The Economics of the Kyoto Protocol

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Introduction

This paper gives an overview of the economics of the Kyoto Protocol, the agreement that was adopted unanimously by government negotiators in December 1997 to tackle the threat of climate change. The Protocol was adopted against a background of hugely disparate perspectives concerning the urgency of action, the costs of limitations, and the appropriate instruments. In the end, the view of the US administration prevailed that binding emission commitments for industrialised countries should be complemented by the use of a number of 'economic instruments' adopted for the first time at the international level.

From a purely economic standpoint, the aim of the resulting agreement is to tackle the threat of climate change by establishing an efficient regulatory framework that sets an international 'price' on emissions of CO_2 and other greenhouse gases, initially focused upon industrialized countries with mechanisms for offsetting against projects in developing countries. The core mechanism for achieving this is quantified emission commitments (established for industrialised countries in Kyoto's first commitment period of 2008–12), which are given market-based flexibility through the use of emissions trading and other international economic instruments, and with negotiations on subsequent period commitments mandated to follow.

The paper analyses the economics of Kyoto in two main parts. The first part explores the basic structure of the Protocol, illustrated with respect to some of the key debates that went into its formation. The second part then examines the practical economic consequences of the final agreement

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on emission targets as elaborated at the Marrakech COP7 conference, including the economic consequences of US withdrawal. Finally, conclusions offer brief thoughts on the future of the Kyoto system given the economic issues noted.

PART I: ECONOMIC STRUCTURE OF THE KYOTO PROTOCOL

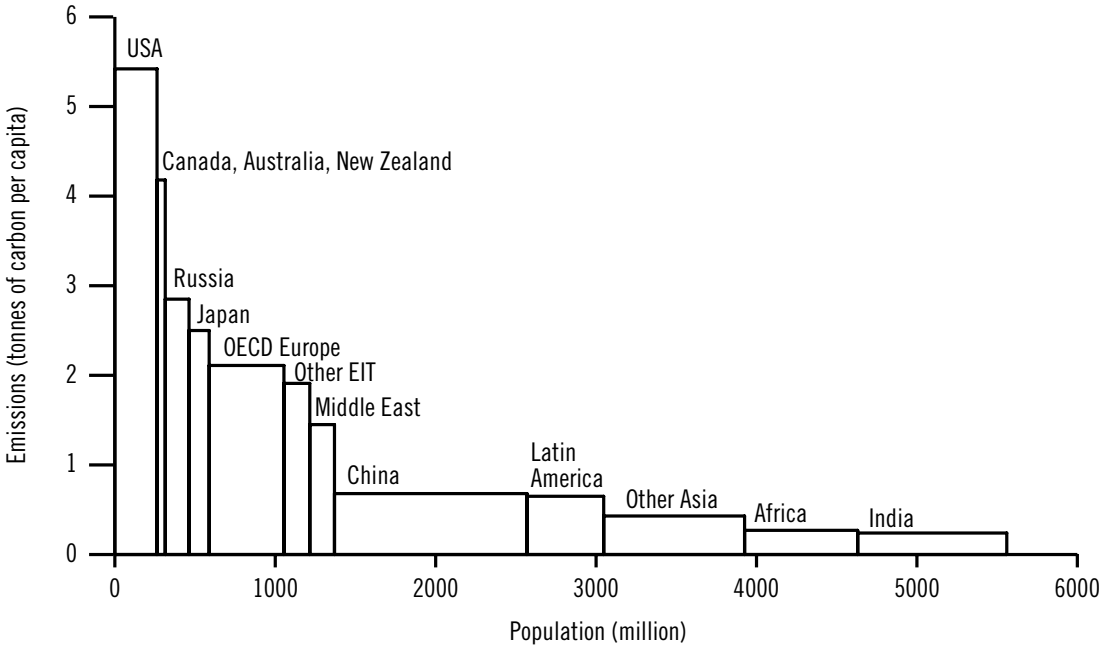
The main aim of the Kyoto Protocol is to contain emissions of the main greenhouse gases in ways that reflect underlying national differences in emissions, wealth and capacity, following the main principles agreed in the UN Framework Convention on Climate Change (UNFCCC). These include the need for evolutionary approaches and the principle of 'common but differentiated' responsibilities, including leadership by the richer and higher emitting industrialised countries.

The large divergence of emissions between countries is illustrated in Figure 1, which shows the global distribution of CO_2 emissions in terms of three major indices: emissions per capita (height of each block); population (width of each block); and total emissions (product of population and emissions per capita = area of block).

This figure illustrates several relevant dimensions. Per capita emissions in the industrialized countries are typically as much as ten times the average in developing countries, particularly Africa and the Indian subcontinent. This is one of the reasons why industrialized countries accepted the responsibility for leading climate change efforts in the UNFCCC and subsequent Kyoto negotiations: unless they can control their own high emissions there is little prospect of controlling emissions from developing countries that start from a very much lower base.[1] There are also large differences among the industrialized countries, with per capita emissions in the EU and Japan at about half the levels in the United States and Australia.

[1] Article 4.2 of the UNFCCC commits industrialised countries to adopt 'policies and measures that will demonstrate that developed countries are taking the lead in modifying longer–term trends in anthropogenic emissions consistent with the objective of the Convention', with the initial 'aim' of returning their emissions of CO_2 and other greenhouse gases to 1990 levels. This became the focus of attention in the years immediately after the Convention and the failure of key industrialised countries to move in this direction was a principal reason why Kyoto moved to binding commitments focused on the industrialised countries.

Figure 1: CO_2 emissions in 2000, per capita and population



Following the agreed negotiating mandate,[2] in Kyoto the countries that took on quantified commitments for the first period (2008–12) are the industrialised countries as listed in Annex I to the Treaty. These correspond roughly to those with per-capita emissions in 1990 of two tonnes Carbon per capita (2tC/cap) or higher—the 'Other EIT' category and all to the left of it in Figure 1.[3]

At the same time, the currently low emissions and large population of the developing countries indicates the huge potential for global emissions growth, if and as their emissions climb towards anything like levels in the industrialized world. The Kyoto negotiations were marked by big tensions on this issue. In the final agreement, in addition to the provisions on national reporting and technology transfer, the Clean Development

[2] The COP1 meeting agreed that the UNFCCC commitments were inadequate, and consequently to 'begin a process to enable it to take appropriate action for the period beyond 2000, including the strengthening of the commitments of Annex 1 Parties, i.e. the industrialized world', to (a) 'elaborate policies and measures'; and (b) 'set quantified limitation and reduction objectives within specified time-frames', such as 2005, 2010 and 2020. It was agreed that these negotiations 'should not introduce new commitments for developing countries', but should enhance the implementation of their existing commitments under the UNFCCC. Thus were launched the intensive negotiations that finally culminated in Kyoto.

[3] Though the basis for the division is general UN categorization, and a few small non-Annex I countries such as Singapore also have high per-capita emissions.

Mechanism is intended to provide a mechanism to start reining in the rapid growth of developing country emissions without these countries themselves bearing the costs. The general assumption in Kyoto is that developing countries will be brought into the system of quantified commitments over time, in subsequent negotiation rounds, if and as the richer countries fulfil their first round commitments; and the implicit threat (or bargaining counter) is that industrialised countries will refuse to take on subsequent commitments unless there is progress in this direction.

The quantified commitments in the Kyoto Protocol cover emissions of six greenhouse gases from identified sources that together account for almost all anthropogenic greenhouse gas emissions in the industrialized world (Table 1). The gases are taken together as a 'basket' compared on the basis of the 100-year 'global warming potentials' (GWP) estimated in the IPCC's Second Assessment Report for the first commitment period; the GWPs may be revised for any subsequent commitment periods.[4] On this basis carbon dioxide, principally from fossil fuels, accounted for over 80% of greenhouse gas emissions from the industrialized world in 1990. Emissions of methane and nitrous oxide in many industrialized countries have declined during the 1990s, making the targets easier to achieve than would be case for just CO_2.[5]

The possible role of sinks—activities that absorb CO_2 from the atmosphere—formed one of the most technically complex issues in the entire negotiations. Proponents argued that CO_2 absorption should be directly offset against emissions (the 'net' approach) because, from an atmospheric standpoint, absorption is equivalent to reduced emissions. Opponents feared that this might allow countries to claim credit for the massive ongoing naturally occurring absorption; that such sinks were inherently far too difficult to monitor accurately; that it would detract from the pressure to limit emissions; and that including sinks could give incentives to replace mature, old-growth forests with fast-growing monoculture plantations. In the end Kyoto included carbon sinks, but in ways carefully circumscribed

[4] Article 5, and Decision 2/CP-3. In the negotiations, technical concerns about the accuracy of monitoring became eclipsed by the economic and political arguments in favour of including a range of gases. If significant gases were excluded altogether, it would weaken the scope and impact of the Protocol. If they were included separately it would add yet more tracks of separate negotiations. But most important of all to the politicians, the inclusion of some other gases—especially methane, emissions of which are easier to control and in several countries were already declining—made it appear more cost-efficient easier and to adopt stronger emission targets.

[5] In most countries the reverse is true for at least some of the three industrial trace gases, emissions of some of which are increasing rapidly, and countries are allowed to take a 1995 base year for the three industrial trace gases.

Table 1: Greenhouse gases in the Kyoto Protocol

Gas	Qualifying sources	Emission trends since the late 1980s	Lifetime (years)	% GHG 1990, GWP–100	Annex I
Carbon dioxide (CO_2)	Fossil fuel burning, cement	EU static, increases other OECD, sharp decline EITs	Variable, with dominant component c. 100 years	1	81.2
Methane (CH_4)	Rice, cattle, biomass burning and decay, fossil fuel production	Decline in most countries (big increase only in Canada, USA, Norway)	12.2 ± 3	21	13.7
Nitrous oxide (N_2O)	Fertilizers, fossil fuel burning, land conversion to agriculture	Varies, small increases in many countries, decline expected before 2000, decline in EITs	120	310	4.0
Hydrofluoro-carbons (HFCs)	Industry, refrigerants	Fast-rising emissions due to substitution for CFCs	1.5–264, HFC 134a (most common) is 14.6	140–11,700; HFC 134a (most common) is 1,300	0.56
Perfluoro-carbons (PFCs)	Industry, aluminium, electronic and electrical industries, fire fighting, solvents	Static	2,600–50,000	Average about 6,770; CF_4 is 6,500; C_2F6 is 9,200	0.29
Sulphur hexafluoride (SF_6	Electronic and electrical industries, insulation	Increase in most countries, further rise expected	3,200	23,900	0.30

Source: Main data from IPCC, SAR WG I, Table 2.9, p. 121.

to be linked to anthropogenic activities and measured as verifiable changes in carbon stocks.[6]

[6] 'The net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period shall be used to meet the commitments under this Article ... [they] shall be reported in a transparent and verifiable manner and reviewed in accordance with Articles 7 and 8.' The subsequent Subsidiary Body meeting in June 1998 clarified this clause as meaning that Parties' assigned amounts should be adjusted by 'verifiable changes in carbon stocks during the period 2008 to 2012 resulting from direct human-induced activities of afforestation, reforestation and deforestation since 1 January 1990'.

The Kyoto allocations

Timing and base year

The Kyoto allocations ('Assigned Amounts' in the formal terminology) specify allowed total national emissions for the period 2008–12, subject to the adjustments that could be made through the international flexible mechanisms. As with everything else, this reflects a compromise between diverse considerations. The US Administration stressed the importance of giving time for policies to take effect and to avoid premature retirement of capital stock, focusing upon a 2010 timescale, and resisted all pressures for quicker action.

2010 became the centre of a 5-year averaging period (to allow for weather and economic cycles) in the final agreement, together with a modest requirement that the Parties show 'demonstrable progress' towards their target by 2005. The first binding point in the Protocol is thus in 2012, some fifteen years after the agreement itself was adopted.

The United States in its original Protocol submission had proposed a second commitment period to follow the first, with an allowance for banking and borrowing of emission commitments between the two periods. The difficulties in negotiating—and even developing positions—on a single set of commitments were so huge as to make agreement on specific second period targets impractical (and unwise given the value of learning in the interim need to learn more). Instead, the Protocol commits parties to open negotiations on a second commitment period no later than 2005, and countries that over-achieve their commitments in the first period can 'bank' their unused allowances for use in the subsequent period. Suggestions that countries might 'borrow' emissions from subsequent periods were recognised as impractical, but the idea was transformed into part of the compliance package (see below).[7]

The negotiations never questioned that Annex I commitments should be defined in terms of changes from historic levels: proposals for other indices, such as defining emissions relative to population or GDP, remained confined to academic literature as they involved changes far greater than countries were willing to contemplate. The Convention had

[7] With 'borrowing' there would be no point in time at which a country could be assessed as being out of compliance, hence no point at which to apply any enforcement procedures—a strange interpretation of the term 'binding'. The United States recast its borrowing proposal in the form of a penalty for non-compliance (a deduction from allowances in the subsequent period) which was taken up in the subsequent Marrakech Accords.

used 1990 as the base year for its non-binding aim—a date which had a huge significance as the year in which all governments, by endorsing the first IPCC report, formally recognized climate change as a serious issue, and launched the negotiations that led to the Rio Convention. The 1990 base year remains as the reference points for the Kyoto agreement: proposals to shift the base year for Kyoto forward to 1995 were rejected on the grounds that such a change would simply reward those countries that had done nothing to limit emissions since the Convention process was launched.[8] This has, however, led to varied problems discussed below, not least concerning the Economies in Transition.

Numerical allowances

The specific commitments, defined as percentage changes relative to base year emissions, are set out in Table 2. The 15 countries of the EU accepted a collective 8% reduction from 1990 levels, a commitment subsequently redistributed between its member states under the Protocol's 'bubble' provision (see below). When added together, the commitments equate to a 5.2% reduction below 1990 levels for the industrialised countries taken together.

As with any major international negotiations, the numbers can only be understood as the outcome of a highly political process arising from the clash between competing numerical aims, structural visions, and root conceptions of political imperative—all combined with the personal and political dynamics of the final days at Kyoto.[9] The dominant and almost

[8] A 1995 base year would have made life much easier for those, like Japan and the United States, whose emissions had risen since 1990, and it would have allowed a more impressive headline figure to emerge for these countries' commitments. Arguably, it would also put the economies in transition on a more comparable footing. But it would have created a whole new set of problems for handling EIT commitments, and rewarded inaction. 1990 remains as the official point of reference for when countries first accepted that climate change was a problem, and industrialised countries had already agreed under the UNFCCC to aim to return their emissions to 1990 levels as the demonstration of their commitment to lead the global effort.

[9] The central clash was between the EU's aim of flat-rate reductions for all in the range 10-15% below 1990 levels, and US and Japanese support for reductions of 0-5%, with varied ideas about differentiation and flexibility, combined with Russian sensitivities and the special circumstances of some of the smaller countries. The United States traded percentage points for increases in the degree of flexibility (e.g. inclusion of sinks enabled them to add three percentage points; after Kyoto, the United States argued domestically that in reality it had only had to concede an additional two percentage points from its original negotiating position of zero, the rest being directly tied to increased flexibilities). Japan, the third party in the internecine OECD debates, was dragged reluctantly along to higher commitments than it had prepared. Russia started with zero and—annoyed by the EU's opening Ministerial reference to the importance of keeping the 'three major Parties' at the same level—refused to budge. All this was overlaid by root political objectives and perceptions that pegged some countries' numbers to those of others. EIT countries aspiring to membership of the EU or OECD wanted to align themselves with the EU's standard-setting commitment. Canada honoured its status as a G7 member by staying within the 'leading'; Australia, feeling no such constraint, simply insisted on being allowed a big increase.

Table 2: Emissions and commitments in the Kyoto Protocol (from base year)

Country	Base year (1990 unless otherwise indicated)	Commitment (% change from base year emissions)	Non CO_2 emissions (% total in 1990)
Australia		+8	51.9
Canada		–6	18.4
European Union*		–8	20.3
Iceland		+10	25.6
Japan		–6	5.8
Liechtenstein		–8	n.a.
Monaco		–8	0
New Zealand		0	68.7
Norway		+1	34.5
Switzerland		–8	17.8
United States		–7	15.2
EITs			
Bulgaria	1988	–8	28.8
Croatia	tbc	–5	n.a.
Czech Republic	1990	–8	13.9
Estonia	1990	–8	16.6
Hungary	1985–8	–6	17.7
Latvia	tbc	–8	16.9
Lithuania	1990	–8	n.a.
Poland	1988	–6	14.6
Romania	1989	–8	30.5
Russia	1990	0	22.4
Slovak Republic	1990	–8	17.8
Slovenia	tbc	–8	n.a.
Ukraine	tbc	0	n.a.

Note: * The fifteen countries of the EU are listed as each having a target of –8. These targets were subsequently redistributed under the 'bubbling' provisions of Article 4; see Table 3.

obsessive focus in the negotiations was on how to distribute OECD commitments. Flat-rate emission targets appeared attractive because of their simplicity, and have indeed been a feature of the first round of several previous international environmental agreements, which have become subsequently more differentiated over time (Greene, 1996). In addition,

there was no specific logical basis upon which to agree differentiated commitments.[10]

In the central political dialogue between the United States and the EU there was a kind of logic to equal percentage cuts from 1990 levels. The United States, with per capita emissions almost twice those of most other OECD countries except Canada and Australia, was vulnerable to accusations that it had a huge potential for reductions and should cut back by more than other countries. Yet internal political pressures pointed in the opposite direction: the United States had the greatest difficulty in mustering any domestic support even for stabilizing emissions. Economic studies of the time varied in their estimates of which would bear the higher cost under equal reductions from 1990 levels. Equal reductions between the United States and the EU seemed the only safe solution in such a peculiar political context, and the most obvious way of keeping the US commitment 'in line' with the international community, in some basic psychological sense.

From a wider perspective, flat-rate reductions were neither efficient nor feasible as a means of achieving emission reductions. As numerous studies showed, different countries faced very different costs of abatement. There was a danger that agreement could only be reached on a 'lowest common denominator target' which would require very little effort from some countries; or, if the pressures for greater resolutions were overwhelming, countries that faced insuperable difficulties might simply ensure that the agreement was full of loopholes. In the end, the negotiators agreed a small amount of differentiation among the dominant industrial powers, and wider differentiation for smaller countries.

In June 1998 the EU Council reached agreement, guided by a previous non-binding agreement of March 1997, and implemented the 'bubble' provision to define the emission commitments of its member states, as set out in Table 3. These now form the legally binding commitments on member states in the EU instrument of ratification.

[10] Every country that supported differentiation had a different idea of how it should be calculated. Many different indicators were proposed, relating to GDP, energy intensity, carbon intensity, historical emissions, trade patterns, etc. Most 'differentiators' argued that low carbon intensity (i.e. low carbon emissions relative to GDP) in 1990 should be a basis for a weaker target; but Australia argued precisely the opposite, claiming that high carbon intensity showed an innate dependence upon fossil fuels that could only be broken at great expense. Almost the only common theme to emerge was that each country proposed indicators that would be most beneficial to itself.

Table 3: The internal distribution of the EU 'bubble'

Country	Internal commitment (% change from 1990 levels)
Austria	–13.0
Belgium	–7.5
Denmark	–21.0
Finland	0
France	0
Germany	–21.0
Greece	+25.0
Ireland	+13.0
Italy	–6.5
Luxembourg	–28.0
Netherlands	–6.0
Portugal	+27.0
Spain	+15.0
Sweden	+4.0
United Kingdom	–12.5

It was well understood at the time that countries were not expected to achieve these emission targets entirely domestically, and indeed that there was considerable room for flexibility arising from the various 'flexibility mechanisms' in the Protocol (discussed below) in particular when combined with the allowances granted to some of the Economies in Transition (EITs). Just how much flexibility this offered was not, however, appreciated at the time.

The context for the EITs was their transition from central planning to a market economy and the associated economic contraction which reduced their emissions considerably. These countries tended still to regard economy, energy consumption and emissions as intimately related, and having suffered such a dramatic decline they were in no mood to consider commitments that they feared might constrain their economic recovery. Most of the central and east European countries agreed to go along with the EU's commitment of 8% below 1990 levels;[11] Russia and Ukraine however insisted on a right to return to 1990 levels. These lax targets, which (due to the trading possibilities) were also an important factor in the US' acceptance of a target stronger than many had expected, have created important difficulties considered in Part II below.

[11] At a late stage of negotiations, Poland and Hungary moved back to –6% in protest at the weaker Russian and Ukrainian allocations.

International flexibility mechanisms

Emissions trading

Emissions trading—the ability for two entities that are subject to emissions control to exchange part of their emission allowances—has evolved principally in a domestic context as a means for controlling industry sector emissions. In the Kyoto Protocol, it enables any two Parties to the Protocol to exchange part of their emission commitment, in effect redistributing the division of allowed emissions between them.

This proved to be one of the most controversial areas of the negotiations, though for different reasons in different quarters. Among the industrialized countries, Japan and some of the EU member states wanted to ensure that any such trading was competitive and transparent so as to prevent the United States using its political leverage to gain preferential access, particularly to the likely Russian surplus; the EU was also particularly anxious that trading should not enable the United States to avoid domestic action as the main agent. However, the developing countries objected more on basic principles, fearing the wider implications and that the US' overwhelming economic power would allow it to use the flexibility to its own advantage over the interests of weaker countries.

In the end, these objections were overridden, but the bare minimum of enabling language survived in the Protocol itself. Elaborating this into a workable structure governing international emissions trading took four years of further negotiations, to the COP7 conference in Marrakech.

The *'clean development mechanism'* enables emission savings or sink enhancement arising from projects in developing countries to generate *emission credits*, which can be transferred to Annex I countries and counted against their emission targets. The stated purpose of the CDM is to help developing countries to achieve sustainable development and to 'assist Annex I Parties in achieving compliance' with their specific commitments. Emission reductions shall be certified on the basis of criteria including voluntary participation, 'real, measurable and long-term benefits' related to mitigating climate change, and emissions additionality ('reductions that are additional to any that would occur in the absence of the certified project activity'). The CDM is not a fund, but shall 'assist in arranging funding of certified project activities as necessary', and participation may explicitly involve private and/or public entities. In addition, 'a share of the

proceeds from certified project activities' shall be used to cover administrative expenses as well as to assist particularly vulnerable developing countries to meet the costs of adapting to climate change. The CDM has been the focus of intense subsequent negotiations and institutional development, to try and establish agreed procedures for estimating the 'additional' ('counterfactual') emission savings arising from projects in acceptable manners without exorbitant administrative or other costs.

Joint Implementation applies the same basic idea to cross-border investments between Annex I Parties, but in this case also involves transfer of part of the allowed emissions of the host country. Because it occurs between countries that are both subject to legally binding constraints, it does not carry many of the political and technical complexities associated with the CDM. It necessarily involves private investment, but to have legal significance under the Protocol—and hence value to the governments concerned—it must be sanctioned by the governments of the participating industries.

The project mechanisms are the focal point for direct private sector involvement in the Kyoto Protocol. Moving from the neat theory to the practical application has however proved complex and time-consuming, and many private sector actors warn that the slow pace, complexity and transaction costs of utilising the mechanisms—and the practicalities of the driving commitments as discussed below—means that private finance to date has been a trickle, not a flood.

Box 1: Economic and crediting aspects of the Kyoto Protocol's Project Mechanisms

(a) Between Annex I countries: 'Joint Implementation' (KP Article 6)

'[A]ny Party included in Annex I may transfer to, or acquire from, any other such Party emission reduction units (ERUs) resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:

(a) Any such project has the approval of the Parties involved;

(b) Any such project [reduces emissions or enhances removals by sinks], additional to any that would otherwise occur;
(c) It does not acquire any emission reduction units if it is not in compliance with its obligations on [compilation of emission inventories and reporting];
(d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3.'

(b) Investments in developing countries: the Clean Development Mechanism (KP Article 12)

Under the clean development mechanism:

(a) 'Parties not included in Annex I will benefit from project activities resulting in certified emission reductions (CERs); and
(b) Parties included in Annex I may use the CERs accruing from such project activities to contribute to compliance with part of their … commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol (COP/MOP).

Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the COP/MOP, on the basis of:

(a) Voluntary participation approved by each Party involved;
(b) Real, measurable, and long-term benefits related to the mitigation of climate change; and
(c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

… a share of the proceeds [shall be used] to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

CERs obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.'

Other elements

The Protocol contains many other provisions. One article lists specific Policies and Measures that countries are encouraged to consider, ranging from energy efficiency and subsidy reform through to technology research, development and dissemination. Generally, these were promoted by many and watered down by others: in general, countries were extremely resistant to anything that could intrude directly on national sovereignty over the choice of instruments adopted. However, these references could provide important pressure points, and hooks upon which to build subsequent negotiations on more specific actions, including international collaboration on technology-oriented measures. Also, an important exception to the *laissez-faire* approach comes in the requirement that parties *shall* (emphasis added) pursue limitation or reduction of emissions from aviation and marine bunker fuels, working through the ICAO and IMO, respectively (international bunker fuel emissions are not included in the Kyoto national allowances because of the complexity of allocating them to any particular country).

Other provisions place requirements on all countries (including developing countries)—for example, reporting on national emission inventories, and on policies and measures being adopted to tackle climate change. In addition, the provisions on technology transfer indicate increased attention to the importance of global diffusion of cleaner energy technologies. Many of these elements build upon provisions in the UNFCCC itself, extending and being more specific about the actions required (see Grubb *et al.*, 1999).

In addition, the Protocol restates a principle of protecting countries from possible adverse effects of any of the policies and measures that may be adopted, 'including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other parties, especially developing country parties'. Reference is made to Articles 4.8 and 4.9 of the FCCC, which list categories of developing countries particularly at risk, including obvious ones such as small island countries or those with areas prone to natural disasters, but also including 'countries whose economies are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products'.

Like most international treaties, the explicit consequences for non-compliance are weak compared to domestic law: the most concrete are that failure to meet the quantified commitments in the first period automatically disqualifies a country from participating in the mechanisms and will be penalised by deductions from allowed emissions in subsequent rounds with a 30% penalty factor. Nevertheless, the compliance section was one of the most highly contested in the Marrakech Accords. The restatement of the principles that the commitments are legally binding, and the establishment of an enforcement branch in the compliance committee, make the compliance package considerably stronger than in most Treaties. Last-ditch Japanese attempts to water down the package (rejected) emphasised that most countries do not consider ratifying and then abrogating the Treaty to be an option.

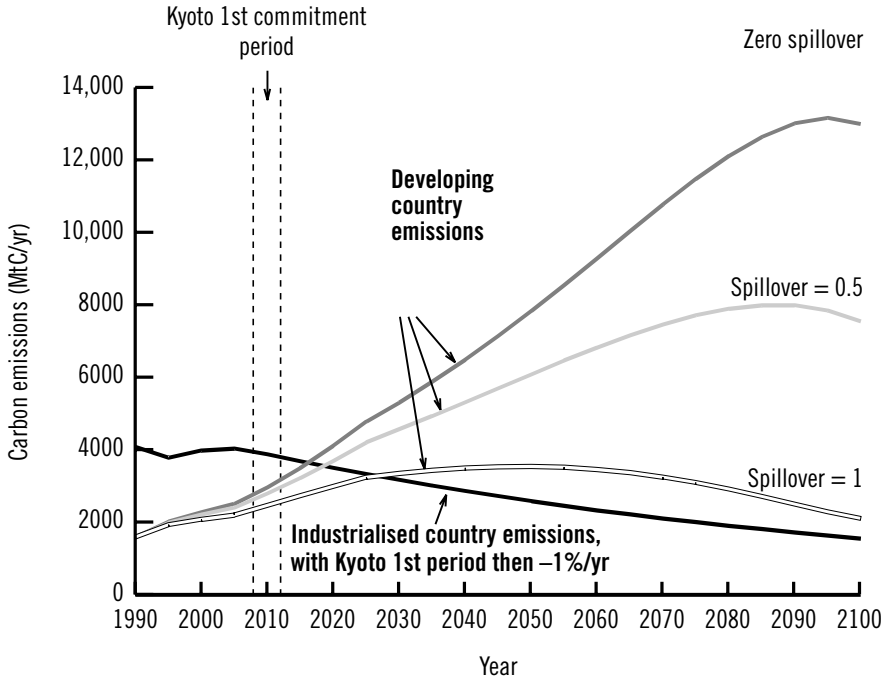
The Kyoto Structure for the longer term

Although debate about Kyoto has tended to focus almost obsessively on the first period commitments, the basic intent is to provide the structure for a dynamic, evolving regime that can effectively tackle climate change over the course of the Century. The current set of emission targets for the first commitment period represent the first concrete step in a much longer-term process of negotiating emission commitments over successive periods. Negotiations on second period commitments are due to start by 2005; it is generally assumed this would take the form of another 5-year period, centred on 2015, though a different timespan would be legally possible.

The current first period emission targets are intended to meet the Convention requirement that industrialised countries should take the lead in tackling climate change by modifying their emission trends, and to provide a period of institutional development of the mechanisms, regime architecture (such as inventories) and national programs for tackling emissions. The first period commitments were never intended to provide the definitive solution to climate change, indeed a moment's thought reveals that no agreement reached in the 1990s could sensibly provide a one-step solution to such a massive and long-term problem.

Second and subsequent periods are likely to require more stringent emission commitments, and for a wider group of Parties, thus gradually

Figure 2: Kyoto 1st period commitments in context: global emissions dependence upon follow-up and spillover



Note: The black (declining) line shows emissions from industrialized (Annex 1) countries, up to 2010 assuming that they *collectively* meet the Kyoto 1st period commitments and then follow with reductions averaging 1%/yr in subsequent Kyoto periods. Emissions from developing countries are modeled in terms of the assumed degree of spillover: A value of spillover = 1 means that aggregate developing country emission intensity (per unit GDP) tracks that of industrialized countries and converges over the century. Such spillover would be a combination of economic, technological and political spillovers, the latter including expansion of commitments to include more countries over successive negotiating rounds.

Source: Grubb, Hope and Fouquet (2002)

'ratcheting up' the Protocol and its resulting environmental effectiveness. Similarly, the Montreal Protocol's initial CFC emission target of a 50% cut was far from being environmentally effective, but was progressively tightened over time to greatly increase the treaty's environmental impact. Figure 2 shows Kyoto's first period commitments in context, and underlines how the Protocol's ultimate impact will depend upon the degree and scope of follow-up to this initial action. The figure also shows that global emissions in the longer term cannot effectively be contained without emission controls in developing countries as well.

In the US particularly, the Protocol was widely condemned for 'not including' developing countries. In fact the Protocol is very much a global

agreement, as is the Framework Convention on which it is based. All parties, including developing countries, have a general commitment to adopt climate change mitigation policies and to report on the action they are taking. The Clean Development Mechanism (CDM) is intended to help disperse the effect of emission constraints globally, allowing industrialised countries (and their companies) to invest in emission reductions wherever it is cheapest globally.

Establishing quantified commitments for countries in early stages of development would not only have been politically impossible, it would also have faced huge uncertainties in their emissions data and growth trends. It is also questionable whether it would have been technically feasible from a negotiating standpoint, given the huge complexities of reaching agreement even amongst the 38 industrialised countries.

That said, the North-South division embodied in the Kyoto Protocol (as well as under the UNFCCC) is undoubtedly a key problem area. There is an understanding that, if and as industrialized countries start to move their economies onto a less carbon intensive path, the developing countries must follow, and the Protocol stipulates that its provisions must be reviewed no more than two years after its entry into force. The structure of sequential negotiations provides a natural opportunity for engaging more countries in quantified emission caps over time, but the major developing countries would have to abandon their present refusal to take part in any debate about any possible future limits. However, the structure does offer a natural point of leverage in that the industrialised countries could simply refuse to take on stronger targets in the future unless more countries become so engaged over time.

PART II: PRICE AND TRADING IMPLICATIONS OF THE KYOTO-MARRAKECH FIRST PERIOD COMMITMENTS

Evolution of analysis

In the aftermath of initial agreement on the Kyoto Protocol, many economic modeling studies of the first period commitments, conducted under a programme of the Stanford-based Energy Modeling Forum, suggested that carbon prices under Kyoto could be several hundred dollars per tonne of carbon ($/tC) if emissions trading were impeded, or on the order of

$100/tC (= 27.3 $/tCO$_2$) even with unrestricted trading amongst the industrialised countries (Weyant, 1999).[12] Figure 3 shows results from the set of models covered in these studies, for the US and EU, for four cases: no trading (giving the marginal costs of achieving Kyoto targets domestically); full Annex I trading; a 'double bubble' in which there is no trade between the EU and the rest of Annex I but each bloc trades within itself; and full global trading, taken as crude approximation to maximal use of the CDM. Generally, increasing flexibility reduces prices as expected, but there is a huge range of prices across the models.

The IPCC Third Assessment (IPCC WGIII, 2001) numbers on the costs of Kyoto drew heavily on this set of studies, whilst noting that the models generally 'do not include carbon sinks, non-CO$_2$ gases, the CDM, negative cost options, ancillary benefits, or targeted revenue recycling'. This rather serious set of limitations goes some way to explaining the gulf between many of these modeling studies and the claims of some others even at that time that the Kyoto targets might be met at relatively low cost, perhaps even in the US (see literature review in IPCC WGIII, also e.g. Yellen, 1998).

A gulf away from modeling studies, a few nascent and speculative market trades did occur. In stark contrast to the projections of the EMF models, most such trades—discounted heavily by the uncertainty about future developments, and representing the first trades at the margin—were at a price of just a few $/tC.

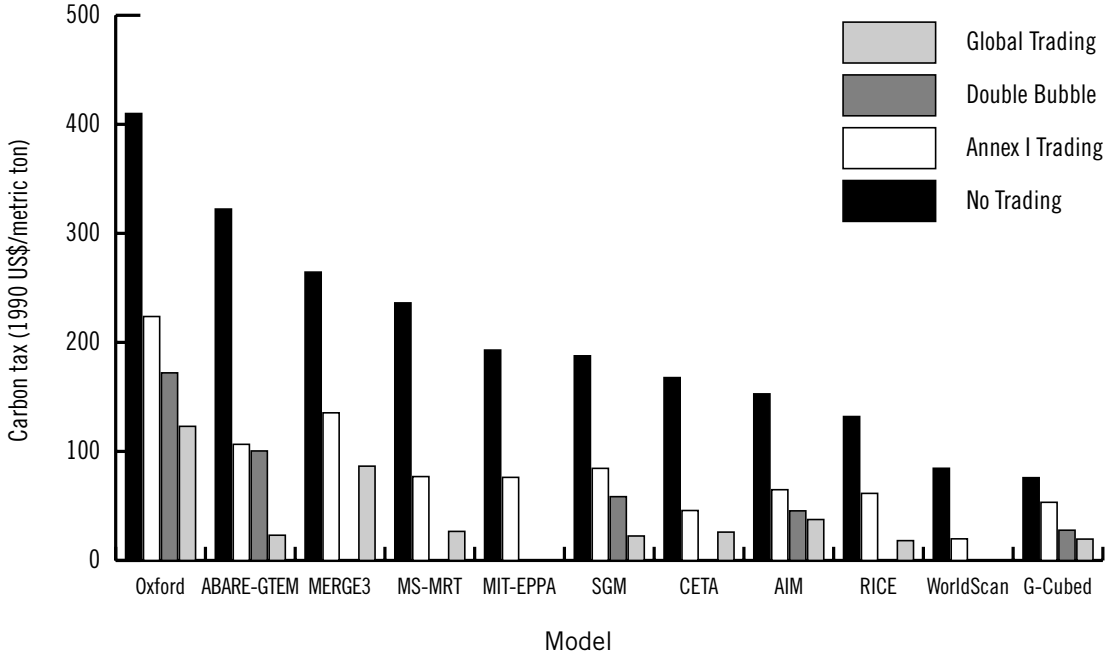
The tumultuous events of 2001 transformed the economic situation further due to at least three major factors explored further below: the withdrawal of the US, by far the largest source of potential 'demand' in the system; revision of Russian energy projections which greatly increased their projected allowance surplus; and the subsequent Bonn/Marrakech deal on carbon sinks. As a result, modeling projections of the price plummeted.

This section addresses the reasons for very divergent views about carbon prices, and the relationship between modeling studies and actual prices that might emerge under the Kyoto first period.

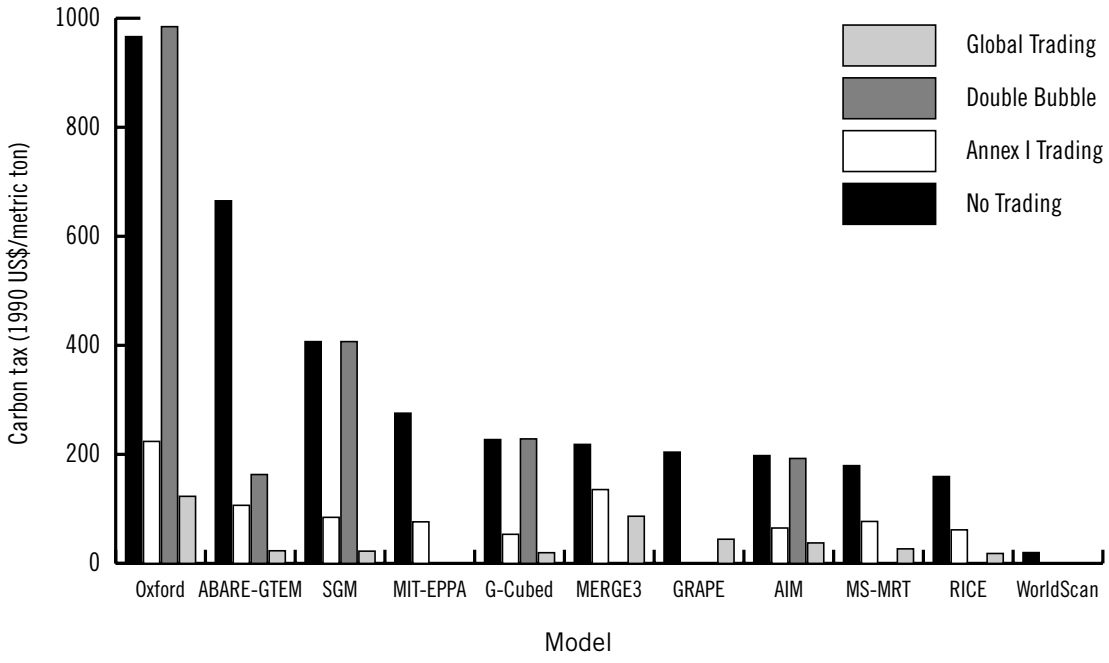
[12] To conform with the emerging standard in the UNFCCC and the private sector, prices in this paper are given per unit MtCO$_2$. The conversion factor between tC and tCO$_2$ is 44/12.

Figure 3: Impact of international trading on abatement costs (EMF-16 studies)

(a) United States



(b) European Union



Note: 'Double bubble' = trading separately within EU and within rest of Annex B countries. 'Global trading' is modeled as giving developing countries allowances equal to their business-as-usual emissions, but can also be considered as reflecting an economically highly idealized operation of the Protocol's Clean Development Mechanism.

Survey of economic determinants and modeling results

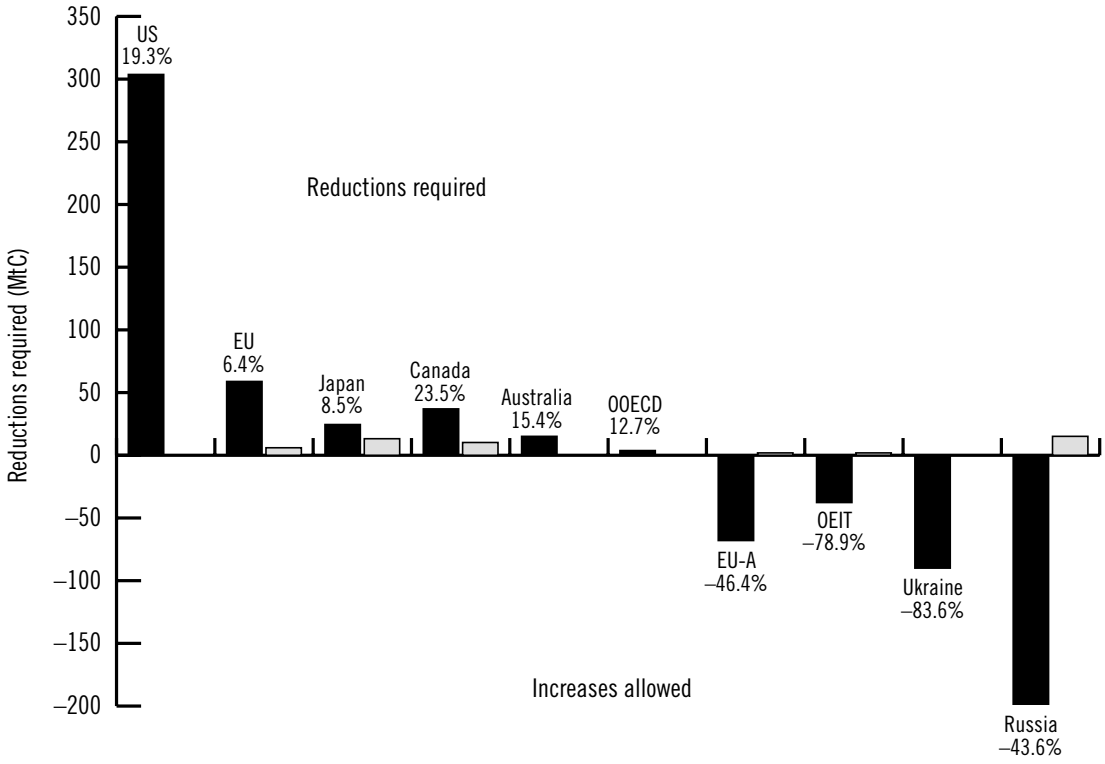
The underpinnings of confusion about carbon prices under the Kyoto Protocol can be represented in terms of one diagram. Figure 4 represents the nearest thing to observable data on the potential supply-demand balance, using the most recent emissions for which comprehensive data are available (year 2000 emissions of industrial CO_2).[13] The main bars show the gap between countries' emissions and their Kyoto allocation. Thus, US emissions in 2000 were 300 MtC above their Kyoto allowance, and would have to reduce by 19.3% to get down to their original Kyoto allocation (7% below 1990 levels). EU emissions had roughly stabilised at 1990 levels and the gap was only 70MtC, whilst Canada faced a gap of c. 40MtC, the highest percentage of any due to its rapid growth since 1990.

In stark contrast, the bars on the right hand side of the graph illustrate that emissions in the Economies in Transition had declined since 1990 and were well below their Kyoto allowance (detailed data for EITs, with recent trends are given in the net section). This illustrates that the countries scheduled to join the EU in 2004 (the 'Accession countries') currently have an emissions 'headroom' about as large as the 'shortfall' in the present EU countries. The 'headroom' currently available to Russia and Ukraine (respectively, 200MtC and about 90MtC) is far larger than any of the individual shortfalls of OECD countries other than the US. In total, in fact, the sum of all these data indicates that the *aggregate* emissions of Annex I countries in 2000 was already below the *aggregate* Kyoto cap of –5.2%, but with a huge east-west discrepancy in the distribution.

For two or three years after the Kyoto agreement, the usual economic perspective was that emissions in all these regions would rise substantially in the absence of strong action to limit domestic CO_2 emissions: growth of US and Japanese emissions would continue apace, the EU would 'recover' from the transitional effects of German reunification, the UK dash-for-gas, and its sluggish economy; and the emissions from the EITs would rise sharply as their economies and recovered and began to grow apace.

[13] Industrial CO_2 here refers to all CO_2 emissions from industrial activity, specifically energy-related activities. This accounts for about 80% of the total GHG emissions across all industrialized countries. Thus the absolute tonnes involved will be higher for the Kyoto basket in full than indicated in Figure 4. Every effort has been made to ensure that the 'emissions gap' calculation is derived from consistent comparison between the target as derived from 1990 emission levels, and actual recent emissions, i.e. both refer to CO_2 emissions from energy. Possible differences in trends of other greenhouse gases, and in carbon sinks other than the managed forest allowance as indicated, are not large enough to affect the main points derived from Figure 4.

Figure 4: Kyoto commitments and trading potential



Note: The main (single or larger) bars show the gap between 2000 emissions and Kyoto commitments for the principal countries/groups in Annex I. The smaller bars alongside show the maximum allowance that each can claim for carbon absorbed from managed forests under the Marrakech Accords (excluding the US which is not included in that agreement), which can in effect be deducted. % numbers show the percent cut required to get from current levels to the Kyoto targets (–ve numbers indicate the corresponding % growth from current levels for EITs).

Key: EU-A = the 10 EU candidate countries heading for early accession. OEIT = the 5 other countries applying for EU membership. OOECD = all other OECD countries. Data represent CO_2 total national emissions.

Source: 2000 emission data: Energy Information Administration, USA

Consequently, economic models at that time mostly predicted that a high carbon price would be required if countries were to cut back emissions enough to comply, with the US and Japan facing the biggest gaps and bearing the biggest costs.

In addition to the fact that many of these models used already outdated data and neglected non-CO_2 gases and carbon sinks, three factors have served to completely reverse this perspective:

- Emissions of most countries, but especially the Economies in Transition, have failed to grow as many models predicted. The only

exceptions were the New World economies (US, Canada, Australia). Emissions in Europe and Japan remain roughly static, and (even more significant) so did emissions from most of the EITs, where economic recovery was generally reflected in increased efficiency rather than emissions growth (see Table 4 below).

- The Marrakech Accords granted countries a certain allowance of carbon sinks from 'managed forests' as shown in Figure 4—essentially a windfall gain, since many forests in industrialised countries are in practice managed in one way or another—and also allowed inclusion of afforestation and reforestation projects in the CDM.
- The Bush administration's rejection of Kyoto removed by far the largest potential source of demand in the Kyoto system.

The result is to leave a large potential supply set against radically reduced demand. This has a dramatic impact on the results of economic models. Table 4 summarises the results of various economic modeling studies conducted since the US withdrawal from Kyoto. Without exception, US withdrawal has a big impact in these models, which mostly assume a freely operating international trade in allowances—in some cases, pushing the price close to zero. Buchner *et al.* (2002) reviewed studies and found the impact of US withdrawal alone to result in more than a halving of the permit price in all studies except their own.[14] The conclusions do not only apply to European studies: the MIT group estimated a carbon price at about US \$10/tCO_2 in the pre-COP6 circumstances, and found this fell to a negligible level under the Marrakech agreement (*sans* US) with free international trade (Babiker *et al.*, 2002). Springer (2002) reviews modeling results, unfortunately without comparing pre- and post-2001 results, and concurs that 'estimated prices fall dramatically, reaching values between 0 and 12 \$/tCO_2.'

The relative influence of the three different factors varies between studies, and indeed the impact of revised emission projections is rarely carried out, presumably because the modelers are not so keen to illustrate just how wrong they were concerning past forecasts. Nevertheless, the withdrawal of the US is clearly an extremely big factor.

[14] This is due to the fact that the Buchner *et al.* model includes both cartelisation of the market, and a feedback between prices and technological change. They argue that the low prices in the absence of the US will slow down technical change and lead to higher emissions in the rest of Annex B. In reality, it is hard to see how such an impact of induced technical change could operate so substantially on a timescale of just a few years, though the point, taken more generally, is pertinent.

Table 4: International carbon prices from Economic models of the Kyoto system: impact of US withdrawal

	Includes		Equilibrium carbon price under Kyoto, $/tCO$_2$e		Price impact of US withdrawal (% decline)
Model/study	Carbon sinks (managed forests/other)	Non-CO$_2$ gases	With US	Without US	
Hagem and Holtsmark (2001)	N	N	15	5	66
Kemfert (2001)	Y/N	N	52	8	84
Eyckmans *et al.* (2001)	N	N	22	10	55
Den Elzen and Manders (2001)	Y/N	Y	37	13.6	63
Böhringer (2001)	Y/N	N		'Close to zero'	
Babiker *et al.* (2002)	Y/Partial	Y	10	Negligible	

Note. The absolute numbers from different studies are not directly comparable as they may refer to different currency base years, as well as embodying different assumptions and base year emissions data used for 'reference' projections. However the impact of different currency and emission base years is small in relation to the impact of US withdrawal.

Kyoto realities: the context

Given the above, many economists have now totally reversed their assessment of a few years previously: no longer will Kyoto be too expensive, rather the international carbon price will be close to zero and hardly any action will be taken. In practice this is no more realistic than the former assessments, for three main reasons:

(i) **The prioritization of domestic action.** Most countries are concentrating first on domestic action. For example, the EU and its member countries are taking a range of measures in all sectors to limit GHG emissions, and even its emissions trading directive is carefully confined to domestic action: whilst states retain the right to international trade under Kyoto, the Directive is clear that companies cannot themselves engage in international trading under the Directive. Climate mitigation policy in the EU already forms a patchwork of measures implicitly at widely divergent marginal costs, and existing policies in many areas (notably transport, in which existing excise duties already typically equate to over Euros 50/tCO$_2$) will be insulated from competition with international carbon trading.

(ii) **Market power and other constraints on the operation of Kyoto as a fully competitive international market.** The international carbon price could be considerably higher because Kyoto will not operate as a fully competitive market. The project-based mechanisms will be inhibited by transaction costs, and international trading may be affected by the potential for major exporters to withhold supply so as to raise prices; they also have the option for holding any unused allowances over for use in the subsequent period through Kyoto's banking provisions.

(iii) **Buyer sovereignty.** Countries looking to import allowances have a sovereign right to choose from whom they buy and on what basis. For a whole variety of political and strategic reasons, elaborated below, countries are unlikely to seek to acquire allowances at least carbon cost.

These factors all involve considerations of political economy, particularly concerning the likely behaviour of sovereign states engaged in the Kyoto system. Kyoto is an intergovernmental agreement and the only entities that can be bound by it *directly* are governments. Value under Kyoto can only be accorded to private sector trades to the extent that these are endorsed, in one way or another, by governments. The Kyoto registries system requires the source of all units to be registered by a unique identifier, so that governments have the potential to be selective about the units they are willing to issue for trading, or to accept and use for their compliance assessment.

To understand how these factors may work, the next section explores the situation in the major countries involved.

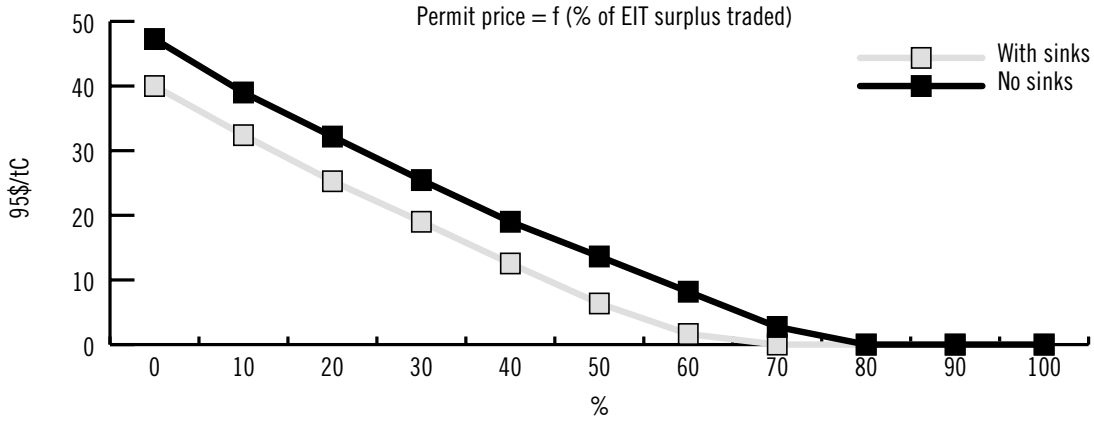
The 'supply side': Economies in Transition and the developing countries

The biggest potential sellers in the international 'Kyoto market' are the Economies in Transition. The initial assumption has been that these countries would seek to sell all they could, providing they can comply with the Protocol's inventory and reporting requirements. In practice things are not so simple.

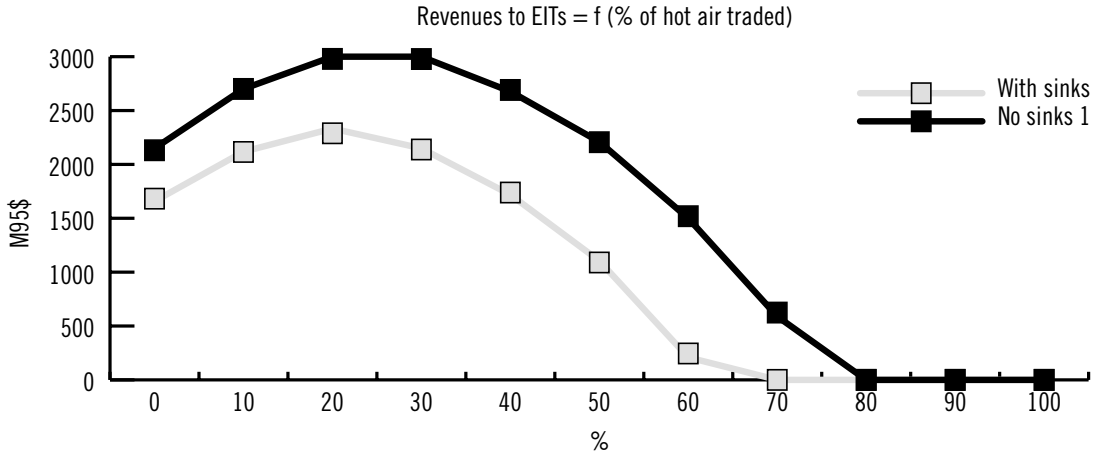
Russian and Ukrainian energy projections are still very diverse and their approach to selling has been cautious to avoid any possibility of having to buy back allowances if emissions growth is high. Also, there is emerging understanding of the trade-off between volume and prices. Figure 5 shows one estimate of the impact on permit prices and revenues to the EITs, as

Figure 5: Impact of trading EIT emission surplus ('hot air') on permit price and EIT revenues

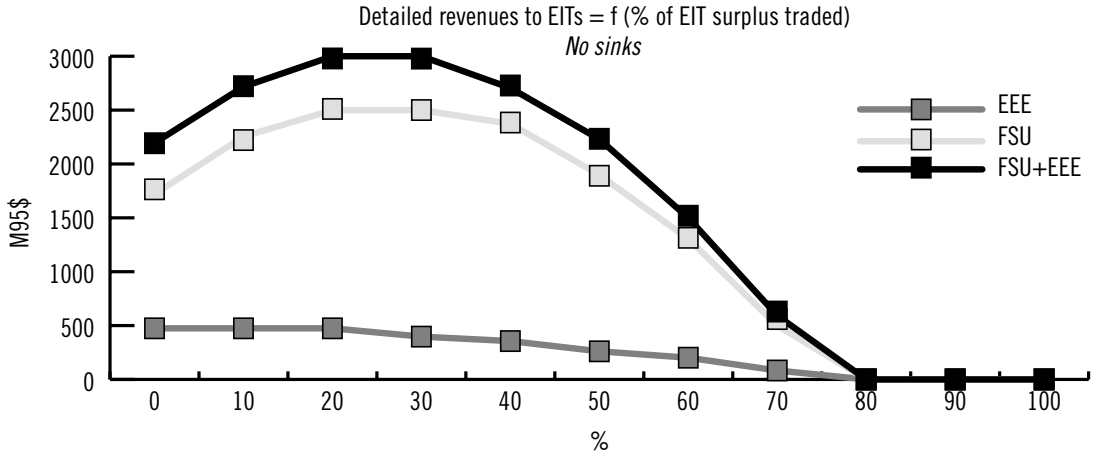
(a) Permit price as a function of the traded EIT surplus



(b) Revenues of FSU and EEE as a function of the traded EIT surplus



(c) Division between Former Soviet Union and other EITs



Price units: millions of US$/tC, at $1995. To express equivalent prices in current $ per tonne of CO_2, divide by about 3.5.

Source: Criqui and Kitous (2001)

a function of the amount of their surplus allowances (relative to the 'business-as-usual' emissions in this projection), more colloquially known as 'hot air'. In that study, the revenues to EITs would be maximised by trading only 20% of their overall surplus, at a price in the region of $20–30/tC (c. $5–7/tCO$_2$) which would yield somewhat over US$2bn/yr; if more is traded, the collapse of price outweighs the increasing volumes. The review by Springer (2002) concludes that if all the EITs were a perfect cartel (obviously not a realistic assumption), they could maximize revenues by selling 10%–60% of their surplus at 5–22 $/tCO$_2$.

This in turn gives rise to the idea that the EITs could seek to maximize their revenues by operating a cartel on emissions supply. Again however things are not so simple—in part because it seems likely that the surplus will be larger and more widespread than originally anticipated. Table 5 shows emissions from the individual EITs, including recent trends. It shows that for all the EITs, with the single exception of Slovenia, emissions by 2000 were well below their base year levels, implying potential for a substantial surplus under Kyoto.

The EU Accession countries are for the most part more advanced in the transition process and it was widely predicted that their emissions would start rising as their economies recovered. As yet, there is little sign of this happening, though there is evidence of a 'bottoming out' by the year 2000. Resumed emissions growth cannot be ruled out, but there remain substantial inefficiencies in these countries and the Accession process (which requires *inter alia* removal of various subsidies, including continuing coal subsidies in many of these countries) may accelerate this.

The relationship between Ukraine and Russia, as the countries with by far the largest potential volumes of surplus to sell, is also important. This relationship is already complex not least because of ongoing struggles over gas supplies and payments.

Cartels are notoriously difficult to hold together. In this case, close collaboration between EU Accession countries and other EITs seems implausible because of the former's close ties to the EU and the likelihood that they will be included in an EU-wide emissions trading scheme.

In addition, many individual actors in these countries are more concerned with *where* the money goes than with the overall flows. Of most direct relevance here, the Russian Ministries of Energy and of Economy in Russia are concerned to see that money flows into real investment to

Table 5: Emissions from Economies in Transition: base year and recent trends

		CO_2 emissions (excluding land-use), MtC/yr			
EIT countries		**In base year***	**(1998)**	**(1999)**	**(2000)**
EU accession countries	Czech Republic	44.7	29.3	27.0	28.4
	Estonia	10.4	2.3	2.0	1.9
	Hungary (1985–7)*	22.2	16.0	15.8	14.9
	Latvia	6.4	2.1	1.8	1.9
	Lithuania	10.8	4.8	3.4	3.6
	Poland (1988)*	115.7	84.9	81.7	81.4
	Slovakia	16.3	10.4	10.7	10.4
	Slovenia	3.8	4.7	4.2	4.2
	*Malta***	–	–	–	–
	*Cyprus***	–	–	–	–
Total accession		230.3	154.5	146.6	146.7
Other EU candidates	Bulgaria (1988)*	28.3	15.3	13.7	15.0
	Croatia	6.4	5.3	5.4	5.7
	Romania (1989)*	53.4	27.2	24.0	24.7
	*Turkey***	–	–	–	–
Other Annex I EITs	Ukraine	191.9	100.0	105.0	104.5
	Russia	647.0	395.8	440.0	450.7

Note: Accession countries = the 10 countries officially accepted for EU Accession in 2004.
* Base year emissions are 1990 unless otherwise indicated, on the same basis as other data (i.e. energy-related CO_2 emissions). Emissions of the other GHGs collectively have generally declined by at least as much as CO_2 emissions, but full data for recent years are not available.
*** Countries not in Kyoto Protocol Annex B,* i.e. *without emission targets, indicated by italics: no emissions data shown as these countries are not relevant to the Kyoto first-period trading system.*
Source: (1) Base year emissions, UNFCCC (EIA for those with base years different to 1990); (2) Other emission years, Energy Information Administration, US DOE, Washington.

improve energy infrastructure. The reduced volume of money without US participation also increases the appeal of using the mechanisms primarily to try and leverage potentially much larger private sector flows.

This sets the context for the Russian proposal on a 'Green Investment Scheme', whereby revenues from emissions trading would be invested in environmentally-oriented projects, principally aimed at improving the efficiency of the energy sector, an idea explored in considerable depth by a recent international study (Tangen *et al.*, 2002).

Finally, the other 'suppliers' in the Kyoto market are the developing countries. They do not have a ready 'surplus' available to sell, but they can generate emission credits through CDM projects.

Table 6: 'Top-down' estimates (prior to 2001) of the size of the CDM

Study	Cost ($billion)	Emission credits (cumulative MtC)	Implied Annex I emissions (% of 1990)
Haites	1–21	27–572	–4.7 – +6.9
MIT	2.5–26	273–723	+0.5 – +10.0
Austin	5.2–13	397–503	+3.2 – +5.4
US administration	4.2–7.9	100–188	–3.1 – –1.3
ITEA	3.3–3.9	67–141	–3.8 – –2.3

Source: Grubb, M., Vrolijk, C. & Brack, D. (1999), *The Kyoto Protocol—a Guide and Assessment*, RIIA/Earthscan, Chapter 5: Table 5.3 and references.

Views on the potential supply of credits from the CDM take one of two fundamental approaches. One consists of 'top down' assessments of potential, based on estimated marginal supply curves of the costs of the limiting GHG emissions in developing countries. Depending in part upon the price projections, the resulting estimates of CDM supply spanned a huge range, up to more than 500MtC/yr (Table 6). The need for 'counterfactual' baselines (i.e. projections of what emissions would have been in the absence of the project) also leads to the fear that credits could be generated spuriously (the additionality problem), with one study suggesting that such 'free riding' in the developing country power sector could lead to as much as 250–600MtC of spurious credits over the first Kyoto period (Bernow *et al.*, 2001).

The other approach focuses upon the various institutional and other obstacles to practical projects and the sheer number of projects that would be required. This results in far lower estimates of the CDM potential. Assessments of the scope for forestry similarly cast doubt on whether the volume of such projects in reality could ever reach even close to the 1% cap in the time available (Bernoux, M. *et al.*, 2002; Forner and Jotzo, 2002). The lower prices and demand after the events of 2001, of course, will also depress CDM investments. A recent estimate of actual project flow suggests that projects in the pipeline as of early 2003 would only generate 3.35MtCO_2e of CDM credits *by 2005* (PointCarbon, 2003), though rapid expansion could be expected as the institutions start to operate fully and if the first deal flows are successful.

The pricing aspect of the CDM is complex. Very low carbon prices are simply not big enough to make much difference to the economics of real

projects; prices need to be several tens of $/tC before they are likely to make material difference to investors' decisions on whether to proceed with complex, potentially difficult and risky projects in developing countries.

The main implication of all this is that Kyoto will be a 'buyers market', and the ultimate effect of the first period commitments will depend upon how the importing countries approach the international mechanisms.

The 'demand side': EU, Japan and Canada

The European Union

The EU's efforts are focusing first upon domestic implementation. Domestic programmes of member states are varied. Some are quite well developed: it is estimated, for example, that UK domestic programmes now give an annual incentive towards low carbon investments of about Euros 2bn/yr (Wordsworth and Grubb, 2003). Germany, France, Netherlands, Austria and the Scandinavian countries also all have substantial domestic programmes. In some others, efforts are still in very early stages (see review in Michaelowa, 2003).

The most potent symbol of Europe's seriousness about domestic action was agreed in December 2002, with the adoption of a Directive on the European CO_2 Emissions Trading Scheme. This requires all member states—including the Accession countries due to join in 2004—to implement by 2005 emissions cap-and-trade regulations to cover the power and main industry sectors. In total the scheme will cover about 45% of total European CO_2 emissions and will be at least ten times larger than the precursor US system on sulphur regulation.

In addition to this tendency to prioritise domestic action, EU reservation about unlimited use of the international mechanisms has a long history. At least three other factors will shape the EU's approach to the international carbon market under Kyoto:

(i) **The politics of EU enlargement.** Economic and political considerations smoothing the path of Accession are likely to take precedence, so the 'price' in intra-Europe trading is unlikely to be allowed to fall to near zero.
(ii) **The EU-Russia energy dialogue.** Engagement with Russia and Ukraine will be set in an explicit context seeking political cooperation

based largely around energy trade, and in particular east-west gas trade and the EU-Russia energy dialogue. Kyoto units are likely to be seen as a tool to be used in the context of this dialogue and its associated efforts to secure a stable basis for foreign investment in the Russian energy system.

(iii) **Political investment in Kyoto.** The EU was at the centre of political efforts to rescue the Kyoto Protocol. This involved convincing both developing countries and the EITs not only that it was the 'right' thing to do, but that they stood to benefit from the system. In addition, the EU has relatively strong ties with many developing countries, partly through ex-colonial links. The result is that the EU is bound (in both senses of the word) to factor political and strategic considerations in to any international trading under the Protocol.

All this will take expression in a diverse willingness to pay. For example, the EU might be willing to pay 'over the odds' to encourage CDM project in Africa, as compared to countries that are perceived to be less 'in need', or which are already attracting foreign investment. Indeed, the promise of international money flows form the glue behind the political consensus underpinning Kyoto. This implies a political need to do some international trading, but to avoid a price collapse. The EU may be a buyer, but it cannot aim to be a least cost/lowest price buyer.

Japan

Japan has been ideologically even further from regarding Kyoto as a 'free market' than was Europe. Japan needs the flexibility, but at the same time the mechanisms are regarded as an instrument, at the sovereign disposal of 'Japan inc.', not a market 'free for all.' As such, perhaps to an even greater extent than the EU, Japan will exercise buyer sovereignty over whom it wishes to trade with, and on what terms.

Against this background, the deep-rooted difficulties of Japanese relations with Russia—sustained since World War II by the continuing dispute over the Kurile Islands—are highly relevant. When in 1998 MITI announced 20 'AIJ projects' with Russia it was seen as a breakthrough; the subsequent failure of any of these projects to materialise has reinforced Japanese scepticism about Russia being a reliable source of supply: Japanese implementation plans do not formally include *any* use of Russian

allowances (Matsumura, 2001). Japanese NGOs are also likely to demand, with influence, that emissions trading should be tied to environmentally legitimate investments—the only way in which transferring money to an old adversary is likely to be politically acceptable. Any Japan-Russia deals on JI or emissions trading will proceed cautiously, hesitantly, with conditions requiring monitorable environmental investments, and at a small scale as pilot programmes in building trust (Tangen *et al.*, 2002).

Insofar as Japan needs emission units, it is likely to seek the bulk in the form of CDM credits from developing countries, and it may be willing to pay substantial prices, using this in part as a political instrument for maintaining good relations with its Asian developing country neighbors. Again, its behavior will focus first upon domestic implementation, topped up by international access on carefully circumscribed terms.

Canada

Of all the countries in Kyoto, Canada probably has both an interest and an ideology inclined to treat Kyoto as a competitive international carbon market. In percentage terms, Canada probably faces an 'emissions gap' larger than Japan; and it may have less resistance to large-scale emissions trading with Russia.

Yet even for Canada, it is becoming apparent that reality will differ markedly from the models, for two big reasons. One is that environmental and international NGOs, which have a large influence in Canada (and the wider public), object strongly to the idea of giving Russia money for 'doing nothing', as indeed does the general public. In addition, Canadian industry has mixed interests. Those companies that have opposed Kyoto would nevertheless like to seek ways of benefiting from it, if Canada does go ahead. And the most obvious way they can do so is if foreign expenditure for emission units is directed primarily towards investments that involve Canadian companies—perhaps particularly for Russia, where the similar range of climatic conditions makes Canadian expertise potentially valuable. Albertan companies, which have so fiercely opposed Kyoto, could be the first to line up in favour of linking emissions trading with Russia to real investments in the Russian energy systems—and at as high a price as possible, if they have prospects of being the main contractors.

Analogies with the oil market

How exceptional is the Kyoto 'market'? The above discussion suggests, at first sight, that it will be so far from the economic ideal of a least-cost market as to scarcely justify the term 'market', and that little insight could be gained from expertise with other market operations. Whilst Kyoto undoubtedly has many unique features, the behaviour sketched is not really so exceptional.

Consider the oil markets. Despite a century of evolution, international oil prices are generally maintained well above $20/bbl, despite the fact that the marginal production cost in Saudi Arabia is probably less than $5/bbl. Saudi Arabia's main influence is wielded through the OPEC alliance of exporting countries, yet even OPEC overall does not exert anything like monopoly control on supplies, whilst its members themselves have widely divergent interests according to their fiscal and reserve situations.

For Kyoto's first period, it is not hard to see Russia as the Saudi Arabia of carbon permits, and the EITs overall, as OPEC. Nor is it hard to paint analogies with the 1980s oil price collapse, envisioning Russia trying to hold back supplies whilst the carbon price sinks lower and lower until it loses patience and threatens to flood the market. One potential feature of such markets certainly is their price instability, and dependence on political decisions and negotiations amongst suppliers. Similar features would hardly be surprising in the Kyoto first period system.

Yet a view of oil markets that focuses only on supply is also fundamentally misguided, or at least extremely dated. The oil price is maintained so far above its marginal production cost through processes that are to a large degree collaborative between producing and consuming nations and with industry. Such collaboration (mostly informal) is only possible because of a perceived common interest in maintaining prices that are stable, and at 'reasonable' levels, which is generally understood to mean in the range c. $20–$25/bbl. Importing countries acquiesce (or even actively collaborate) to maintain prices an order of magnitude higher than marginal production costs, for a variety of complex reasons. These include the internal politics of their own oil industries, and long-term strategic calculations that oil is, ultimately, a highly valuable and (on strategic timescales) scarce resource. Higher prices do not only protect domestic investments in

frontier non-OPEC production, and keep high-cost domestic oil companies in business; they also underpin efforts to reduce long-term dependence on imports through efficiency and diversification. Again, analogies with the carbon markets are not hard to draw.

Finally, much as the oil markets involve a high degree of government-industry interaction (though now somewhat less than formerly), the Kyoto system is bound to involve the same. Some governments at least wish to protect and support emergent industries that can deliver, and profit from, lower carbon futures.

Differentiation among the Kyoto units

The Protocol itself places no significant restrictions on the fungibility of the different units defined under Kyoto;[15] all can be added to bring a country into compliance.[16] Despite this effective lack of formal restrictions, there will be considerable price discrimination for the reasons set out here. Some such discrimination will come directly from the private sector in this nascent market. Especially in this formative stage, the value accorded to emission units by the private sector is strongly affected by both reputational and political risk considerations. Reputational considerations will make companies averse to large scale and potentially controversial projects, such as large-scale agroforestry where land rights are disputed. Political risk considerations will include the risks associated with uncertainty about what kind of units home governments will ultimately accept.

With the Marrakech Accords establishing the fundamentals of project eligibility, the major governmental distinctions are likely to depend upon region—and corresponding mechanisms—but with important subdivisions according to project type (see Box 2).

[15] Namely Annex I carbon sink projects (**RMUs**); CDM projects (**CERs**, from investments in developing countries under Art. 12); JI projects (**ERUs**, from investments in other Annex I countries under Article 6); Trading of Assigned Amount Units (**AAUs**, acquired from another Annex I country through trading under Article 17).

[16] There are restrictions on the volume of RMUs allowable (1% of initial Assigned Amounts), though Jotzo and Michaelowa (2002) make a persuasive case that this cap could not be reached anyway. RMUs cannot be banked for use in subsequent periods, but their allowable and likely volume is sufficiently small that they can readily be used in the first period for compliance and other units banked instead. Similar remarks apply to ERUs and CERs, of which a maximum of 2.5% of initial Assigned Amounts each can be banked.

Box 2: Differentiation among the Kyoto project mechanisms

Project mechanisms. Credits from project mechanisms may attract a premium over AAUs from trading, principally because they can be seen on all sides to be associated with real project investments—real action and measured environmental gain—as opposed to paper trading. Supplementary reasons include the interests of domestic actors (e.g. within Russia) to use project credits to attract and leverage much larger overall investment to specific sectors and projects, as well as the sheer political difficulty of developing domestic corporate emission trading systems. However there is likely to be discrimination even within the project mechanisms.

CERs may attract a premium over ERUs for three reasons: they are more likely to be perceived as contributing to developmental needs in poor regions; the crediting can begin immediately (as opposed to being a forward transfer of credits projected from 2008); and they will pass through a more rigorous international procedure for accreditation. Amongst CERs, there may be preference for those generated from small-scale, renewable energy projects under the 'fast track' procedures agreed at COP8, because of the general perception that renewable energy promotion is a good end in itself and because the COP8 decision removes much political risk.[17] Detailed rules for accrediting other CDM project types have yet to be determined by the Executive Board. Discounting may be particularly large for some forestry projects, given both greater potential land-use conflicts, and the longer timescales likely to be involved in resolving rules for these (which are not scheduled to be resolved until COP10, in 2004).

[17] FCCC/CP/2002/L.5, Report of the Executive Board of the CDM, Decision CP8, Annex A: 'Draft simplified modalities and procedures for small-scale clean development mechanism project activities'. Such projects are defined as (i) renewable energy project activities with maximum output capacity equivalent of up to 15 megawatts; (ii) energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 15 gigawatt hours per year; and (iii) other project activities that both reduce anthropogenic emission by source and directly emit less than 15 kilotonnes of carbon dioxide equivalent annually.

ERUs may be somewhat more homogenous, in part because of the smaller geographic and economic range of the source countries. However, there could clearly be a distinction between the 'mainstream' and 'track two' JI procedures. The former, for projects in countries that have fulfilled all relevant eligibility criteria, might give greater legal security about the credits, but for many EITs, full eligibility may imply a long delay, and the detailed project supervision is slight compared to CDM projects. 'Track two' procedures in principle could come onstream quicker, but uncertainty still exists about the exact form and functioning of the Supervisory Committee.

RMUs (from carbon sink activities) may be more difficult to locate in the spectrum of perceived value. Carbon sink projects are frequently criticised on the grounds that the incremental emission savings are very hard to monitor and quantify, that they may displace 'better' land uses, and that the carbon stored might later be re-released (the problem of permanence). In these respects, the RMUs resulting from sink projects may be seen as less valuable than CERs and ERUs derived from energy sector investments. However, this perception of sink projects is also strongly disputed.[18]

Direct trading of national emission allowances appear subject to the greatest political risk, and consequently the greatest discounting. Conversely however, allowance trading is likely to be an essential component of the compliance portfolio at least for Japan and Canada, simply because it is probably the only source large enough to ensure their compliance given the real-world constraints on project volumes. Within allowances trading, one can distinguish four possible components:

[18] The idea that energy-sector emission savings are inherently 'better' than carbon sinks has been strongly disputed for certain kinds of land use projects. E.g., Chomitz (2002) argues that from a carbon perspective the differences between energy and land-use projects are far less clear and systematic than often supposed, and Pandey (2002) makes a strong case that agroforestry in developing countries could have large ancillary benefits for host countries.

- 'Greened' trading, in which any revenues from trading are linked directly to environmental investment; this is likely to be the most widely favoured and attract the highest premium.
- Trading from OECD countries that have exceeded their targets demonstrably due to domestic action may be considered next, and would provide a sense of diversity in the portfolio. The UK is one of few OECD countries likely to surpass its target, and international availability of such allowances may depend in large measure upon the EU's wider progress towards compliance including Accession countries.
- AAUs could also be made available from EITs in a controlled manner through non-GIS-type routes: for example, EIT governments could develop some domestic trading schemes with allocation that is seen to have some degree of environmental credibility.
- Finally, wholesale transfers of allowances without any such linkage would be legal under the Marrakech Accords, but for all the reasons discussed this is likely to be the option of 'last resort' and the most heavily discounted.

All this, of course, makes price prediction extremely difficult. However, various approaches, or influences, can be considered:

- *expert prediction* of those already engaged in real trading; these confirm strongly the hypothesis of wide price differentiation between projects and mechanisms;
- *sufficiency*, i.e. prices required to significantly affect investment behaviour; this implies prices around \$/Euros 10–20/tCO_2 to be relevant in project economics;
- *financial flow constraints* arising from the desire to protect existing domestic policies on the one hand, but to constrain intergovernmental financial transfers on the other.

The last of these relates mostly to Canada, because of its likely high demand. Table 7 shows implications for Japan and Canada under combinations of extreme cases. If the need for allowance imports is low, and it is considered acceptable for international carbon allowance expenditure to reach 20% of ODA expenditure, then Japan might accept international carbon prices about \$20/tCO_2e, compatible with the other measures. Canada, however, with a much higher proportion of carbon import needs relative to ODA expenditure, may find it hard to tolerate international

Table 7: International revenue flow constraints on carbon prices

	Current ODA expenditure (1998 data)		Likely volume of imports, $MtCO_2e/yr$		Price required for allowance trade to equal x% of ODA	
	US $bn/yr	% GNP	Low	High	20%	5%
Japan	10,640	0.28	100	200	21.28	2.66
Canada	1691	0.29	50	100	6.76	0.85

allowance prices much above $\$5/tCO_2$ even under relatively favourable conditions. Much more likely is that Canada will seek large volume international transfers of allowances at prices well below this, and perhaps as low as $\$1/tCO_2e$. Prices much above this are likely to run into varied political constraints: from the same domestic pressures that have curtailed ODA expenditure to the present levels; from domestic development aid constituencies, arguing that development is a far more pressing need for such large expenditures—and, indeed, from developing countries themselves, on the same grounds.

These considerations underline why price differentiation is probably inevitable in the Kyoto system. Prices for project-mechanism credits that are high enough to be effective, in terms of influence on discrete projects, are likely to lead to unacceptably high financial transfers if applied to wholesale allowance trading. Allowance transfers will generally be at much lower prices—but to avoid undermining the basic purpose of Kyoto and of domestic measures already in train, they will be contained in application to those cases where such transfers are deemed necessary and acceptable to enable countries to comply.

This suggests a wide range of prices, differentiated according to the nature of the source, project and mechanism. Grubb (2003) suggests that prices for companies engaging in Kyoto-compliant projects in developing countries and EITs will be in the range $€10–€25/tCO_2$ for the smaller-scale, widely-approved projects such as renewable energy investments, and $€5–€15/tCO_2$ for more potentially controversial (and lower cost) projects including land-use, but also, for example, for large-scale boiler retrofitting or gas conversion. Prices for allowances themselves may be lower, but they may be seen as having lower value, and little or no co-benefits,

except where they are visibly linked to environmental investments at prices that may push towards the level of project credits.

In turn, the prices for large-scale transfers of allowances between governments may be lower still; but the private sector will not be given access to these. The reason for this, fundamentally, is that although emissions trading under Kyoto has been analysed as one instrument, in reality it will be used to fulfil two quite different functions. One is the traditional role of providing market flexibility and efficiency at the margin of project investments. The other is fundamentally a redistributional function, correcting the excessively lop-sided nature of the original Kyoto allocations. The cost of making such transfers at the 'market' price that would be required to sustain action effective action on climate change is politically untenable. Neither 'east nor west' has the market power to exact such a price, nor could the fledgling Kyoto institutions withstand the political pressures such transfers would generate. So, large-scale intergovernmental transfers, most notably for Canada, will occur at much lower prices—and domestic programmes, and the private sector, will be shielded from the malign influence that such low prices would otherwise exert on international efforts to initiate some real action under Kyoto.

Thus in the 'Kyoto market' there will not be one uniform 'price of carbon', but many diverse prices at least in terms of implications for actual project economics. It may be that international trading facilities develop a 'carbon price' for Kyoto units, but not all sellers will make their units available at a flat price, nor will all buyers choose (as governments) to buy at such a price. Some will trade at a discount, some at a premium, because their value to companies for complying with domestic legislation will vary correspondingly.

This in fact is a characteristic of the nascent private sector market at present. Companies are more willing to pay for emission credits from projects that are perceived as very high quality and uncontroversial—projects to which hardly anyone is likely to object, and which seem likely to attract the approval of both governments and NGOs. Emission credits or allowances from other sources may be traded, but at a discount.

The Kyoto Protocol, as elaborated in the Marrakech Accords, will not in itself define 'the standard'. It may well do so for CDM project credits, though even for this, credits from renewable energy projects in the poorer countries may well be given a premium compared, for example, to forestry

projects in some of the richer developing countries. The COP8 decision on expedited procedures for small-scale CDM projects, indeed, could help to define the first real international carbon market component, and renewable energy credits generated under the CDM fast track procedures could emerge to be the 'marker' commodity in the carbon market.

The Marrakech Accords may also set market standards for JI project credits—but the Accords themselves create two tracks for JI. With 'track one' contingent upon meeting quite onerous national reporting requirements, and the value accorded to projects developed under 'track two' dependant in part upon choices yet to be made by the Supervisory Committee, JI credits are unlikely to generate a standard marker price in the near future; and the laxer the standards that may be set, the wider the price differentiation may be.

For Kyoto's first period, price convergence, stability and greater homogeneity could only realistically be expected both as the institutions mature and if the supply overhand were somehow eliminated to make the market much 'tighter'.

Volume flows and potential carry-over of Kyoto units

As explained above, the international flexibility in Kyoto is not undermining the general impetus to domestic action in Kyoto countries; rather, the mechanisms are being developed as a 'reserve' to enable compliance when countries fall short of domestic targets. This, combined with recent emission trends, the carbon sink agreement, and US withdrawal, together have huge implications for the balance of supply and demand in the Kyoto first period. Table 8 shows two scenarios of potential volumes, that probably represent limiting high and low cases for the degree of surplus. These are constructed in terms of emission trends from the latest year's data, the year 2000, and taking account of underlying trends (such as high population and economic growth rates in Canada).

Under a 'low surplus' scenario that combines high demand with low supply, gross CO_2 emissions in the EU-15 might be about 120MtC above its Kyoto allocation, and those from Japan and Canada might each be about half that (60MtC/yr) in absolute terms. Assuming that Australia and the US remain outside the Protocol, and after taking account of other greenhouse gases and the managed forest allowance, the total demand

Table 8: Supply-demand balance in Kyoto system (MtCeq./yr): limit scenarios

	Historical emissions		Low surplus (High demand, low supply)		High surplus (Low demand, high supply)	
	1990	2000	% change 2000–2010	Carbon balance	% change 2000–2010	Carbon balance
Gross demand				**220**		**53**
EU carbon	911.4	895.5	7	120	–3	30
Japan carbon	305.3	313.7	10	58	–3	17
Canada carbon	128.6	158.0	15	61	0	37
+ Net other GHGs (+5, –5%)				12		–2
– Managed forest allowance				–30		–30
Supply				**331**		**587**
Russia carbon	647.0	450.7	20	106	0	196
Ukraine carbon	191.9	104.5	20	67	0	87
Accession 10 carbon	245.2	146.6	25	45	5	75
Other EITs	87.8	45.4	25	24	0	36
Other GHGs (10, 20%)				24		79
+ Managed forest allowance				40		40
CDM (MtC/yr equiv. in Kyoto period)				15		50
Net surplus				**110**		**530**

from OECD countries might be about 220MtC/yr. Under 'low supply' assumptions, in which emissions from the EITs grow 20%–25% from their levels in year 2000, the total supply from EITs might be about 330MtC/yr, to which a minimum level of CDM investment might add the equivalent of about 15MtC/yr. The result is a surplus of 110MtC/yr—or a total over the 5-year period of 550MtC presumably 'banked' into subsequent commitment periods.

Under the 'high surplus' scenario, in which emissions from the EU and Japan decline 3% below current (2000) levels and Canada stabilizes at 2000 levels, the potential demand (after taking account of the Marrakech forest allowances) is shrunk to only just over 50MtC/yr. If emissions in the EITs follow their emission trend of the last three years—essentially flat at current levels in which economic growth is matched by equivalent gains in energy efficiency—then total availability of allowances from the EITs is

likely to exceed 500MtC/yr. If there is also greater take-up of the CDM, then the potential net surplus could be 550MtC/yr.

These are limiting scenarios that combine extremes in opposite directions, particularly concerning the 'low surplus'. Far more likely is something more central; the actual surplus will probably be in the range 200–450MtC/yr, or 1000–2250MtC total unused from the first Kyoto period. For comparison, US CO_2 emissions in 2000 (and in 2001, in which emissions fell slightly) exceeded the US' original Kyoto allowance by about 300MtC/yr.

PART III: DISCUSSION AND CONCLUSIONS

The Kyoto Protocol stands out primarily for its unprecedented inclusion of a range of international economic instruments. Many of these ideas had been anathema a generation earlier; by the mid-1990s, when the Protocol's core ideas were born, they had become almost hegemonic in economic but not in environmental policy. The Protocol is essentially an agreement to extend economic globalization to environmental policy: to establish a global emissions market to counter the global environmental consequences of global economic growth. A great deal of work remained to be done to determine how such mechanisms might actually work and be governed in the international context, a task that took four years and culminated in the Marrakech Accords agreed at COP7, generally dubbed the 'rulebook for implementing Kyoto'.

Politically, the most striking feature of the Protocol's design is the dominance of the US. The United States got virtually everything it wanted in respect of flexibility for Annex I commitments with the sole exception of 'borrowing' (which, in a different form, was finally embodied as part of the penalties for non-compliance after US withdrawal). The main policy objective of US strategy was to establish flexibility in all dimensions. This was a result of the country's confluence of political interest and economic ideology. Politically (and with good reason), the administration lacked confidence about what measures on CO_2 emissions could be ratified or implemented domestically, and it regarded the ability to meet any commitments through action on other gases, sinks and international mechanisms as a political imperative. Economically, US thinking was dominated by general equilibrium concepts which automatically imply that flexibility achieves

the same environmental benefits at lower costs: hence, the more flexibility the better. That attitude, combined with US political dominance and the relative paucity of counter-arguments, largely determined the outcome of most of the key policy debates. As noted by the author elsewhere, 'to discover the source of most of the ideas in the Protocol, one only needs to read the US proposal of January 1997' (Grubb *et al.*, 1999)—which makes the subsequent developments all the more ironic.

Economic fundamentals

In terms of its basic structure (abstracted from the specific numerical targets of the first period), the *fundamental economic issues* concern not so much the mechanisms, but the interface between uncertainties, technology, and the scope and evolution of commitments. There is no inherent 'right' answer to the issue of timescales. Long term targets would maximise time for adjustment and technological change, but would suffer from huge uncertainty about their political credibility and give no room for learning in the interim. Shorter term commitments give politically plausible signals on timescales of immediate relevance, and allow scope for future commitments to be negotiated and expanded as knowledge accumulates. The balance struck in Kyoto, with a 15-year gap between the point of adoption in Kyoto and the first compliance point in 2012, seems not unreasonable, but its limitations in providing 'bankable' signals for longer term investment are becoming more apparent as time passes.

There are also deeper diverse perspectives about the relationship between targets and technology, and related issues of 'leakage' and longer term strategies. One perspective equates technical change largely with public R&D and proposes to focus on some kind of intergovernmental technology programme; from this perspective, the Kyoto targets are a premature and potentially costly distraction, and moreover subject to 'leakage' of emissions if some industries migrate to countries without emission caps (Barrett, 2001). Most economists, however, remain sceptical about the utility of governments choosing and fostering technologies, and recognise that technical change is to an important degree fostered by market conditions (for a review with reference to modelling, see Grubb, Koehler and Anderson, 2002). From this perspective, the Kyoto targets can be the impetus for investment in low carbon technologies, with the view that as

the associated industries develop the technologies can diffuse globally (aided by Kyoto's CDM and technology transfer provisions, and subsequently by extension of commitments), thus bringing down emissions globally as well.

First period economics

This is one reason why the Kyoto Parties are focusing first upon domestic implementation, with the international mechanisms as a backup to aid compliance, rather than treating Kyoto as a free market. This, combined with the lop-side nature of the initial allocations and the US withdrawal, has precipitated a 'buyers market' and the *first period economics* are subtle and complex. The over-arching role of governments, and the varied interests and mechanisms as sketched in this paper, have several implications. Governments are not cost-minimising agents irrespective of geography: they exist primarily to represent their populations, who would far rather see money spent domestically than abroad, and far rather see it spent on 'good things' than on paper transfers. These are additional reasons why they are likely to be quite discriminating about the emission credits they use, making sure they are derived from projects they consider desirable and legitimate, or are otherwise linked to environmentally acceptable use of revenues. As a result, as explained, there will be considerable price divergence between different mechanisms and projects.

Kyoto may evolve towards greater price consistency over time, but price instability and discrimination between different kinds of emission units may be fundamental features of the early stages especially. As with other historical markets, the 'emissions market' is thus likely to evolve from the bottom-up, albeit in the global context set by Kyoto. The Kyoto/Marrakech Accords simply cannot in themselves set a definitive standard for the international trading of all the units potentially available, for the simple reason that this would lead the whole Kyoto system to collapse under a sea of meaningless paper transactions: the surplus of allowances available could be several hundred MtC/yr. Given the reality of such numbers, it is hard to see how a free and competitive market could emerge in the first period unless the US were to rejoin the system in ways that eliminate the huge supply/demand imbalance—not a prospect that seems likely at present.

Economics of the next step

In considering Kyoto's prospects, it is important to distinguish between the basic structure, and the specific first period allocations. Nearly all the criticisms have focused upon the latter. Obviously, the situation now arising from the first period allocations is neither desirable, nor not what was originally intended, and this has been used to claim the whole approach is flawed (e.g. Victor, 2001).[19] If Kyoto does move to negotiations on a second commitment period, as mandated, there are three reasons for thinking that similar problems would not arise:

- The core problem in the first period allocations (apart from the US withdrawal) concerned allocations to the EITs that have proved excessive. This is a direct consequence of the transition from centrally-planned economies, and would not recur—even most developing countries now operating loosely on market principles, however imperfectly.
- Countries would be immensely better informed and prepare much more carefully, in terms of understanding emission trends both for themselves and for others.
- Second period negotiations would involve deciding allocations not as far ahead as the fifteen-year gap inherent in the Kyoto first period allocation, so the scope for major unexpected deviations would be more limited.

Nevertheless, the potential degree of 'banked' allowances carried forward into the second period would exacerbate the difficulties, and in reality, little progress can be expected on developing country engagement unless and until after the US rejoins in some meaningful way.

Overall, Kyoto can be seen as a potent symbol of intent to control emissions, a basic regulatory framework with initial targets backed by a modest international price signal, and as a vast learning exercise. Through their national reporting requirements and implementation plans, countries are becoming familiar with what can be delivered in terms of emission reductions and the policies involved. Internationally, they are learning the

[19] Note however that Victor's proposed alternative structure is in many ways similar to Kyoto, being also based upon the fundamental core of sequentially negotiated national emission caps with emissions trading. The main differences are that he proposes restricting the system to CO_2 only, rather than the full set of gases, and to OECD countries only in the first instance to avoid many of the uncertainties and institutional difficulties associated with the transition economies.

fundamentals of developing efficient international responses including what is required to make international market instruments work. Whether or not the world draws on this investment—by proceeding to the next big step of negotiating second period allocations—remains to be seen.

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