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From small to insignificant

Climate impact of the Kyoto Protocol with and without US

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Sammendrag: USAs president George W. Bush har erklært at han ikke vil be Senatet ratifisere Kyotoprotokollen. I denne kommentaren presenteres derfor noen anslag på virkningene av å gjennomføre Kyotoprotokollen uten deltagelse fra USA. Fordi USA i praksis skulle tatt en ganske stor del av Kyotoprotokollens forpliktelser om utslippsreduksjoner, er konklusjonen at gjennomføring av avtalen uten USA vil medføre betydelig lavere globale utslippsreduksjoner. Den internasjonale kvoteprisen vil bli betydelig lavere dersom USA ikke deltar.

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Abstract: American president George W. Bush has declared that he will not ask the Senate to ratify the Kyoto Protocol. This commentary explores the potential impact of implementing the Kyoto Protocol without the participation of the United States. Because, in practice, the United States would have taken on a relatively large share of the Protocol's abatement commitments, we conclude that implementing the Protocol without the participation of United States will lead to significantly less reductions in global emissions. The international permit price will be considerably lower if the United States does not participate.

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1 Introduction

The Kyoto Protocol, which was negotiated in 1997, requires all industrialized countries to limit their emissions of a basket of six greenhouse gases (or groups of gases) for the period 2008–2012. In all, the agreement requires that the average annual emissions of industrialized countries in the period 2008–2012 not exceed 95 percent of 1990 emissions.

All industrialized countries, including the United States, have signed the agreement. The agreement will not enter into force, however, until it has been ratified by at least 55 countries, and these ratifying countries must have contributed at least 55 percent of the industrialized world's CO_2 emissions in 1990.[1]

President George W. Bush has now made it clear that he does not intend to send the Kyoto Protocol to the Senate for ratification. And irrespective of Bush's position, the Protocol is unlikely to have garnered the necessary 2/3 majority in the Senate to achieve ratification. It thus does not appear as if the United States, despite the signature from the previous administration, wishes to join the effort to bring the Protocol into force.

President Bush's decision has ignited a discussion among the remaining industrialized countries about whether or not to implement the Protocol in the absence of the United States. Because the United States was responsible for "only" 36 percent of the industrialized countries' CO_2 emissions in 1990, the Protocol can – in principle – enter into force without ratification by the United States. This would, however, require virtually all of the other major industrialized countries – including Russia, which was responsible for 17 of the industrialized countries' CO_2 emissions – to ratify the Protocol.

To evaluate the impacts of implementing the Kyoto Protocol without the United States, we have taken our point of departure in a numerical static partial-equilibrium model that integrates energy markets with an international market for emissions trading. The model is used to compare the impacts of the Kyoto Protocol both with and without the participation of the United States. The main results from the model calculations are that, if the Kyoto Protocol is implemented without the participation of the United States, then

- the effect on global emissions will be reduced from small to insignificant, and
- the international permit price will be reduced to one third of what it would have been if the United States had upheld its commitments.

2 Description of the numerical model and dataset

We apply a static partial equilibrium model developed at CICERO (Center for International Climate and Environmental Research – Oslo) that emphasizes the links between the fossil fuel markets and a market for emissions permits under the Kyoto Protocol.[2] The model divides the world into 32 countries and regions. In each country or region, a numeraire good is produced using four inputs: oil, coal, gas, and non-CO_2 climate gases. The three fossil fuels are modeled as substitutes, while the marginal product of non-CO_2 gases is independent of the use of fossil fuels. The assumed production technology yields a linear demand function for all inputs.

There are five markets for fossil fuels: one global oil market, one global coal market, and three regional gas markets (North America, Asia, and Europe including Russia). Furthermore,

[1] Ratification means that the agreement is approved by the country's legislative body.

[2] A more detailed description of the model and some possible impacts of the Kyoto Protocol with the participation of the United States is found in Holtsmark and Mæstad, 2000.

there is an international market for emissions permits across all the industrialized countries with emissions caps under the Kyoto Protocol (Annex B countries). All markets are assumed to be competitive except for the oil market, where it is assumed that OPEC behaves strategically and restricts its oil supply in order to increase the oil price. The model determines equilibrium prices in the fuel markets and the market for emissions permits as well as the different countries' and regions' export and import of fossil fuels and emissions permits.

The model is calibrated to a scenario of the world economy and world energy markets in year 2010. The "business as usual" (BAU) scenario is constructed by taking the *Conventional Wisdom* (CW) scenario developed by the European Commission, 1996, as our baseline. The total growth in emissions from 1990 to 2010 in USA, Annex B countries excluding USA, and in the rest of the world is set to 24, 8, and 50 percent, respectively.

The abatement cost follows implicitly from the formulation of the demand functions and the elasticity of demand for each fuel in each country. There is no consensus in the literature about demand elasticities in fossil fuel markets. Estimates range from –0.15 (Smith *et al.*, 1995) to less than –1.0 (see e.g. Golombek and Bråten, 1994 and Golombek, Hagem and Hoel 1995). For lack of decisive evidence, we have chosen a middle road by assuming average demand elasticities of –0.5 for all fossil fuels. Demand elasticities for oil and coal have, however, been differentiated across countries in order to reflect the different structures of fuel demand in different countries. By using detailed information from the IEA, 1995, the consumption of oil and coal in each country has been divided into two parts, one which is inelastic and one which presumably is more elastic.

Projected producer prices in 2010 are taken directly from the European Commission study (op.cit), except in the case of the gas market, where the study reports only one gas price. We have taken the gas price to be the European gas price, while the other gas prices have been calculated under the assumption that relative gas prices between the three markets will be as projected by the IEA, 1998.

Consumer prices in the BAU scenario are obtained by adding existing fiscal taxes to the producer prices.

As for fuel supply, it is generally recognized that the supply of coal is more elastic than the supply of other fuels. We have followed Golombek and Bråten, 1994, by assuming supply elasticities of 2.0 for coal producers and .75 for both gas producers and competitive oil producers.

3 Calculating emissions reductions with and without the participation of the United States

As mentioned in the introduction, the Kyoto Protocol requires industrialized countries to reduce emissions in the period 2008–2012 by an average of 5 percent in relation to 1990 levels. Given the figures that we have used in this commentary, this would require industrialized countries to reduce their emissions by an average of 12.8 percent from current BAU emissions.[3]

The global emissions reduction resulting from the Protocol will, however, be significantly less. This is because the Kyoto Protocol does not place any restrictions on emissions from developing countries. Emissions from developing countries constituted 45

[3] Emissions for industrialized countries as a whole are expected to increase by 9 percent from 1990 to the first commitment period (2008–2012) if the Protocol is not implemented, that is, under a "business as usual" scenario (BAU).

percent of the global emissions in 1990, and they are expected to increase by 50 percent up to the period 2008–2012 if the Kyoto Protocol does not enter into force. Furthermore, because the Kyoto Protocol will result in a drop in the market price (producer price) of fossil energy, developing countries are expected to increase their emissions even more should the Protocol enter into force (carbon leakage). The model calculations estimate that all in all the global emissions reduction during the first commitment period will be about 5.5 percent, if the United States implements the agreement.

The model calculations predict that the Kyoto Protocol without the United States means that the global emissions will be reduced only by 0.9 percent relative to BAU. The reason that the global effect of the climate agreement becomes so minimal if the United States drops out is related to three conditions. First, US emissions of greenhouse gases made up a large portion of the industrialized countries' emissions in 1990 (32%). Second, in accordance with the Kyoto Protocol, the United States must reduce its emissions by 7 percent, which is higher than the average of 5 percent for the industrialized countries as a whole. Third, the expected increase in BAU emissions in the United States is higher than average for the industrialized countries. If the United States were to uphold its Kyoto commitments, emissions would have been 27 percent lower than in the BAU scenario. The comparable figure for the other industrialized countries is (on average) 3.4 percent.

Thus implementing the Kyoto Protocol without the participation of the United States means that the global impact becomes minimal, both because the United States was responsible for a large share of the industrialized countries' total emissions in 1990, but also because the Kyoto Protocol set particularly stringent abatement requirements for the United States in the period 2008–2012 compared to BAU emissions.

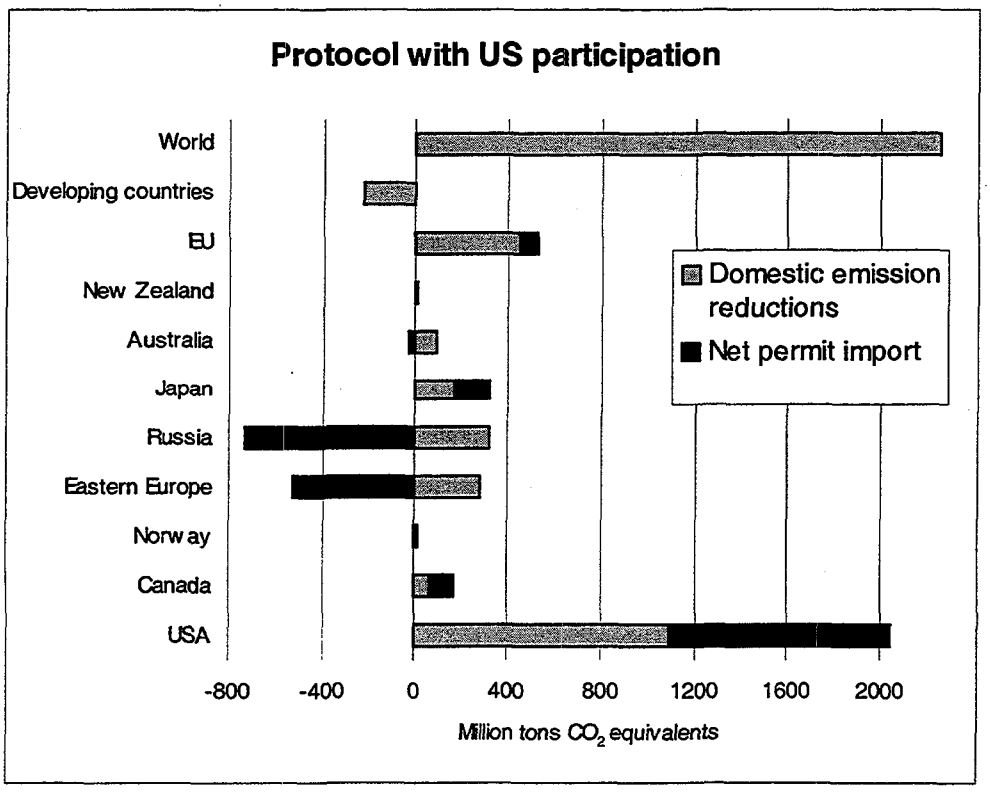

Figure 1: Simulated emissions reductions and flows in the quota market if the United States implements the climate agreement. The black bars on the right hand side represent permit import, while black bars on the left hand side represent permit export.

4 The permit market

The calculations assume that there is unrestricted permit trade between the industrialized countries. The Kyoto Protocol also allows for the industrialized countries to meet some of their commitments by reducing emissions in developing countries through the Clean Development Mechanism (CDM). Because the regulatory framework for the CDM is still under development, it is difficult to estimate how this mechanism will function in practice, and is therefore not incorporated into the model calculations. It is clear, however, that the permit price will be lower if this mechanism is brought into use.

4.1 The permit market with the participation of the United States

Figure 1 illustrates the distribution of emissions reductions and the flows in the quota market given the participation of the United States. With respect to emissions trading, we see that the United States is the main buyer, while Russia and other Eastern European countries are the main sellers. The United States also represents a large portion of the emissions reductions, nearly 1100 million tons[4] of CO_2 equivalents compared to a total global reduction of just under 2300 million tons of CO_2 equivalents in this scenario. The emissions increases that take place in developing countries result from carbon leakage related to the drop in price of fossil fuels. We can also note that the emissions reductions in Russia and the other Eastern European countries are less than the permit export from these countries. This is a case of selling permits without undertaking corresponding domestic reductions and is related to the generous quota allotments for these countries, which allows them to sell hot air.

Here, the permit price is calculated at about USD 15 per ton CO_2.[5]

4.2 The permit market in the absence of the United States

Figure 1 illustrates how important the United States is for the Kyoto Protocol. Without the participation of the United States, a large portion of the emissions reductions is eliminated, at the same time as the demand for quotas on the international market drops dramatically. Figure 2 illustrates the results of the US withdrawal. Global abatement is reduced from 2300 million tons to less than 400 million tons. Even though the participation of the United States would have meant a US abatement of just over 1000 million tons, the withdrawal of the United States means that global emissions will be almost 2000 million tons higher. This is derived clearly from the fact that the quota allocated to the United States is, in this particular scenario, almost 2000 million tons less than the country's BAU emissions. The permits that the United States would have imported now become available to other countries.

The withdrawal of the United States results in the permit price falling from USD 15 per ton CO_2 equivalent to only USD 5. The considerable price drop corresponds well with the picture we have already painted of how important the US emissions cap is to the Kyoto Protocol.

We see that the emissions trading in this scenario is mainly based on hot air. Abatement carried out by the permit exporters in this scenario is far less than the extent of permit export should indicate.

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[4] In this paper, we use "tons" to mean "metric tons."

[5] The literature provides a number of different estimates of quota prices resulting from the Kyoto Protocol. In a special edition of the Energy Journal (see Weyant, 1999), various studies are presented of the impacts of the Kyoto Protocol. The introductory chapter by Weyant and Hill, 1999, compares eleven different models calculations of the quota price in a non-restricted market between Annex B countries. The quota prices vary from USD 7 to USD 61 per ton CO_2. In eight of the model calculations the quota price was under USD 20 per ton CO_2.

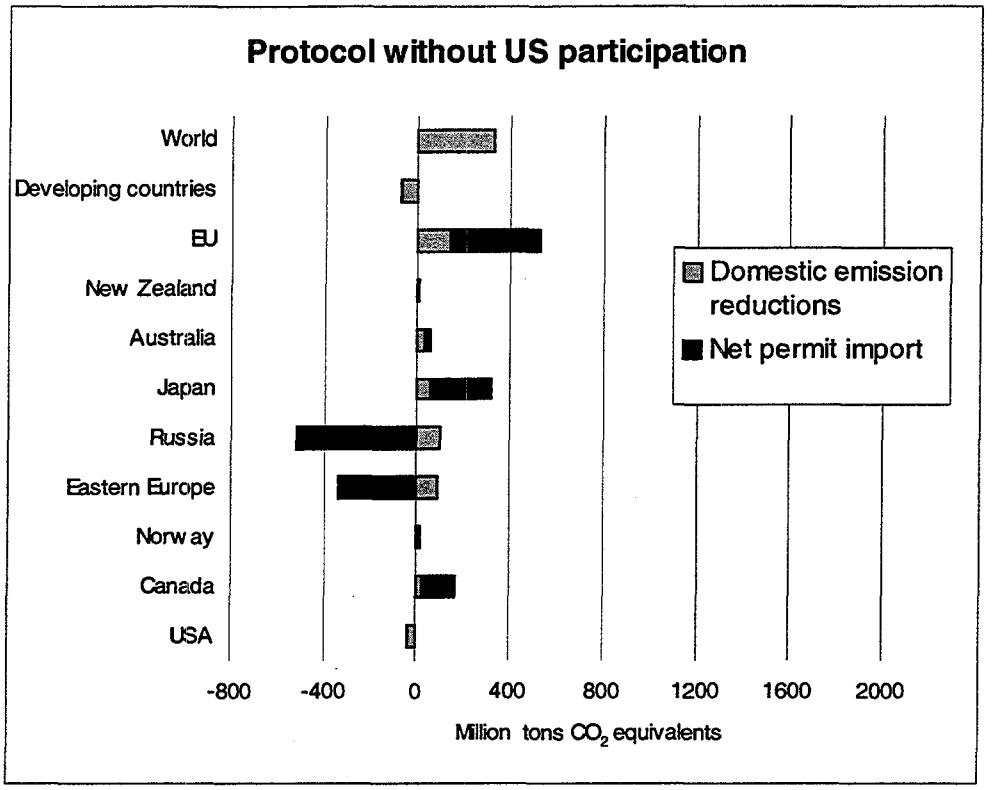

Figure 2: Simulated emissions reductions and flows in the permit market should the United States withdraw from the agreement. The black bars on the right hand side represent permit import, while the black bars on the left hand side represent permit export.

5 Restricted emissions trading

As illustrated by Figure 2, without the participation of the United States, emissions trading will largely be based on hot air. The Kyoto Protocol stipulates that the Parties may participate in emissions trading, but that such trading should be supplementary to domestic abatement measures. EU and other countries favor regulations that would restrict permit sales that do not correspond with domestic abatement. In 1999, the EU Council of Ministers submitted a proposal that would put a ceiling, or cap, on the right to both purchase and sell permits (UNFCCC (1999)). In practice this proposal is unlikely to effectively restrict permit buying. However, it will put effective restrictions on sales of quotas from countries with hot air. [6] It is unclear whether the EU will still wish to uphold this restriction should the Protocol enter into force without the participation of the United States. To evaluate the effects of possible restrictions on the sale of hot air also in an agreement that does not include the United States, we have taken a look at the impact of implementing the EU proposal in the absence of US participation. With the EU proposal, the permit price will jump from USD 5 to USD 16. The resulting 7.3 percent reduction in emissions in Annex B countries, excluding the United States, will contribute to a global emissions reduction of 1.8 percent relative to BAU emissions.

[6] The effect of this is discussed in greater detail in Holtsmark and Mæstad, 2000.

Table 1. Effects of the Kyoto Protocol with and without the participation of the United States

	Permit price (USD/ton CO_2 equivalent)	Emissions reduction in participating countries (in % of BAU)	Global emissions reduction (in % of BAU)
Kyoto Protocol with the United States. Unrestricted trading.	15	12.8	5.5
Kyoto Protocol without the United States. Unrestricted trading.	5	3.7	0.9
Kyoto Protocol without the United States. Restricted trading.	16	7.3	1.8

6 Summary and conclusion

Table 1 summarizes the results. When the United States withdraws from the agreement, calculations show that the permit price drops from USD 15 to USD 5 per ton CO_2 equivalent under unrestricted trading. This dramatic price drop is a clear illustration of much of what has been said about the importance of the participation of the United States to the Kyoto Protocol.

The second and third columns of table 1 show the impact of the Protocol on emissions reductions within participating countries and on global emissions. The emissions reduction is here given in relation to what emissions would be if the Kyoto Protocol does not enter into force (BAU). We can state unequivocally that emissions reductions would be negligible without the participation of the United States, particularly if sales of hot air are not restricted. Whether the Kyoto Protocol should be kept alive or scrapped thus depends on factors other than the direct emissions reductions that would result. The question becomes what is considered to be the optimal policy in the long run. If the global emissions are to be reduced considerably, it is essential to have an agreement that contributes to reducing emissions both from the United States and from the developing countries. The key issue is whether the Kyoto Protocol without the participation of the United States is the best starting point for working toward such an agreement.

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