An assessment of the EU proposal for ceilings on the use of Kyoto flexibility mechanisms

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July 2000

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Abstract

The Kyoto Protocol is the first international environmental agreement that sets legally binding greenhouse gas emissions targets and timetables for Annex I countries. It incorporates emissions trading, joint implementation and the clean development mechanism. Because each of the Articles defining the three flexibility mechanisms carries wording that the use of the mechanism must be supplemental to domestic actions, the supplementarity provisions have been the focus of the international climate change negotiations subsequent to Kyoto. Whether the supplementarity clauses will be translated into a concrete ceiling, and if so, how should a concrete ceiling on the use of the three flexible mechanisms be defined remain to be determined. To date, the European Union (EU) has put forward a proposal for ceilings on the use of these flexibility mechanisms. Given the great policy relevance to the ongoing negotiations on the overall issues of flexibility mechanisms, this paper has provided a quantitative assessment of the implications of the EU ceilings with and without considering the however clause. Our results suggest that such ceilings are less restrictive to the EU than to the US and Japan in terms of levels of restriction on permits imports, and can prevent one third of the amount of hot air from entering the market. Our results also demonstrate that although the US and Japan are firmly opposed to such a restriction, they tend to benefit more from it than the EU which strongly advocates such ceilings, in terms of the reductions in the total abatement costs relative to the no trading case. Moreover, their gains can increase even further, provided that the however clause would operate as intended.

Keywords: Emissions trading; Clean development mechanism; Joint implementation; Greenhouse gases; European Union; Supplementarity restrictions

1. Introduction

In the face of a potentially serious global climate change problem, 158 countries reached an historical agreement on limiting greenhouse gas emissions in December 1997, Kyoto. While the United Nations Framework Convention on Climate Change (UNFCCC) signed at the Earth Summit in June 1992, committed Annex I countries (i.e., the OECD countries and countries with economies in transition. These countries have committed themselves to greenhouse gas emissions targets) to "aim" to stabilize emissions of carbon dioxide (CO_2) and other greenhouse gases at their 1990 levels by 2000, the so-called Kyoto Protocol goes further. It sets legally binding emissions targets for a basket of six greenhouse gases and timetables for these countries. Together, Annex I countries must reduce their emissions of six greenhouse gases by 5.2% below 1990 levels over the commitment period 2008-2012, with the EU, the United States and Japan required to reduce their emissions of such gases by 8%, 7% and 6% respectively (UNFCCC, 1997). The Protocol will become effective once it is ratified by at least 55 parties whose CO_2 emissions represent at least 55% of the total from Annex I Parties in the year 1990.

Climate change is a global problem requiring a global response. Reflecting the underlying principle in Article 3.3 of the UNFCCC, which states "policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost", the Kyoto Protocol incorporates a variety of provisions for flexibility mechanisms through which the costs of abating emissions can be lowered. Article 6 authorizes the transfer or acquisition of emission reduction units (ERUs) from joint implementation (JI) projects among Annex I Parties. Article 12 establishes the so-called clean development mechanism (CDM). Through the mechanism, Annex I countries will be able to obtain the certified emission reductions (CERs) from clean development projects jointly implemented with non-Annex I countries (i.e., developing countries), and use them to count towards meeting their commitments under the Kyoto Protocol. In addition to this two project-based mechanisms, the Kyoto Protocol accepts the concept of emissions trading in principle, under which one Annex B (an annex to the Kyoto Protocol that lists the quantified emission limitation or reduction commitment per Party) country or its sub-national entities (e.g., companies, non-governmental organizations) would be allowed to purchase the rights to emit greenhouse gases (GHG) from other Annex B countries or their regulated entities that are able to cut GHG emissions

below their assigned amounts or their targets. However, designing the rules and procedures governing these mechanisms has been deferred to subsequent conferences. One year later, after two weeks of intense debate at the fourth Conference of the Parties to the UNFCCC held in November 1998, Buenos Aires, delegates adopted the Buenos Aires Plan of Action, an ambitious two-year work programme intended to make the Kyoto Protocol operative (UNFCCC, 1999a). According to the Plan, decisions on rules governing these flexibility mechanisms are to be made in the year 2000 at the latest.

Under the Kyoto Protocol, each of the Articles defining the three flexibility mechanisms carries wording that the use of the mechanism must be supplemental to domestic actions. Article 6 state that emission reduction units from joint implementation projects shall be "supplemental to domestic actions" for the purpose of meeting quantified emission limitation or reduction commitments. Article 12 states that Annex I Parties may use the certified emission reductions from CDM projects to contribute to compliance with "part of their quantified emission limitation and reduction commitments", while Article 17 states that emissions trading shall be "supplemental to domestic actions" for the purpose of meeting quantified emission limitation or reduction commitments. Because the Protocol itself does not define the precise meaning of supplementarity, this leads to the differing interpretations of these provisions. At one extreme, the supplementarity clause could be interpreted as simply meaning that domestic actions should provide the main means of meeting Annex I countries' commitments, so that any action abroad would be additional to domestic actions. At the other extreme, it could be interpreted as meaning that any action abroad will be supplemental to whatever domestic actions are taken (Grubb *et al.*, 1999; Lanchbery, 1998; OECD, 1999). Then the implication is that one Annex I country could use the flexibility mechanisms to meet its Kyoto commitments as much as it wished.

Whether the supplementarity clauses will be translated into a concrete ceiling remains to be seen. If this were a case, supplementarity should be an overall ceiling collectively imposed on all three flexibility mechanisms (Haites, 1998; European Union, 1999). Put another way, the issue of supplementarity should be addressed together for all three flexible mechanisms. There are at least two reasons for this view.

Over-restrictions on one mechanism, such as emissions trading, could lead to a shift to another mechanism, such as the CDM. Unless the Kyoto Protocol is further amended to impose a specific ceiling for each mechanism, it seems to be lack of legal basis to reject the legitimate claim that the three

mechanisms are substitutes in terms of complying with national emissions commitments. In addition, given that it is more costly to establish and monitor heterogeneous CDM projects than homogenous permits, such a shift away from trading to the CDM would provide few incentive for developing countries to take on emissions commitments, a prerequisite for engaging in emissions trading. Without the emissions targets for developing countries, while the CDM can provide an incentive for firms to invest in energy efficient technologies in developing countries, it would likely occur on a smaller scale than what would be anticipated under an emissions target with effective international trading (US Administration, 1998).

If a ceiling were to be imposed on the use of flexibility mechanisms, two questions then arise. First, it raises the question of how to ration available credits when their availability exceeds the demand as constrained by a ceiling. One option is based on a first-come, first-served approach (Tietenberg *et al*., 1999; Dutschke and Michaelowa, 1998). This approach could be implemented by setting a "soft" quota that slowly discounts the carbon credits achieved beyond this point to a minimum of their initial value. Because projects declared first would be fully credited under the approach, this would advance CDM projects as CDM credits can accrue from 2000 onwards. But main problem associated with the approach is that it does not guarantee that a country will meet the ceiling requirement. Another possibility would be to allow banking of credits for the next commitment after the quota is filled (Tietenberg *et al*., 1999; Dutschke and Michaelowa, 1998). These credits would get preference in filling the next quota. As such, projects with long duration would be penalized less.

The second question is how a concrete ceiling itself on the use of the three flexible mechanisms should be defined. To date, there have been many proposals. The most representative is the EU proposal. Documented as the Community Strategy on Climate Change (European Union, 1999), the EU proposal calls for the limits on both buying countries and selling countries. For a buying country, the maximum purchase for GHG emission reduction units via all three flexible mechanisms can not exceed the higher of the following two alternatives:

Alternative 1: 5% of {(its base year emissions multiplied by 5 + its assigned amount)/2};

Alternative 2: 50% of the difference between its annual actual emissions in any year between 1994 and 2002, multiplied by 5, and its assigned amount.

The EU proposal is based on quantities already agreed upon or emissions that will be observed before the proposed restriction becomes applicable (Ellerman and Wing, 2000). The difference between the two alternatives is that the first is based mainly on the Kyoto Protocol's quantified emission limitation or reduction commitments, whereas the second takes the actual emission reduction efforts of buying countries as its basis (*Joint Implementation Quarterly*, June 1999). One reason behind the two alternatives is that industrialized countries whose emissions are already very high on a per capita basis should take the lead in reducing their own emissions so that developing countries are encouraged to follow suit and take on emissions commits at a later date. Another reason has been to urge Annex I countries to stimulate technical innovation domestically by raising marginal abatement costs of buying countries, although it is unclear to what extent a stimulus of increased technical innovation in buying countries would remain. Motivated by alleviating the concern about hot air, the EU proposal also sets the rule for a selling country. Similar to the first alternative for a buying country, the EU proposal specifies that the maximum allowed sale for GHG emission reduction units via all three flexible mechanisms can not exceed the amount calculated by: 5% of {(its base year emissions multiplied by 5 + its assigned amount)/2}, referred to hereafter as Alternative 1. This proposed restriction on transfers provides an indirect way of implementing supplementarity since the higher market price as a result of the restriction on the amount of hot air for sale restricts the acquisitions from what would otherwise have occurred.

Under the EU proposal, "however, the ceiling on net acquisitions and on net transfers can be increased to the extent that an Annex B Party achieves emission reductions larger than the relevant ceiling in the commitment period through domestic action undertaken after 1993, if demonstrated by the Party in a verifiable manner and subject to the expert review process to be developed under Article 8 of the Kyoto Protocol." (European Union, 1999). This is the so-called however clause. It allows an importing (exporting) country to purchase (sell) more than the amount defined by the above alternatives if verifiable domestic abatement by the importing (exporting) country can be demonstrated. Thus, the however clause effectively raises the importing ceiling and allows an importing country to purchase emission reductions from abroad up to 50% of the emission reduction requirement, provided that the country can verify a similar volume of domestic abatement undertaken after 1993.

Given the great policy relevance to the ongoing negotiations on the overall issues of flexibility mechanisms, this paper aims to provide a quantitative assessment of the implications of the EU proposal for concrete ceilings on the use of flexibility mechanisms for the division of abatement actions at home and abroad. In so doing, this study takes the year 2010 as representative of the first commitment period 2008-2012, is based on compilation of the national communications from 35 Annex I countries to the UNFCCC, and covers all six greenhouse gases considered under the Protocol. By taking into account the price effects and the corresponding endogenous responses as well as the however clause, our study goes well beyond the earliest analysis of the EU proposal by Baron *et al.* (1999). It also differs from the analysis by Ellerman and Wing (2000) in that our study starts from the official national communications to the UNFCCC and examines the economic effects both on Annex I countries and on non-Annex I countries. To our knowledge, this is the first study to quantify the implications of the EU proposal on the basis of the individual national communications to the UNFCCC.

2. A quantitative analysis of the EU proposed concrete ceilings

Annex I countries under the United Nations Framework Convention on Climate Change are Australia, Austria, Belgium, Belarus, Bulgaria, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom, and the United States. The Kyoto Protocol to the UNFCCC sets differentiated emissions targets for these Annex I countries between 2008 and 2012, except for Belarus and Turkey, neither of which has ratified the UNFCCC. Thus, in this section, we put the however clause aside and focus on examining the implications of the EU proposal for all the above 35 Annex I countries with emissions targets.

2.1. Annex I countries' GHG emissions in base year and their Kyoto targets and baseline emissions in 2010

In order to quantify the implications of the EU proposed concrete ceilings on both buying and selling countries, we need to determine GHG emissions in the base year and the Kyoto targets in 2010 for each Annex I country.

Let us first determine GHG emissions for each Annex I country in the base year. The base year refers to the year 1990 for all the Annex I countries, except for Bulgaria, Hungary, Poland and Romania. The decision 9/CP.2 allows the four countries to use base years other than 1990: Bulgaria and Romania use 1989 as their base year; Hungary uses the average emissions between 1985 and 1987; and Poland uses 1988 (UNFCCC, 1996). Because emissions were higher prior to 1990, these base year adjustments have given these four countries targets that are less stringent than suggested by Annex B. In accordance with the decision 9/CP.2, Annex I parties were required to submit their second national communications not later than 15 April 1998. At the third session of the Conference of the Parties, the Secretariat was requested to prepare a full compilation and synthesis of the second national communications from Annex I parties. With these information available at the web site of the UNFCCC Secretariat, the first step in essence involves gathering data on inventory of greenhouse gas emissions from the second national communications submitted by Annex I countries (or from an update of the second national communication in the case of the Netherlands, or from the first national communications in the cases of Lithuania, Slovenia and Ukraine) and the corresponding Secretariat's second compilation. For many countries in the Eastern Europe and the former Soviet Union that only provide aggregate emissions of CO_2, CH_4 and N_2O in their inventories, see Zhang (1999) for estimates of their total GHG emissions in 1990.

Let us now turn to the Kyoto target for each Annex I country in 2010. Annex B to the Kyoto Protocol specifies the allowed percentage change from its 1990 level for each Annex I country over the first commitment period 2008-2012. The emissions target is stated in terms of an average over the commitment period of five years, not in terms of a specific year. The multi-year compliance is designed to smooth out the effects of short-term events such as fluctuations in economic performance or certain extreme weather conditions, and to provide Annex I countries with additional flexibility in meeting their targets. This study takes the year 2010 as representative of the first commitment period. As set out in column 5 in Table 1, the emissions targets that are expressed as the percentages relative to the base year

emissions levels vary among Annex I countries, particularly within the European Union following its internal burden sharing of the Kyoto commitments among its member countries. By multiplying each Annex I country's emissions in the base year by one plus its allowed percentage change from its base year emissions level, we can obtain the Kyoto target in 2010 for each Annex I country. As indicated at the bottom of column 5 in Table 1, the Kyoto commitments add up to a reduction of 5.2% below Annex I countries' base year emissions levels.

< Table 1 here>

Once the Protocol enters into force, the emissions targets will become legally binding. Because emissions are expected to continue to rise under the business-as-usual and because the emissions targets will not become binding until the first commitment period, the real reductions must thus be measured against their projected business-as-usual (BAU) or baseline emissions levels over the commitment period. The question then arises: how do GHG emissions evolve over the first commitment period?

In estimating baseline GHG emissions for each Annex I country over the first commitment period, we have drawn projections for GHG emissions in 2010 from most Annex I countries' national communications to the UNFCCC. For Austria, Belgium, Estonia, France, Greece, Hungary, The Netherlands, Poland, Slovenia, and Ukraine whose estimates of aggregate GHG emissions in 2010 are not provided, refer to Zhang (1999) for estimates of their emissions.

For most OECD countries, their Kyoto targets are more stringent than they appear at first glance. As indicated in Table 1, emissions in most OECD countries were on a rising trajectory during the period 1990-96 and are expected to rise under the BAU trends. Relative to their BAU scenarios, the targets imply a reduction of up to 28% for the United States, 23% for Japan, 19% for Canada, and 18% for Australia. For the OECD excluding the EU as a whole, its total GHG emissions in 2010 under the BAU scenario are expected to rise to 2714 million tons of carbon (MtC) equivalent, 25.6% above its allowed level.

When an Annex I country is allocated assigned amounts under the Kyoto Protocol that are below its anticipated emissions in 2010, it has to make up the difference in order to meet its Kyoto target. The difference represents the country's demand for GHG offsets By adding up the demand from the countries

whose emissions targets are below their BAU emissions, the aggregate magnitude of demand for GHG offsets is estimated to be 620.6 MtC equivalent in 2010.

In contrast with countries whose emissions targets are well below their BAU emissions, some countries are allocated assigned amounts under the Kyoto Protocol that exceed their anticipated emissions requirements even in the absence of any limitation. When emissions trading were allowed, these countries would be able to trade these excess emissions to other countries, thus creating the hot air that would otherwise have not occurred. Because the transfer of the hot air does not represent any real emissions reductions by the selling countries, allowing to acquire the surplus from the selling countries to meet the buying countries' commitments makes the total emissions higher than what would be in the absence of emissions trading, although not above the aggregate Kyoto targets. As indicated in Table 1, the hot air problem is acute in the former Soviet Union and Eastern Europe, particularly Russia and Ukraine. The economic transition led to a large decline in their emissions as economies contracted and energy markets were deregulated since the collapse of the Soviet Union. As indicated in Table 1, by 1995 GHG emissions in these countries had declined to 20-46% below their base year levels. Although economies are projected to begin recovering during the period under review, emissions in most countries with economies in transition are expected to remain below their base year levels. For the bloc as a whole, its total GHG emissions in 2010 under the BAU scenario are expected to be 1389 MtC equivalent, 4.5% below its base year level.

2.2. Implications of the EU proposal

Applying the first alternative to each Annex I country, we have calculated the maximum allowed acquisitions in 2010 for those Annex I countries whose emissions targets in 2010 are below their projected BAU emissions. As indicated in Table 2, the aggregate magnitude of acquisitions in 2010 from all three flexibility mechanisms amounts to 170.4 MtC. Expressed as a percentage of the difference between the projected baseline emissions and the targets, this number, on average, is calculated to be 27.5% under the first alternative. For the so-called JUSSCANNZ countries (Japan, the United States, Switzerland, Canada, Australia, Norway, New Zealand), an umbrella group that meets daily during the international climate

change negotiations to exchange information and discuss substance/strategy on issues where there is common ground, the aggregate magnitude of acquisitions in 2010 from all three flexibility mechanisms amounts to 111.5 MtC. Expressed as a percentage of the difference between the projected baseline emissions and the targets, this number, on average, is 20.2% under the first alternative. For the EU as a whole, the corresponding figure in 2010 is 110.4%.

< Table 2 here>

In order to quantify the implications of the second alternative, we need to find the highest annual GHG emissions in any year between 1994 and 2002. To this end, we first examine the emissions data over the period between the base year and 2005, which are documented at the second national communications submitted by Annex I countries (or from the first national communications, in the case of Lithuania and Slovenia) and the corresponding Secretariat's second compilation. We found that the highest GHG emissions appeared in 1994 for Lithuania, in 1995 for Austria, in 1996 for Belgium, Denmark, France, Germany, Greece, Sweden, and United Kingdom. For those Annex I countries whose emissions are on a rising trajectory, we follow the procedure discussed in estimating GHG emissions in 2010, and estimate their emissions in 2002 in most cases by interpolating their projected emissions in 2000 and 2005. Applying the second alternative to each Annex I country, we have then calculated the maximum allowed acquisitions in 2010 for those Annex I countries whose emissions targets are below their BAU emissions. As indicated in Table 2, the aggregate magnitude of acquisitions in 2010 from all three flexibility mechanisms amounts to 230.6 MtC. Expressed as a percentage of the difference between the projected baseline emissions and the targets, this number, on average, is calculated to be 37.2% under the second alternative. For the JUSSCANNZ countries as a whole, the corresponding figures are 189.3 MtC and 34.3% respectively, whereas for the EU as a whole the aggregate magnitude of acquisitions in 2010 is 99.3% of the difference between the projected baseline emissions and the targets.

Comparing the maximum allowed acquisitions in 2010 under the two alternatives, and assuming that countries would wish to use the higher allowed acquisitions in 2010, we can obtain the higher allowed acquisitions in 2010 for each Annex I country's whose emissions targets in 2010 are below its BAU

emissions. The higher allowed acquisitions in 2010 from all three flexibility mechanisms add up to the aggregate magnitude of 261.9 MtC. On average, the number is equivalent to 42.2% of the difference between the projected baseline emissions and the targets in 2010. For the JUSSCANNZ countries as a whole, the corresponding figures are 191.6 MtC and 34.7% respectively, whereas for the EU as a whole the aggregate magnitude of acquisitions in 2010 is 138.6% of the difference between the projected baseline emissions and the targets.

The bottom line of the EU proposal for concrete ceilings is that at least 50% of GHG emissions reductions must be achieved via domestic actions. If this were applied to the Annex I countries as a whole, the EU demand will be met because the aggregate allowed acquisitions in 2010 from all three flexibility mechanisms under the above alternatives are well below 50% of the difference between the projected baseline emissions and the target in 2010. However, the EU proposed restrictions to each country vary, in some case even substantially. Although for major GHG emitters, such as the US and Japan, the second alternative allows for a higher quantity of acquisitions than the first alternative, it is still very restrictive, particularly for the US. Under either of the two alternatives, the US is not allowed to acquire more than one third of the difference between its projected baseline emissions and the target in 2010. This is the intended outcomes of the EU proposal. The outcomes themselves explain why the JUSSCANNZ countries, particularly the US, disagree with the EU proposal.

On the other hand, the EU proposal allows, in percentage terms, some countries, particularly its member countries, to undertake a significant amount of acquisitions. There are at least three reasons for the high figures well above 100%, for example, for the United Kingdom (220%), Germany (280%), Denmark (450%), and France (1266%). The first reason is related to certain extreme weather conditions in some countries, which in turn result in sharp variations in GHG emissions. For example, due to low hydroelectricity available from Norway and Sweden in 1996, Denmark used much more coal, the most carbon-polluting fuel, than what would otherwise have been the case. This led to the large increase in CO_2 emissions in that year. As a result, the difference between its emissions in 1996 and its target in 2010 appears high relative to the gap between its projected baseline emissions and the target in 2010.

The second reason is due to largely unrelated political events or policies of a one-off nature. Because of economies contracting and a shift from coal to natural gas in the former East Germany

following unification and the utility privatization and reform of coal subsidies encouraging a shift from coal to natural gas in the United Kingdom, for Germany and the United Kingdom their projected baseline GHG emissions in 2010 are below emissions in 1990 and their highest annual GHG emissions in any year between 1994 and 2002 appeared in 1996. As a result, the differences between their emissions in 1996 and their targets in 2010 appear high relative to the gaps between their projected baseline emissions and the targets in 2010. This will lead to very high percentages for the two countries under the second alternative.

The third and main reason is related to projected baseline emissions in 2010. The official projections of baseline GHG emissions in 2010 by most EU member countries are very close to their targets. For the EU as a whole, its total GHG emissions in 2010 under the BAU scenario are expected to rise to 1096 MtC equivalent, 2.6% higher than its allowed level. There are at least three reasons for the low EU baseline projections. The first reason is internal burden sharing of the Kyoto commitments among the member countries. The 15 member countries of the EU are each listed with an 8% reduction from 1990 levels in Annex B to the Protocol. In June 1998, the EU Council reached an agreement under which the commitments are redistributed among its member countries under the bubble provision as specified in Article 4 of the Protocol. This will now serve as the basis of EU ratification and the redefined targets in Table 1 will become the "quantified emission limitation and reduction commitments" for each EU member country under the Protocol. Comparing the differentiated targets with the common 8% reduction commitments, we can see that the redistribution of the commitments has allocated more assigned amounts to the countries, whose emissions are expected to rise fast, than their allowed levels under the Protocol. The second reason is related to what is meant by business-as-usual projections. The baseline projections by economic modelling studies do not include the impacts of energy policies that are currently being either implemented or negotiated in response to climate change. By contrast, given that the EU has taken the lead in addressing climate change problem, the baselines projected by its member countries might have already incorporated the intent to limit GHG emissions. By eliminating some projects that would have been carried out anyway and/or subtracting emissions induced by energy subsidies and other market distortions, the EU comes out the baseline projections close to the targets. The third reason is related to the choice of base year. The UNFCCC has used 1990 as the base year. During the period 1990-96, CO_2 emissions rose by 8.4% for the United States, by 14.3% for Japan, and by 9.5% for Australia, whereas the EU CO_2 emissions

rose only by 0.9% (Jefferson, 1997).[1] During the negotiations leading up to Kyoto, there was some discussion of moving forward the base year for all countries to 1995. In the end, efforts to make such a change failed, although a 1995 base year was accepted for the three trace industrial gases whose emissions comprise only a small share of total GHG emissions based on the 100 year global warming potentials for greenhouse gases. The EU high emissions in 1990 base year, combined with expectation for modest growth over the projection period, would put the EU projected emissions in 2010 close to its target. As a result, there are very small discrepancies between their baseline emissions and their targets. Thus, the allowed acquisitions are high relative to the gap between their projected baseline emissions and their targets in 2010. This explains why, in percentage terms, many EU member countries have a significant amount of acquisitions under either of the two alternatives.

Following the same procedure as one in calculating the maximum allowed acquisitions, we have calculated the maximum allowed transfers in 2010 for those Annex I countries whose emissions targets in 2010 are above their projected BAU emissions. As indicated in Table 2, the aggregate magnitude of transfers in 2010 amounts to 70.2 MtC. Expressed as a percentage of the total magnitude of hot air, which amounts to 105.0 MtC as indicated in Table 1, this number, on average, is calculated to be 66.9%. Because of a large decline in GHG emissions in Russia since the collapse of the Soviet Union, and, as discussed earlier, because the official Russian projections of baseline emissions in 2010 are very close to its base year levels, certain percentages of the sum of its base year emissions and the target appear high relative to its size of hot air. This will lead to very high percentage for Russia under the first alternative. For Slovakia, its projected baseline emissions in 2010 are almost the same as its target. It is thus not surprising that its allowed transfers are extremely high relative to the minor size of hot air. In addition, because some EU member countries project their baseline GHG emissions in 2010 below their targets, they appear sellers, although, as discussed earlier, for reasons very different from those for Russia and Ukraine. Depending to a

[1] As indicated in Table 1, Germany and the United Kingdom contributed nearly 30% and 20% of the total GHG emissions in the EU, respectively. Thus, the stagnation in the EU emissions between 1990-96 had been influenced considerably by the substantial decrease in Germany (10% reduction) and the big drop in the United Kingdom (5% reduction). Such a substantial emission drop in Germany is a result of the German unification, which led to not only big emission drops in the former East Germany, but also a sluggish economic growth for the entire, united Germany. As estimated by the German national communication to the UNFCCC, further emission drops in future are well conceivable for Germany, even with recovering economic growth, if its long overdue policy to protect domestic coal is abandoned.

large extent on the differences between their projected baseline emissions and the targets in 2010, some EU member countries appear, in percentage terms, to have a significant amount of transfers.

Now let us summarize the implications of the EU proposal for the division of abatement actions at home and abroad, without considering the however clause. In the first part of this section, the aggregate magnitude of demand for GHG offsets in 2010 has been estimated to be 620.6 MtC. In the second part of the section, we have estimated that the maximum allowed acquisitions in 2010 from all three flexibility mechanisms amount to 261.9 MtC under the EU proposal for concrete ceilings. If the EU proposal were adopted, the remaining amount of 358.7 MtC must be met in 2010 via domestic abatement actions. In addition, because hot air is available at zero abatement cost, hot air is assumed to be used to the full extent. Given that the amount of hot air allowed for sale in 2010 is estimated to be 70.2 MtC, then the maximum net demand for acquisitions in 2010 from all three flexibility mechanisms amounts to 191.7 MtC (261.9 MtC minus 70.2 MtC) under the EU proposal for concrete ceilings.

3. The economic effects of the EU proposed concrete ceilings

In this section, we will examine the economic effects of the EU proposed concrete ceilings both on Annex I countries and on non-Annex I countries. To this end, we have developed the 12-region's marginal abatement cost-based model.[2] The twelve regions considered are given in Table 3. The first six regions are Annex I regions, whereas the other six are non-Annex I regions whose emissions are unconstrained under the Kyoto Protocol.

< Table 3 here>

Using the model, we will examine the following three trading scenarios.

[2] See Zhang (1999, 2000) for a detailed description of the model and other applications of the model.

- No limits scenario: No caps are imposed on the use of all three flexibility mechanisms so that one Annex I country can trade as much as it wished until it becomes more costly for the country to trade than to abate domestically;
- The EU ceilings scenario: Just as the name implies, the scenario follows the EU proposal for concrete ceilings on the use of all three flexibility mechanisms, as discussed in Section 2;
- The however clause scenario: For an importing country, the above EU ceilings are relaxed to the extent that the maximum acquisitions from all three flexibility mechanisms are allowed up to 50% of the difference between projected baseline emissions and the Kyoto targets in 2010, provided that the country can verify a similar volume of domestic abatement undertaken after 1993. For now, we simply assume that such a verification is possible without incurring significant transaction costs. We will briefly discuss this issue in the end of the paper. On the export side, following Ellerman and Wing (2000), we assume that unconstrained countries (those with hot air) would be limited to exporting only the amount of hot air, which is defined by the alternative 1 under the EU proposal.

3.1. Effects on Annex I countries

When there are no limits imposed on the use of flexibility mechanisms, the marginal cost of domestic abatement for each region equalizes, and there is no distinction between the international price and domestic prices. When supplementarity restrictions are imposed on the acquisitions, the purchases of permits are restricted. This will push down the market price. Thus, the international prices of permits are much lower under the two supplementarity scenarios considered here than under no limits scenario (see Table 4). Moreover, binding ceilings lead to a distinction between the international price and domestic prices of buying countries. The lesser extent it is allowed to purchase permits abroad, the higher the autarkic marginal abatement costs, and hence the larger the distinction between the international price and domestic prices. As indicated in Table 4, because the autarkic marginal abatement cost for Japan is highest, the EU proposed restrictions lead to the highest ratio of the domestic price in Japan to the international price of permits. On the other hand, because the official projections of baseline GHG emissions in 2010 by most EU member countries are very close to their targets, the EU only needs to purchase a vey small

amount of permits to meet its targets. As a result, the supplementarity restrictions examined here on the EU are much less severe than on Japan and the US. Consequently, domestic prices for the EU are very close to or even equal the international price of permits when the EU is allowed to purchase more than needed.

< Table 4 here>

In the absence of any restrictions on trading, countries with higher autarkic marginal abatement costs can avoid their undertaking of more costly domestic actions by importing more permits. Given that Japan and the US have the highest autarkic marginal abatement costs, these two countries will meet 95.2% and 81.1% of their emissions reductions required in 2010 by purchasing permits, respectively (see Table 5). As a result, the abatement costs of Japan and the US are cut by 93.1% and 85.2% under the no limits scenario in comparison with the no trading case (see Table 6). By contrast, under the EU ceilings scenario, Japan and the US are required to undertake 55.6% and 67.7% of the emissions reductions required through domestic actions, respectively. Consequently, their gains from emissions trading, namely, the reductions in abatement costs relative to the no emissions trading case, drop to 71.9% and 63.7%, respectively. While Japan and the US depend far more on imports of permits in the absence of the restrictions on trading, the EU abates 71.4% domestically. Thus, the EU achieves only small gains from trading (0.2%). Under the EU ceilings scenario, the EU is allowed to purchase more than needed. Put another way, the ceilings would not bind on the EU. Thus, the EU can benefit from taking otherwise very little domestic actions and generating more permits for sale, thus gaining much more (39.2%) under the EU ceilings scenario than under the no limits scenario. For the Annex I countries as a whole, the EU ceilings mean a requirement to abate 62.5% domestically in comparison with 27.7% under the no limits scenario. As a result, the gains of the OECD from emissions trading decrease from 86.5% under no limits scenario to 66.0% under the EU ceilings scenario (see Table 6).

< Table 5 here>

< Table 6 here>

By definition, the however clause relaxes the above EU ceilings by allowing for the importing countries to purchase up to 50% of the emissions reductions required. As would be expected, the countries with higher autarkic marginal abatement costs will benefit more from this clause. This is confirmed in Table 6, which shows that the gains of Japan and the US increase from 71.9% and 63.7% under the EU ceilings to 76.5% and 79.8% under the however clause scenario, respectively. By contrast, the gains of the EU are cut by over 50%. This is because the restriction under the however clause scenario would become binding on the EU in comparison with the above non-binding restriction under the EU ceilings scenario. Note that the Eastern Europe abates over 50% domestically under the however clause scenario. This is mainly because its low marginal costs allow it to benefit from exporting permits up to the extent that its domestic abatement costs equal the international prices of permits. As a result, the Annex I countries as a whole purchase slightly over 50% of their emissions reductions required.

On the supply side of Annex I countries, the gains of the former Soviet Union are reduced by about 75% under the EU ceilings scenario (see Table 6), in comparison with that under the no limits scenario. This is mainly because the restrictions on the demand side reduce the market price received for its sold permits. Such restrictions are relaxed under the however clause scenario. Thus, its gains rise to 41.3%, which are still less than half of that under the no limits scenario.

3.2. Effects on non-Annex I countries

Given that the EU proposal restricts the total demand for permits and thus reduce the market price of permits, it should thus come as no surprise that such restrictions on the use of flexibility mechanisms are not beneficial to developing countries too because they restrict the total financial flows to developing countries under the CDM as a result of fewer permits sold and lower prices received (see Table 7). Moreover, for the OECD as a whole the however clause is less restrictive than the EU ceilings, and thus allows a significant increase in demand for the certified CDM credits. As a result, the CDM flows under the however clause scenario are 1.4 times higher than under the EU ceilings scenario, although they are still less than half of that under the no limits scenario. With respect to the geographical distribution of the

CDM flows, because of a great deal of low-cost abatement opportunities available in the energy sectors of China and India and their sheer sizes of population, the two countries are expected to emerge as the dominant host countries of CDM projects. This is confirmed in Table 7, which shows that about 60% and 16% of the total CDM flows go to China and India, respectively.

< Table 7 here>

4. Conclusions

At the June 1999 Sessions of the Subsidiary Bodies of the UNFCCC, the EU has put forward a proposal for concrete ceilings on the use of flexibility mechanisms. Given the great policy relevance to the ongoing negotiations on the overall issues of flexibility mechanisms, this paper has provided a quantitative assessment of the implications of the EU ceilings with and without considering the however clause. It takes the year 2010 as representative of the first commitment period 2008-2012, is based on compilation of the national communications from 35 Annex I countries to the UNFCCC, and covers all six greenhouse gases considered under the Protocol.

Our results suggest that if the bottom line of the EU proposal were that at least 50% of GHG emissions reductions must be achieved via domestic actions for the Annex I countries as a whole, the EU demand will be met because the aggregate allowed acquisitions in 2010 from all three flexibility mechanisms under the two alternatives are well below 50% of the difference between the projected baseline emissions and the target in 2010. However, the EU proposed restrictions to each country vary, in some case even substantially. Under either of the two alternatives, the US is not allowed to acquire more than one third of the difference between its projected baseline emissions and the target in 2010. For the JUSSCANNZ countries as a whole, the restriction is 34.7%. On the other hand, the EU proposal allows, in percentage terms, some countries, particularly its member countries, to undertake a significant amount of acquisitions. This can be attributed to certain extreme weather conditions in some countries, largely unrelated political events or policies of a one-off nature, and/or to projected baseline 2010 emissions by

most EU member countries very close to their targets. Moreover, we point out that the low EU baseline projections are attributable in large part to internal burden sharing of the Kyoto commitments among the member countries, having incorporated the impacts of energy policies that are currently being either implemented or negotiated in response to climate change, and to the choice of base year. Furthermore, our results show that the EU proposal restrains one third of the amount of hot air from entering the market.[3]

Using the model based on marginal abatement costs of 12 regions, we have then analyzed the economic effects of the EU proposed concrete ceilings both on Annex I countries and on non-Annex I countries. Such an analysis has clearly shown that although the US and Japan are firmly opposed to such a restriction, they tend to benefit more from it than the EU which strongly advocates such ceilings. On the other hand, the EU benefits much more with such a restriction than without it, whereas the US, Japan and the former Soviet Union are made worse off in comparison with the no limits case. Given that the EU proposal restricts the total demand for permits and thus reduces the market price of permits, it should thus come as no surprise that such restrictions on the use of flexibility mechanisms are not beneficial to developing countries too because they restrict the total financial flows to developing countries under the CDM. Moreover, our results have shown that the EU ceilings with the however clause have the more loosening effects on the US, Japan, the former Soviet Union and developing countries than the EU ceilings without such a clause. However, it should be pointed out that the importance of the clause depends crucially on how well a verification procedure might work in real practice. In this present study, we simply assume ideal conditions that the amount of domestic abatement to be verified could be demonstrated without costs. Consequently, the however clause relaxes the otherwise very restrictive limits on the use of flexibility mechanisms. However, in real practice, because the counterfactual baseline emissions are never actually observed, verifying any domestic abatement that reduces emissions below the counterfactual baseline emissions will be subject to technical and political disputes. This needlessly increases transaction costs. If, as seems likely, the verification procedure in practice falls considerable short of the ideal, then the extent to which the however clause can bring down the cost of meeting the Kyoto commitments will

[3] Restrictions on permits exports will not get rid of any existing excess assigned amounts. These unsold assigned amounts can be carried forward from the first commitment period to the subsequent periods. See Manne and Richels (1999) for an analysis of the relative benefits of banking versus selling in the first commitment period.

become very limited. In the worst case, it could even make the however clause's promise of relief just illusive.

Finally, it should be pointed out that the Kyoto Protocol as it stands now leaves many questions, including rules governing three flexibility mechanisms, open. Thus, it is important to bear in mind that without clear rules on how three flexibility mechanisms will be implemented in practice, our assessment should be understood as tentative.

Acknowledgements

This paper formed part of the presentations at the Asian Development Bank/United Nations Environment Programme's Workshop for Policymakers on the Institutional Design of the Kyoto Protocol Cooperative Implementation Mechanisms, UN Conference Center, Bangkok, 12-14 October 1999; the International Workshop on Enhancing GHG Mitigation through International Cooperative Mechanisms in Asia, Kanagawa, Japan, 26-27 January 2000; China-US Workshop on Economic and Environmental Modeling, Beijing, 5-6 March 2000; the 3rd Biennial Conference of the European Society for Ecological Economics, Vienna, 3-6 May 2000; the 10th Annual Conference of the European Association of Environmental and Resource Economists, Crete, Greece, 30 June – 2 July 2000; and at the Joint Meeting of the Energy Modeling Forum, the International Energy Agency, and the International Energy Workshop, Stanford University, 20-22 June 2000; as well as at a seminar at Tsinghua University, Beijing, 17 March 2000. The author would like to thank participants in the above workshops, conferences and seminar, three anonymous referees, J.R. Bhatt, A. Denny Ellerman, Prodipto Ghosh, Erik Haites, Neha Khanna, Tom Kram, and Naoki Matsuo for useful discussions and comments on an earlier version of the paper. Financial support from the Asian Development Bank is gratefully acknowledged. The views expressed here are those of the author, and do not necessarily reflect the positions of the Asian Development Bank. All errors and omissions are my own.

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Table 1
Annex I countries' GHG emissions in base year, the Kyoto targets and projected baseline emissions in 2010, the demand for offsets and the size of hot air in 2010

	1990	1996	Kyoto target in 2010		Projected emissions in 2010		Demand for offsets in 2010 (MtC)	Hot air in 2010 (MtC)
	Emissions (MtC)	Change from 1990 levels (%)	Emissions (MtC)	Change from 1990 levels (%)	Emissions (MtC)	Difference to Kyoto target (%)		
Non-EU&EIT Annex I Countries	**2298.1**		**2161.9**		**2714.3**	**25.6**		
Australia	113.3	7	122.4	8	144.1	17.8	21.7	
Canada	163.0	12	153.2	-6	182.4	19.1	29.2	
Iceland	0.8	-4	0.9	10	1.0	11.1	0.1	
Japan	337.2	11	317.0	-6	388.2	22.5	71.2	
New Zealand	19.8	3	19.8	0	22.9	15.7	3.1	
Norway	15.0	7	15.2	1	17.3	13.8	2.1	
Switzerland	14.6	0	13.4	-8	14.5	8.2	1.1	
United States	1634.4	9	1520.0	-7	1943.9	27.9	423.9	
European Union	**1159.5**		**1068.0**		**1095.9**	**2.6**		
Austria	21.6	0.5	18.8	-13	20.3	8.5	1.6	
Belgium	37.9	10	35.1	-7.5	41.6	18.5	6.5	
Denmark	19.6	10	15.5	-21	16.6	7.1	1.1	
Finland	19.8	7	19.8	0	18.5	-6.6		1.3
France	151.9	1	151.9	0	152.5	0.4	0.6	
Germany	329.5	-10	260.3	-21	266.9	2.5	6.6	
Greece	28.7	9	35.9	25	32.8	14.3		3.1
Ireland	15.5	5	17.5	13	18.1	3.4	0.6	
Italy	145.2	2	135.8	-6.5	129.6	-4.6		6.2
Luxembourg	3.7	-24	2.7	-28	1.8	-33.3		0.9
Netherlands	60.8	6	57.2	-6	70.6	23.4	13.4	

Portugal	18.6	6	23.6	27	22.4	-5.1		1.2
Spain	82.1	8	94.4	15	98.6	4.4	4.2	
Sweden	18.1	4	18.8	4	20.4	8.5	1.6	
United Kingdom	206.5	-5	180.7	-12.5	185.1	2.4	4.4	
Former Soviet Union	**1113.5**		**1110.7**		**1032.2**	**-7.1**		
Estonia	11.1	-43	10.2	-8	5.5	-46.1		4.7
Latvia	9.7	-46	8.9	-8	5.5	-38.2		3.4
Lithuania	14.0		12.9	-8	13.8	7.0	0.9	
Russia	828.4	-31	828.4	0	793.4	-4.2		35.0
Ukraine	250.3		250.3	0	212.0	-15.3		38.3
Eastern Europe	**368.4**		**342.5**		**358.3**	**4.6**		
Bulgaria	37.1	-36	34.1	-8	37.8	10.9	3.7	
Czech Republic	52.4	-21	48.2	-8	52.9	9.8	4.7	
Hungary	27.8	-24	26.1	-6	28.2	8.0	2.1	
Poland	153.8	-22	144.6	-6	160.3	10.9	15.7	
Romania	72.2	-38	66.4	-8	55.6	-16.3		10.8
Slovakia	19.9	-21	18.3	-8	18.2	-0.5		0.1
Slovenia	5.2		4.8	-8	5.3	10.4	0.5	
Total	**4939.5**		**4683.1**	**-5.2**	**5198.7**	**11.0**	**620.6**	**105.0**

Sources: See Text; Austria (1998); CEC (1999); Estonia (1998); Greece (1997); UNFCCC (1997, 1998, 1999b); VROM (1998); Own calculations.

Table 2
Allowed acquisitions and transfers of GHG emission reduction units under the two EU ceiling alternatives

	GHG emissions in base year (MtC)	Highest annual GHG emissions between 1994 and 2002	Kyoto target in 2010 (MtC)	Baseline GHG emissions minus the target in 2010 (MtC)	Allowed acquisitions in 2010 under Alternative 1		Allowed acquisitions in 2010 under Alternative 2		Maximum acquisitions in 2010		Allowed transfers in 2010 under Alternative 1	
					Volume (MtC)	As % baseline emissions minus the target	Volume (MtC)	As % baseline emissions minus the target	Volume (MtC)	As % baseline emissions minus the target	Volume (MtC)	As % baseline emissions minus the target
Non-EU&EIT Annex I Countries												
Australia	113.3	129.9	122.4	21.7	5.9	27.2%	3.8	17.3%	5.9	27.2%		
Canada	163.0	182.9	153.2	29.2	7.6	27.1%	14.9	50.9%	14.9	50.9%		
Iceland	0.8	0.9	0.9	0.1	0.0	42.5%	0.0	0.0%	0.0	42.5%		
Japan	337.2	380.2	317.0	71.2	16.4	23.0%	31.6	44.4%	31.6	44.4%		
New Zealand	19.8	21.6	19.8	3.1	1.0	31.9%	0.9	29.0%	1.0	31.9%		
Norway	15.0	16.7	15.2	2.1	0.8	36.0%	0.8	35.7%	0.8	36.0%		
Switzerland	14.6	14.7	13.4	1.1	0.7	63.6%	0.6	59.1%	0.7	63.6%		
United States	1634.4	1793.6	1520.0	423.9	78.9	18.6%	136.8	32.3%	136.8	32.3%		
European Union												
Austria	21.6	21.6	18.8	1.6	1.0	63.1%	1.4	87.5%	1.4	87.5%		
Belgium	37.9	41.6	35.1	6.5	1.8	28.1%	3.3	50.0%	3.3	50.0%		
Denmark	19.6	25.4	15.5	1.1	0.9	79.8%	5.0	450.0%	5.0	450.0%		
Finland	19.8		19.8	-1.3							1.0	76.2%
France	151.9	153.2	151.9	0.6	7.6	1265.8%	0.6	108.3%	7.6	1265.8%		
Germany	329.5	297.3	260.3	6.6	14.7	223.4%	18.5	280.3%	18.5	280.3%		
Greece	28.7	30.9	35.9	-3.1							1.6	52.1%
Ireland	15.5	16.9	17.5	0.6	0.8	137.5%	-0.3		0.8	137.5%		
Italy	145.2		135.8	-6.2							7.0	113.3%

Luxembourg	3.7		2.7	-0.9							0.2	17.8%
Netherlands	60.8	66.7	57.2	13.4	3.0	22.0%	4.8	35.4%	4.8	35.4%		
Portugal	18.6		23.6	-1.2							1.1	87.9%
Spain	82.1	93.0	94.4	4.2	4.4	105.1%	-0.7		4.4	105.1%		
Sweden	18.1	19.8	18.8	1.6	0.9	57.7%	0.5	31.3%	0.9	57.7%		
United Kingdom	206.5	195.3	180.7	4.4	9.7	220.0%	7.3	165.9%	9.7	220.0%		
Former Soviet Union												
Estonia	11.1		10.2	-4.7							0.5	11.3%
Latvia	9.7		8.9	-3.4							0.5	13.7%
Lithuania	14.0	12.2	12.9	0.9	0.7	74.7%	-0.4		0.7	74.7%		
Russia	828.4		828.4	-35.0							41.4	118.3%
Ukraine	250.3		250.3	-38.3							12.5	32.7%
Eastern Europe												
Bulgaria	37.1	32.2	34.1	3.7	1.8	48.1%	-0.9		1.8	48.1%		
Czech Republic	52.4	45.9	48.2	4.7	2.5	53.5%	-1.2		2.5	53.5%		
Hungary	27.8	24.2	26.1	2.1	1.3	64.2%	-1.0		1.3	64.2%		
Poland	153.8	140.6	144.6	15.7	7.5	47.5%	-2.0		7.5	47.5%		
Romania	72.2		66.4	-10.8							3.5	32.1%
Slovakia	19.9		18.3	-0.1							1.0	955.0%
Slovenia	5.2	4.5	4.8	0.5	0.3	50.0%	-0.2		0.3	50.0%		
Total	**4939.5**		**4683.1**		**170.4**	**27.5%**	**230.6**	**37.2%**	**261.9**	**42.2%**	**70.2**	**66.9%**

Sources: See Text; Austria (1998); CEC (1999); Estonia (1998); Greece (1997); UNFCCC (1997, 1998, 1999b); VROM (1998); Own calculations.

Table 3
Definitions of countries and regions

Annex I countries and regions	Non-Annex I countries and regions
1. United States	7. Energy Exporting Countries
2. Japan	8. China
3. European Union	9. India
4. Other OECD Countries	10. Dynamic Asian Economies
5. Eastern Europe	11. Brazil
6. Former Soviet Union	12. Rest of the World

Table 4
Autarkic marginal abatement costs in the no trading case, and domestic prices and the international price of permits in 2010 under the three trading scenarios (at 1998 US$ per ton of carbon)

Scenarios	United States	Japan	European Union	Other OECD	Eastern Europe	International price
No emissions trading	160.1	311.8	9.1	33.4	4.5	-
No limits	9.6	9.6	9.6	9.6	9.6	9.6
EU ceilings	79.0	144.3	3.5	9.7	3.5	3.5
However clause	46.3	126.4	6.1	6.2	5.6	5.6

Table 5
The share of domestic abatement actions in 2010 (%)

	No limits	EU ceilings	However clause
US	18.9	67.7	50.0
Japan	4.8	55.6	50.0
EU	71.4	31.5	50.0
Other OECD	59.0	59.3	50.0
Eastern Europe	92.4	51.8	68.7
Annex I total	27.7	62.5	50.8

Table 6
The gains in 2010 under the three trading scenarios (%)[a]

Scenarios	United States	Japan	European Union	Other OECD	OECD	Former Soviet Union
No limits	85.2	93.1	0.2	45.3	86.5	100.0
EU ceilings	63.7	71.9	39.2	70.8	66.0	23.5
However clause	79.8	76.5	16.3	63.9	78.4	41.3

[a] The gains are measured relative to the total abatement costs in the absence of trading for the OECD countries or the total benefits under the no limits scenario for the former Soviet Union.

Table 7
The value of the CDM market and the shares of China and India in 2010 under the three trading scenarios

	No limits	EU ceilings	However clause
CDM market (million US$)	2795.6	456.9	1103.4
of which:			
China	60.3%	59.6%	60.0%
India	15.1%	15.9%	15.5%
Net CDM market (million US$)	1565.0	244.6	603.0
of which:			
China	59.9%	59.2%	59.6%
India	15.5%	16.3%	16.0%