the 100-year IPCC GWPs as relative weights. The cost calculations consider both the emissions mitigation that occurs as a byproduct of actions directed at CO_2, and reductions resulting from gas-specific control measures. Targeted control measures include reductions in the emissions of: CO_2 from the combustion of fossil fuels; the industrial gases that replace CFCs controlled by the

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[3] Aside from the full inclusion of the non-CO_2 gases (see below) changes from the version documented by Babiker *et al*. (2001a) include: (1) updating of oil and gas resources to be consistent with a recent USGS re-evaluation (USGS, 2000); (2) revision of the electric sector, including separation of hydroelectricity from other conventional sources based on IEA data (IEA, 2001), reformulation of the backstop renewable electric sector, and addition of a biomass electric generation technology; and (3) revision of China's energy and emissions outlook to be consistent with reports of recent trends.

Montreal Protocol and produced at aluminum smelters; CH_4 from energy supply and use, large landfills, and sewage; and N_2O from chemical production. Limited reduction possibilities from agriculture also are included for control of CH_4 from manure management in large concentrated livestock operations, and N_2O reductions from the improved management of inorganic fertilizer applications. Because of a lack of proven technologies and/or the difficulty of measurement and monitoring we do not consider reductions in process CO_2 from cement production, N_2O from organic nitrogen application and fossil fuel combustion, or CH_4 from small landfills, ruminant digestion, and manure management on small farms. The effects of human emissions on tropospheric ozone, and the influence of the various carbon aerosols, also are not considered in the analysis, as these substances are not included in the Kyoto framework.

Non-energy activities are aggregated to three sectors, as shown in **Table 1**. The energy sector, which contributes to emissions of several of the non-CO_2 gases as well as to CO_2 itself, is modeled in more detail. The synthetic coal gas industry produces a perfect substitute for natural gas. The oil shale industry produces a perfect substitute for refined oil. These “backstop” technologies do not enter in the 2010 time period analyzed here. All electricity generation technologies produce perfectly substitutable electricity except for the “Solar&Wind” technology, which is modeled as producing an imperfect substitute, reflecting its intermittent output.

The regional and sectoral disaggregation also is shown in Table 1. The disaggregation of Annex B into six nations or multi-nation groups is seen in the analysis below. Under this EPPA aggregation the countries of the Former Soviet Union (FSU) are taken to represent those economies that are in Annex B and thereby assuming a Kyoto commitment (principally Russia and Ukraine). This aggregation is not exact, but the difference does not have a significant effect on the results below, or the conclusions to be drawn from them.[4]

3.2 The Crucial Role of the Non-CO_2 Gases and Hot Air

Before proceeding to the details of post-Kyoto developments, it is useful to highlight the influence of two features of the agreement, multiple gases and hot air, in a simpler if hypothetical context where all Annex B parties participate and the reduction targets are as agreed in Kyoto but without carbon sinks or CDM credits. As demonstrated by Reilly *et al*. (1999) and Reilly, Jacoby and Prinn (2002), consideration of the non-CO_2 gases has a substantial effect on environmental performance and control costs, as compared with model calculations limited to CO_2 only. In **Figure 1**, we summarize both the effects of their inclusion and the combined effect of an all-gas policy with emissions trading that includes access to Russian and Ukrainian hot air. The figure

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[4] In the aggregation of the GTAP database used here, the FSU includes not only Russia and Ukraine, Latvia, Lithuania and Estonia (which are included in Annex B) but Azerbaijan, Armenia, Belarus, Georgia, Kyrgyzstan, Kazakhstan, Moldova, Tajikistan, Turkmenistan, and Uzbekistan which are not. The total carbon-equivalent emissions of these excluded regions are presently only a small portion of the FSU aggregate (their fossil carbon emissions are about 20% of those of the FSU in 1995). In addition, at COP-7 Kazakhstan, which makes up 5-10% of the FSU total joined Annex I and indicated its intention to assume an Annex B target. The EET (Eastern Europe) also includes a number of former Yugoslav republics and Albania which are not included in Annex B, which contribute only a small percentage of overall EET emissions.

Table 1. Countries, Regions, and Sectors in the General Equilibrium Model

Country or Region		Sectors
Annex B		***Non-Energy***
United States	(USA)	Agriculture
Japan	(JPN)	Energy Intensive products
European Union	(EEC)	Other Industries products
Other OECD	(OOE)	***Energy***
Former Soviet Union	(FSU)	Coal
Eastern Europe	(EET)	Crude Oil
Non-Annex B		Natural Gas
India		Electric: Fossil, Nuclear, Hydro
Brazil		Solar&Wind, Biomass
Energy Exporting Economies		Refined Oil
Dynamic Asian Economies		Synthetic Gas from Coal
Rest of World		Oil from Shale
China		

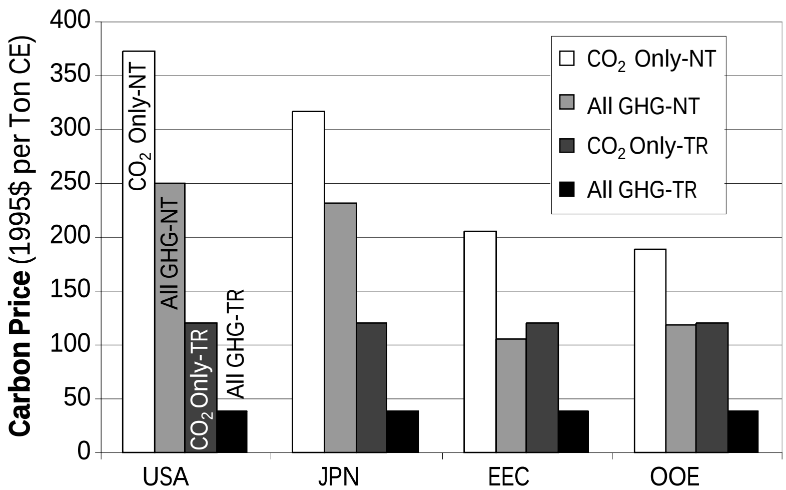

Figure 1. Carbon-Equivalent Price Under the Kyoto Protocol, With the U.S. Participating

shows the four Annex B regions that would be under restraint under the original Kyoto definitions (*i.e.*, with the U.S. participating).

Taking the U.S. as an example, and assuming no emissions trading, the first bar in the figure shows that a CO_2-only implementation of the 7% U.S. Kyoto reduction (*i.e.*, CO_2 only in the base-year emissions and in the 2010 target quantity) requires an emissions price of over $350 per ton of carbon (tC). Shifting to a cost-minimizing all-gas approach (*i.e.*, including all gases in the base year and in the 2010 projection) lowers the required price substantially, to around $250 per ton. Similar effects are shown for the other three regions. The lower price is attributable to the fact that some of the non-CO_2 gases offer relatively cheap opportunities for abatement, particularly when considered in carbon-equivalent terms with GWPs ranging from 21 for CH_4 to 24,000 for SF_6.[5]

[5] The calculations shown here use the GWPs in the IPCC Second Assessment Report. They have been changed somewhat in the Third Assessment Report.

The figure also shows the effect of adding emissions trading, and the dramatic effect of the hot air available in Russia and Ukraine. Under the EPPA reference emissions projection used here, the excess of their allocation, over and above our reference projection of emissions in 2010, is 230 MMtC.[6] This is a large number in relation to the reductions required by the four regions shown, and the introduction of emissions trading and free sale of hot air drops the carbon price for the participating countries to around $150 per ton, even in a calculation that does not consider the relatively cost-effective opportunities available among the non-CO_2 gases. When the assumed policy includes not only the trading and hot air but the non-CO_2 gases as well, the clearing price falls below $50 per ton C. The effects of multiple gases and hot air play a large role in the change from these "early Kyoto" conditions to the conditions in place after Marrakech, presented below.

From this point on we will focus on our stylized Kyoto case, which includes all six gases. However, there are other potentially cost-reducing features of the Protocol that we do not consider. We do not include possible sinks credits under Article 3.3 that accounts for sinks generated by activities started after 1990.[7] Also, we do not take account of possible credits gained through the CDM. The omission of these features contributes an upward bias to our estimates of the clearing price for carbon emissions.

On the other hand, there are features of the calculation that tend to yield an underestimate. First, it is far from clear that a full trading system can be put in place by 2010, so its advantages are likely overstated for the Kyoto first commitment period. Also, governments are not likely to implement policies that are as efficient as an EPPA-type model assumes. Of course, the effect of an "inefficient" policy depends on the circumstance. In some situations seemingly less-than-ideal policies may be almost as good or better in economic terms than a cap-and-trade policy or uniform carbon tax. Pre-existing imperfections or distortions that affect economic decision-making can interact with new policies introduced into the economy.[8]

On balance, however, possibilities of wasteful policies probably dominate, so that the results likely understate the carbon-equivalent prices that would actually be required to meet the targets.

[6] All these estimates are uncertain, but the pace of Russian economic recovery and thus the level of hot air is particularly so. For example, our reference estimate is below that of the Department of Energy's Energy Information Administration, which puts the level at 261 MMtC in its reference case (EIA, 2000, Table 22).

[7] We also do not account for the effects of Article 3.7 of the Protocol, which establishes a separate accounting scheme for countries with net positive land-use emissions. Australia is the only Annex B country to qualify, and the provision is estimated to add 19% to that country's target (Hamilton and Vellen, 1999).

[8] For example, Babiker *et al*. (2001b) show that exempting transportation fuels from a carbon tax, for at least some countries in Europe where gasoline taxes are already high, can improve welfare compared with the case where they are not exempted. In another example, Babiker, Reilly and Ellerman (2000) demonstrate that a nuclear subsidy in Japan is not nearly as distortionary as might be expected, because existing electricity prices are higher than is economically efficient. A nuclear subsidy, by partly offsetting the high electricity prices, is almost as efficient as a comparable carbon cap-and-trade system introduced on top of the existing energy price structure.

4. THE CHANGING CHARACTER OF THE PROTOCOL

4.1 Targets, Performance, and Costs

The years of negotiation since COP-3 in Kyoto have brought both clarification of the Protocol language, and what some would view as changes in its original intent. This evolution affects both the environmental performance of the agreement and the likely costs of implementation. As a measure of performance, we use the reduction in carbon-weighted greenhouse emissions from their levels in 2000. Much of the discussion of expected achievements under the Protocol uses 1990 as a base, but the final decisions on provisions, and the initiation of programs to achieve the agreed reductions, all take place around the year 2000 and after. It is the achievement from today that is at issue, and changes brought about primarily by political events and differential growth rates over the previous decade only serve to obscure what is at issue. For an indicator of the cost, we use the carbon-equivalent price of emissions that is implicit in the imposed emissions restriction.

The performance and cost of the various versions of the agreement are presented in **Figure 2**. The horizontal axis shows the reductions below 2000 levels for the aggregate of the European Union (EEC), Japan (JPN) and the other OECD countries (OOE), under various assumptions about the agreement and country behavior. The vertical axis is the carbon price in 1995 dollars per ton, carbon-equivalent. Carbon prices are plotted for the three EPPA regions that remain under some restraint after the U.S. has dropped out. When a trading regime is in place, the price is the same for all, a group denoted "Kyoto 3."

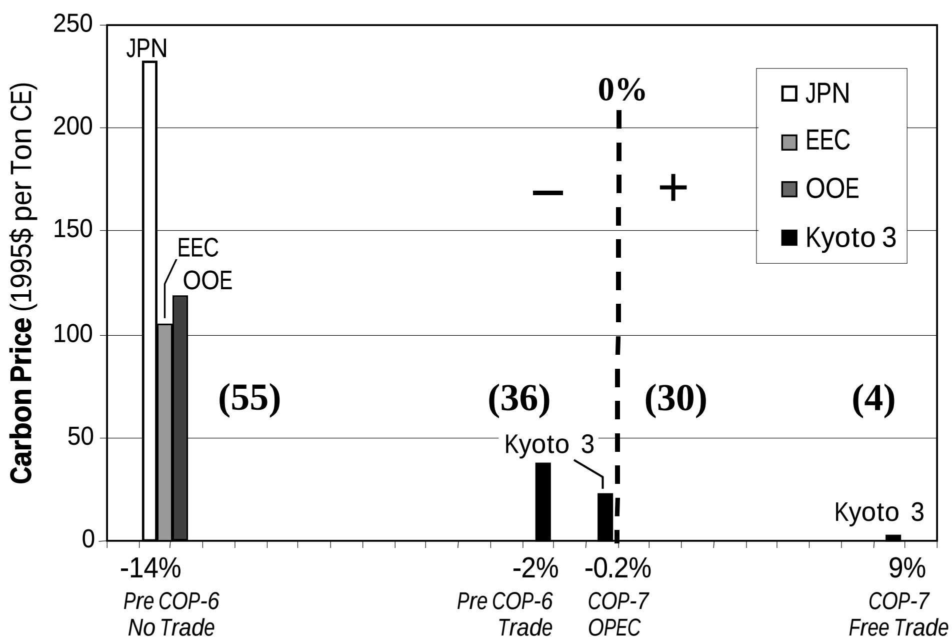

Figure 2. Required Emissions Change in Relation to 2000 and Carbon-Equivalent Prices for the E.U., Japan, and the other OECD countries (% of reduction from CO_2 in parentheses)

If the original Kyoto targets were imposed under the definitions as they stood before COP-6, and if (other than the E.U. bubble) no international exchange of emissions trading were allowed, then the three regions in Figure 2 would be required to achieve a reduction of emissions below the 2000 level, by the 2008-2012 commitment period, of about 14%. Prices would differ among regions because of their differential growth rates, different mixes of gases within their total emissions, and varying opportunities for mitigation. The carbon-equivalent price in the European Union and the other OECD countries would be somewhat over $100 per ton C, whereas the price in Japan would be approximately twice that amount. (The United States, not shown here, would experience a price similar to that in Japan were it to adopt its Kyoto target under these assumptions). The addition of permit trading, in an imagined pre-COP-6 world in which the United States was meeting its target and Russian hot air was freely offered on the market, would yield a reduction below 2000 levels by the non-U.S. group by slightly over 2%.[9] Also, duplicating the results for this case shown in Figure 1, the equilibrium price in carbon-equivalent terms would fall to below $50, even with the United States participating.

The events between The Hague and Marrakech combine to change these results dramatically. Not only is there abandonment by the U.S. but also the granting of the Article 3.4 sinks, shown in **Table 2**, relaxes the targets substantially. Most restraints on trading were lifted, most notably the requirement of supplementarity. The Marrakech text includes language regarding a commitment period reserve, whereby countries must demonstrate via a recent inventory that they indeed have made reductions, and are not selling credits they are not likely to have when the end-of-period accounting is done. We assume that this mechanism works so that targets are met, but that it does not substantially limit the amount of credits that can be sold. It might occur that steep emissions reductions in the last year or two of the commitment period might not be verifiable in time to sell these credits. However, there is a three-month true-up period after the end of the commitment period. Thus while this feature of the agreement may place some limits on trading, we believe its effect would be minor and we ignore it in the analysis.

Here we show two different outcomes of the Marrakech agreement, differing according to the behavior of Russia and Ukraine. First, if all the Russian and Ukrainian hot air were made

Table 2. Sinks Allowed in the Bonn and Marrakech Agreements

Region	**COP**	**Amount** (MMtC)
EEC	6 *bis*	5.2
OOE	6 *bis*	13.1
EET	6 *bis*	3.8
JPN	6 *bis*	13.0
FSU	6 *bis*	19.5
FSU	7	15.4
Total	7	69.9

[9] For the reader accustomed to seeing Kyoto targets in relation to a 1990 base year, this case, which includes the influence of the hot air, yields the familiar 5% reduction.

available on a "free trade" basis, and if the countries of Annex B made full use of the additional Article 3.4 sinks granted in Bonn and Marrakech, then emissions in 2010 would not be required to be below the 2000 level, but would only be limited to be no more than around 9% growth. The calculated carbon-equivalent price falls to below $5 per ton C. The agreement is still binding under this forecast, but only barely.[10] The result is broadly consistent with other studies of the agreement by Manne and Richels (2001), Nordhaus (2001), Den Elzen and de Moor (2001), and Bohringer (2001).

Of course, the credibility of a permit trading schemes depends on the magnitude of the implied financial transfers, a point to which we will return below. As a basis for judgment about these matters, **Table 3** presents the value of permit purchases and sales in the year 2010, stated in billions of 1995 U.S. dollars. In the pre-COP-6 case with trading the flows are very large, with an annual transfer from the U.S. to Russia and Ukraine of near $20 billion dollars. The fact total U.S. overseas development assistance to *all* countries in 1999 was only $9 billion, and had declined at a rate of some 4% per year through the 1990s (OECD, 2001), raises serious questions about the realism of the Kyoto Protocol, even if the U.S. would have been willing to go along on other grounds. On the other hand, under the Marrakech terms with free trade, Russian and Ukrainian net revenue drops to around $500 million, with smaller flows to the Eastern European states (EET).

The observation that Russia and Ukraine would be, by far, the largest sellers of permits leads to the second case. It is reasonable to expect that Russia and Ukraine would not put all their available permits on the market, but would try to maximize revenue by forming a cartel—a sort of climate OPEC as denoted in the figure. Assuming they could operate effectively to maximize revenues (or national welfare, which leads to roughly the same level of permit sales), the increase in Annex B emissions between 2000 and 2010 would be held to approximately the year-2000 level, with a carbon-equivalent price of around $25 per ton C. Their permit revenues would increase by a factor of 6, to around $3 billion per year. Of course their degree of market power would depend on the behavior of the Eastern European countries (EET in the EPPA aggregation). We believe that, because of their desire for integration into the E.U., it is unlikely that these countries would actively participate in any such cartel arrangement. In fact, E.U.

Table 3. Annual Value of Permit Purchases (+) and Sales (–), $1995 Billions

Region	Pre COP-6 Trade	COP-7 Free Trade	COP-7 OPEC
USA	16.2		
JPN	2.3	0.11	1.2
EEC	4.1	0.35	3.1
OOE	2.5	0.19	1.6
FSU	–19.9	–0.50	–3.0
EET	–5.2	–0.13	–2.9

[10] Note this is all the agreement *requires* these countries to do. They may indeed take more substantial action, of which more later.

enlargement will bring several of these countries within the E.U. bubble. If that assumption is correct, then (like the other OPEC) Russia and Ukraine would face a problem of free-riding. As shown in Table 3, the EET region would benefit almost as much as the OPEC participants, increasing their revenues to near $3 billion per year as well. Of course, entry into the E.U. for some of these countries may involve a revision of the E.U. burden-sharing agreement—in principal the E.U. could reallocate hot air of countries that enter as part of E.U. enlargement to other E.U. members. The current burden-sharing arrangement appears likely to result in greater difficulties for some current E.U. countries than others in meeting their targets (Viguier *et al*., 2001).

The Protocol provision that allows banking of permits for subsequent commitment periods might exert an additional restraint on permit sales by Russia and Ukraine (Manne and Richels, 2001), but we do not consider it in the calculations shown here. Studies of this prospect require assumptions about (1) whether there will be a second commitment period under current rules, (2) if so, how stringent the targets will be, and (3) whether the U.S. and other Umbrella group countries will participate and the stringency of their targets. These matters may be largely resolved before decisions must be made about ultimate permit transfers in the first commitment period, but many intermediate decisions about transfers would need to be made before then. Also, a Russian-Ukrainian oligopoly would already have a large carryover of permits (about 50% of their first-period hot air or 115 MMtC under our reference case) and the risk discount would likely be high. The joint effect of cartel action and banking is a fruitful topic for further analysis, but we would not expect a substantial effect on the character of the results presented.

4.2 The Changing Role of Non-CO_2 Gases

A final aspect to note about the evolution from Kyoto to Marrakech is the change in the focus of mitigation activity. By our analysis, a cost-effective response to the Bonn-Marrakech agreement is achieved almost exclusively through the reduction of non-CO_2 greenhouse gases. The numbers in parentheses in Figure 2 indicate the percentage of overall reductions derived from fossil carbon. Under the pre-COP-6 conditions with no permit trade, 55% of the reductions (measured from the EPPA projection of 2010 emissions) would come from CO_2. The addition of permit trade lowers the CO_2 role to 36%. Under COP-7 conditions and unrestricted trade, the contribution of CO_2 to the cost-minimizing reduction strategy would be a mere 4%! If, however, Russia and Ukraine were able to form an effective cartel in emissions permits, this would raise the CO_2 fraction to around 30%. This result is consistent with early experience in the German emissions control program. A recent study of emissions since 1990 found that reductions came mainly from CO_2, but that the majority of the CO_2 cuts came about as a result of reunification (so-called wall-fall profits), whereas reductions in non-CO_2 greenhouse gases arose primarily from actual policy measures (Schleich *et al*., 2001).

4.3 Conclusions About the Current State of the Protocol

While predicting the future is always dangerous, there is no sign the U.S. administration will change its mind about the Kyoto Protocol. Further, it is implausible to imagine that the nations that remain within the Kyoto framework would not make full use of the facilities they fought for at Bonn and Marrakech. Russia will seek to maximize revenues from its excess credits, and Japan and Canada will make full use of Article 3.4 sinks credits in their implementation plans. Therefore, the final Bonn-Marrakech agreement, while superficially similar to the original Kyoto text, is substantially different for all Parties. Absent the U.S., the Bonn-Marrakech agreement is close to non-binding if all of the flexibility mechanisms are used. In this regard, it is worth noting that EPPA reference projections assume robust GDP and energy growth. If the current slow economic growth in Europe and Japan persists for a few more years then the reference projections of emissions used here would be too high, and only slightly slower growth in emissions would indeed make the cap non-binding.

A remaining issue is whether a trading system will be designed in the E.U., Russia, Ukraine and elsewhere that will allow market access to the hot air across multiple sectors and nations. More likely than a private trading system may be quota trading among countries, and these quota trades may not involve cash transfers but political considerations such as support for IMF loans, entry into NATO or the E.U., or strategic energy agreements. Moreover, as already noted some of the Eastern European nations may have entered the E.U. by the end of the first commitment period, and thus any hot air in these countries could automatically count toward an expanded E.U. bubble target.

In many respects, then, the Protocol appears to have evolved back to the looser commitment of Article 2 of the Framework Convention, only with less ambitious reduction goals. The FCCC had the “aim” of returning within ten years to 1990 emissions levels. (Even then most nations failed to meet their targets, the most notable exceptions being Germany by dent of unification and Britain as a result of the “dash to gas”). For those parties shown in Figure 2 the Bonn-Marrakech agreement would, by our reference forecast, allow a 9% emissions growth from 2000 to 2010. Thus these countries can pursue independent policies and measures, including a large dependence on voluntary schemes, achieve some modest reductions, and remain relatively assured that there will be enough hot air available so that any shortfall can be covered by a political agreement during the true-up period. The chance of facing the embarrassment of non-compliance is small.

5. WHAT NEXT IN THE EVOLUTION?

In the interregnum, while the U.S. is tentatively seeking its own approach to the climate issue and other nations are considering ratification and developing domestic legislation to implement the Protocol, it is useful to think about what may come next in the evolution of the international regime. What the U.S. ultimately decides to do, and how soon it gets about it, will have international repercussions. But also it matters how the Kyoto-Marrakech result comes to be viewed and, whether viewed as a success or a failure, what lessons are drawn from the experience as a guide to future development.

Given the huge international effort that has gone into the Kyoto negotiations, and the importance of the Protocol to the larger “project” of European unification, there will be many incentives for the nations that ratify the Protocol to claim success. Viewed in a generous light, the less-ambitious targets are perhaps more in line with what is appropriate in a first commitment period. Even with its likely modest environmental achievements and low cost, implementation of the Protocol in the first commitment period offers an opportunity to refine its various elements, so that the agreement and its subsidiary institutions might be more effective in future periods. With some measure of success in meeting emissions reduction targets, countries *might* be willing to negotiate tighter targets for succeeding commitment periods and/or tighten the definitions for the first period developed at Marrakech. Some countries clearly intend to do more than the minimum that would be required as the Protocol now stands, and some may even choose to meet the original first-period targets without the many degrees of flexibility afforded them. Others understandably prefer not to risk compliance penalties by agreeing to commitments they are not sure they can meet, but may still move aggressively because of domestic pressures for action. Thus the agreement may lead to real reductions beyond those described in our analysis. If the Protocol comes into force and is viewed in this positive light, it will be difficult to envisage substantial changes in the architecture when nations constrained under Kyoto seek to expand the agreement to the U.S. and Non-Annex B parties in future commitment periods.

Of course, to return the regime to the spirit rather than the letter of targets-and-timetables would require moving towards targets (or rules) with real bite. Even without renegotiating the Annex B targets, a strengthening would occur if the U.S. were to enter the Protocol in the second commitment period. This turn-about seems unlikely even under the most favorable circumstances (which many believe would be a Democrat-controlled Congress and White House in 2004). Without the U.S., the E.U. and other parties are even less likely, on competitiveness concerns, to impose stringent economy-wide constraints.

On the other hand, therefore, Kyoto may ultimately be viewed as a failure, because the Protocol promises to achieve so little in the first commitment period in spite of government rhetoric that has led many in the public, the press, and the environmental movement to acclaim Kyoto, and even Bonn-Marrakech, as a major environmental achievement. It is useful to recall that, in the lead-up to the Kyoto agreement and subsequently, an expectation was created that anything short of an absolute decline in emissions from an historical base year would certainly be a failure. Those few countries, such as Australia, that negotiated a target greater than its 1990 emissions were widely seen among the environmental community of having agreed to less than nothing. It would seem to take a considerable reframing of the political discussion for either the environmental community or the developing countries to come to view increased emissions from current levels in most of the Annex I countries as the signal of success. Indeed, despite the Protocol language that supposes binding international targets, the post-Marrakech agreement retains very little that would constrain national emissions. The nations ratifying the Protocol have in fact moved into a largely domestically-determined world of “policies and measures,” organized behind the façade of an international “targets and timetables” agreement.[11]

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[11] It is a further irony that the U.S., having opposed policies and measures prior to Kyoto, now appears to be operating in this mode as well, albeit with technology development as its principal “measure” (Watson, 2001).

If emissions trajectories continue their upward trend even after the first commitment period, the question will be, what went wrong? An easy answer, of course, will be that the weak environmental result is the fault of the U.S. The main Kyoto arrangements, importantly including the provisions creating the Russian hot air, were predicated on an agreement with the U.S. participating, and when the U.S. withdrew after COP-6, the inertia of the negotiations and the newfound leverage of Japan and Russia meant that the non-U.S. Umbrella group were able to extract more than they had been asking for at COP-6, when the overall costs would have been much steeper.

It would be unfortunate, however, if U.S. withdrawal clouded thinking about other lessons that could be learned. A more modest view, and one consistent with the history of international agreements, is that it is unlikely that countries will ever commit to an agreement where the costs are uncertain and possibly quite large (Downs, Rocke, and Barsoom, 1996). In this view, it is not surprising that, one way or another, the agreement ended up with targets unlikely to seriously constrain emissions. Were this to be the lesson drawn, future negotiations would seek to avoid arrangements that imposed restrictions that were unresponsive to differential rates of economic growth, or that contained features (like the hot air) that create big and hard-to-predict differences among adherents in the cost of compliance. These are features of any target set back in history. Thoughtful reflection on ways around this situation is essential because developing countries considering accession in later commitment periods will inevitably want to receive an allocation as generous as that received by Russia, Ukraine, and Eastern Europe.

In the logic of Kyoto, the inequity of these differentials was to be moderated by free use of international permit trading, but the system seems unlikely to be credible. By creating very different 2010 emissions gaps to be closed, the Protocol would have implied large financial transfers, as shown in Table 3. The available economic studies have not been particularly helpful in their representation of these trading options. Most analysis has focused on the efficiency of an international trading system given an allocation of permits. While the analysis might be technically correct, these flows were not likely to prove politically sustainable, particularly when a substantial portion of the funds would be paying for hot air. The idea that governments will allocate permits in such a way that their citizens must first send abroad large amounts of money to get them back as permits is most generously viewed as unrealistic. With this errant focus, and the resulting bitter debate about supplementarity and sinks, other issues of real importance were given less attention. For example, what forms should assistance take to Russia, the Economies in Transition, and poor but industrializing countries such as China or India, to help them achieve meaningful reductions in emissions without distorting their economic development priorities? For many poor countries threatened by sea level rise or other adverse effects of climate change, the question is how best to help them adapt.

Were such questioning of the Kyoto structure to take hold, other paths might open up. There is much to recommend control regimes and associated agreements based on prices rather than quantities, and some useful experiments are under way on CO_2, particularly in Europe. To date, however, we see no evidence of a taste for any serious, national effort, let alone international discussions, on this basis. The nascent cap-and-trade systems could grow, in an organic fashion, into a larger network over time. But that process would likely be slow, because the current efforts are so few and so limited. Most are defined downstream, for example, and (except within the E.U. bubble) purposefully limited to domestic sources. Bolder national experiments may be tried under the existing Protocol, perhaps involving parties on the fringes of Annex B, such as Australia, Canada or Norway, but there are no such indications yet.

For the next few years, the focus of those parties supporting the Protocol will be on the agreement they've got: on the ratification process, the creation of the Protocol institutions, and the domestic policies needed even under the agreements now limited objectives. Reaching consensus on success or failure will take a while, and so discussion of modifications in the architecture will not get much attention. Having reached a delicate agreement it is hard to imagine any way in which basic provisions of the Protocol would be reopened for discussion among the existing Parties even if it many view it as an environmental failure. In this circumstance, and despite the dubious current prospects for *any* serious U.S. climate policy, the absence of the U.S. from the Protocol perhaps provides the only real possibility for some genuinely new and perhaps necessary changes to be brought to the bargaining table. Certainly, the parties who have agreed to the Protocol would not be expected to, nor should they, receive well an entirely new international architecture proposal from the U.S. without some concrete U.S. domestic actions commensurate with their own domestic policies. So, only after the U.S. has settled on an approach and taken some domestic actions— perhaps totally inconsistent with Kyoto, perhaps consistent with foreseeable modification—will progress come in knitting together a more universally suitable, and sustainable, approach to the issue. But this may provide the best opportunity to reconsider the international architecture of climate policy and revise those features of the Protocol that made it political unsustainable as originally conceived.

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