Emissions Trading, CDM, JI, and More: The Climate Strategy of the EU

Gernot Klepper and Sonja Peterson***

The objective of this paper is to assess the likely allocation effects of the current climate protection strategy as it is laid out in the National Allocation Plans (NAPs) for the European Emissions Trading Scheme (ETS). The multi-regional, multi-sectoral CGE-model DART is used to simulate the effects of the current policies in the year 2012 when the Kyoto targets need to be met. Different scenarios are simulated in order to highlight the effects of the grandfathering of permits to energy-intensive installations, the use of the project-based mechanisms (CDM and JI), and the restriction imposed by the supplementarity criterion.

1. INTRODUCTION

The European Emissions Trading Scheme (ETS) for CO_2 is one of the major components of the European climate strategy for reaching the European Kyoto targets. The ETS that started in January 2005 covers facilities for electricity generation, the production and processing of ferrous and non-ferrous metals, energy intensive activities in the mineral industry and the pulp, paper and board production. These installations are responsible for around 45% of the European CO_2-emissions. Besides trading emission allowances within the trading scheme, a linking between the ETS and the two flexible project mechanisms "Clean Development Mechanism" (CDM) and "Joint Implementation" (JI) has been established. This allows European facilities covered by the ETS to carry out emission-curbing projects in other Annex I countries (JI) and non-Annex

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* Head of Research Department, Environment and Resource Economics, Kiel Institute for World Economics, 24100, Kiel, Germany, Telephone: ++49 431 8814-485, Fax: +49 (0)431-8814-522, E-mail: gernot.klepper@ifw-kiel.de.

** Research Department, Environment and Resource Economics, Kiel Institute for World Economics, 24100, Kiel, Germany, Telephone: ++49 431 8814-406, Fax: +49 (0)431 8814-502, E-mail: sonja.peterson@ifw-kiel.de.

I countries (CDM) and to convert the credits earned into emission allowances under the ETS.

While the ETS guarantees that the emission targets in the ETS sectors are achieved at minimal costs, the efficiency of the overall climate strategy of the EU as well as the efficiency at the level of the European Member States depends crucially on the climate policies introduced outside the ETS. The current system is thus a hybrid system of which the efficiency properties are quite unclear. There are broadly three policy types through which the reduction of greenhouse gas emissions in the Member States can be achieved in order to meet the Kyoto-targets:

1. Domestic CO_2-emission reductions for the energy intensive installations in the ETS
2. Domestic reductions of CO_2-emissions in the sectors not covered by the ETS and reductions of other greenhouse gases (domestic reductions outside the ETS)
3. Emission reductions abroad - mainly through CDM and JI since it is not clear whether international emissions trading will take place within the 1st Kyoto commitment period from 2008-2012.

The third option can be used by firms covered by the ETS as well as by those governments, which have set domestic targets not sufficient to meet the emissions limits of the European Burden Sharing Agreement in the Kyoto Protocol.

The allocation of permits to the ETS is determined in the so-called National Allocation Plans (NAPs), which each member state has to prepare before the beginning of an ETS trading period. For the first trading period from 2005-2007, the final NAPs for all of the EU25 countries are since June 2005 accepted by the European Commission and made public. The NAPs as well as some government programs contain information on the planned government purchase of CDM and JI credits. Some NAPs also indicate the targets for the ETS sectors until 2012. Given this information it is possible to determine how the different EU member states plan to achieve their Kyoto targets in terms of domestic reductions in and outside the ETS and reductions abroad.

Existing simulation studies are based on hypothetical allowance allocations to the ETS and ignore the possibility of using CDM and JI credits within the ETS and by European governments. In contrast, the objective of this paper is to examine the implications of the current NAPs under different assumptions about the use and availability of CDM and JI credits using the DART model (Klepper et al. 2003). DART is a computable general equilibrium model designed for the analysis of international climate policies and calibrated for the enlarged EU. With DART it is possible to simulate the ETS, the CDM and JI market and the domestic action under different assumptions about the functioning of these three markets. Since the Kyoto targets are not binding for the former accession countries, except Slovenia, the focus will be on the EU15.

The paper proceeds as follows. In section 2, we derive the current climate strategy towards the Kyoto targets of the different EU Member States and provide some information on the ETS and the market for CDM and JI. Section 3 and

4 present the DART model, our simulation studies and interpret the simulation results. Section 5 summarizes the findings and draws some conclusions.

2. REACHING THE EUROPEAN KYOTO TARGETS

In this section, we summarize the information available on how the former EU15-countries plan to meet the Kyoto targets by making use of the three options described in the introduction: trading in the ETS, emissions reduction in the Non-ETS sectors and in GHGs other than CO_2, and through purchases of CDM and JI credits. In addition, we give an overview over the potential market for CDM and JI credits and discuss the issue of hot-air.

2.1. The European Climate Strategies

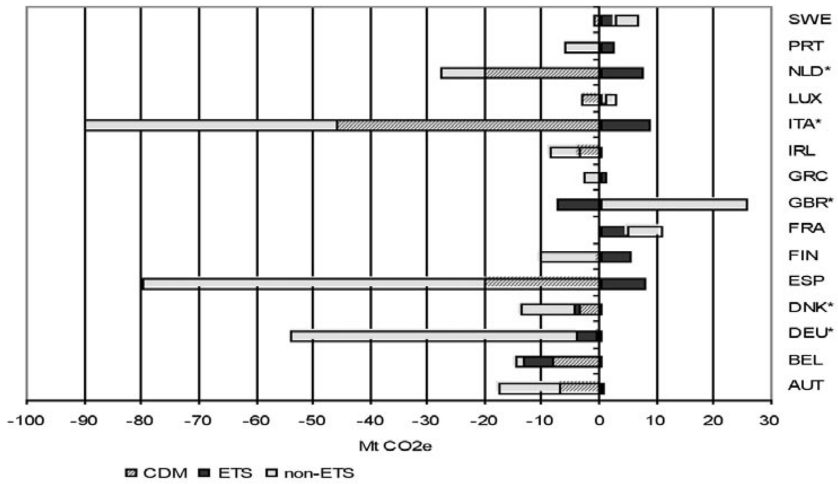
In the Kyoto Protocol from 1997, the EU agreed to cut their overall GHG-emissions relative to the 1990 level by 8% in the period from 2008-2012. In 1998, this target was differentiated between the different member states in the so-called Burden Sharing Agreement giving cohesion member states, such as Spain, Portugal, Ireland and Greece, a lighter burden, compared to richer member states. The (former) accession countries that joined the EU in May 2004 and the countries that are scheduled to join in 2007 are not part of the Burden Sharing Agreement but have their own Kyoto targets.

Since the signing of the Kyoto Protocol, greenhouse gas (GHG) emissions have risen in most of the EU15 Countries, and only few of the countries (Sweden, Great Britain, France and Germany) appear to be on track to fulfill their commitments. With the exception of Slovenia, in all of the (former) accession countries emissions fell drastically since 1990 due to the economic break down of their economies. For these countries, the question is not how and where to reduce emissions, but rather, how much of the excess emission rights (hot-air) they decide to sell on the European ETS market.

The national climate strategies of the EU member states are summarized in the National Allocation Plans (NAP). The NAPs contain information in different detail and with differing time horizons. Table A1 in the Appendix summarizes the relevant information concerning the allocation to the ETS sectors, the emissions of these sectors and the use of CDM and JI. With the help of official data on GHG-emissions, it is possible to derive or estimate the emissions of the ETS and non-ETS sectors in 2002, the allocation to the ETS in 2007, the planned use of CDM and JI and the remaining reductions that have to be achieved to reach the Kyoto targets. Four countries have also indicated the allocation to the ETS in 2012. Germany, the UK, and the Netherlands plan to reduce the ETS-emissions by 1.5 to 2.5% from 2007 to 2012. In Denmark, the reduction is even set to almost 20%.

Figure 1 shows for each of the EU15 states the emission reductions that are necessary to reach the Kyoto target relative to 2002 emissions. All numbers are in megatons of CO_2 equivalent (Mt CO_2e). The dark part of the bars indicates

Figure 1. Climate Strategies in the EU15 According to the NAPs
(* targets for 2012, otherwise targets for 2007)



the reduction (or increase) of the CO_2-emissions of the ETS sectors according to the allowance allocation in the NAPs. Where available, these data are for 2012. In most cases, information is only available until 2007. The striped bars show those reductions that are officially planned to be obtained through CDM and JI projects. These reductions will only be relevant for the first Kyoto commitment period from 2008-12, which also is the second trading period of the ETS. The light bars show the difference between the Kyoto targets and the reductions from the ETS and the state run project mechanisms. These reductions will need to be realized in the sectors other then the ETS installations and with gases not covered by the ETS. This residual can be influenced, of course, if the allocation of allowances in the second ETS trading period or the CDM and JI credits are adjusted accordingly.

According to the numbers shown in Figure 1 only France, the UK and Sweden already meet their Kyoto target in 2002. The UK plans to reduce emissions in the ETS even further, which leaves room for rising emissions in the non-ETS sectors. Even though most countries have to reduce emissions considerably for meeting their Kyoto targets, Portugal, Finland, Denmark, Austria, the Netherlands and Italy allocate allowances to ETS sectors that surpass emissions in 2002. In the remaining countries, emission reductions in the ETS sector also play a minor role given the overall Kyoto target. Only Belgium plans to achieve a major part (about one third) of the reductions necessary for the Kyoto target within the ETS. CDM and JI are also of relatively little importance in most countries. Italy, the Netherlands and Spain plan to make use of these mechanisms most strongly. CDM and JI are also part of the climate strategy in Belgium, Denmark and Ireland. Given these reduction plans, the major burden for domestic reductions falls on the sectors outside the ETS in almost all countries.

Even though the last NAPs for the first trading period have been finalized in June of 2005, the European Emissions Trading Scheme has started in January 2005. There is some evidence that it can indeed generate considerable cost savings (Criqui and Kitous 2003, Klepper and Peterson 2004, Svendson and Vesterdal 2003). Trading prices have started at 8.5€/tCO_2 and have meanwhile gone well beyond 20€/tCO_2.[1] On the other hand, there are estimates for the shadow taxes needed to achieve the necessary reductions outside the ETS reaching 40€/tCO_2 and more (Klepper and Peterson 2004). However, studies have so far only analyzed potential allowance allocation, since the NAPs were not known when the studies were undertaken. They also ignore the possibility of using CDM and JI credits.

2.2. Some Background on CDM and JI

The project-based mechanisms Clean Development Mechanism (CDM) and Joint Implementation (JI) allow Annex I Parties of the Kyoto Protocol to use carbon credits from projects that reduce emissions in other Annex I countries (the JI projects) and in non-Annex I countries (the CDM projects) to fulfill their Kyoto commitments. In the EU, CDM and JI credits can be used by the installations subject to the ETS and by the government for meeting the Kyoto targets.[2]

In the last few years, the global market for carbon credits from project-based mechanisms has been steadily growing (see e.g. Lecocq 2005). The future demand and especially the supply of CDM and JI credits are hard to estimate, not only since institutional issues constitute significant barriers to a more widespread use (Ellis et al. 2004) but also since the role of CDM in the Post-Kyoto period is not yet clear. Furthermore, most top-down simulation studies crucially depend on the assumptions about e.g. available hot-air and total Annex B demand for international carbon credits. Given these uncertainties, current evidence (Haites and Seres 2004, CDM & JI Monitor 2005, Lückge and Peterson 2004) suggests that the minimum supply of CDM and JI credits is around 200 MtCO_2 p.a. and that it seems unlikely that it will be far above 600 MtCO_2 p.a.

Prices for CDM and JI credits range from 2.5 to 15 €/tCO_2e (Lecocq 2004, Ellis et al. 2004, CDM & JI Monitor 2005). A problem for deriving prices, e.g. from a simulation model, is the existence of transaction costs for CDM and JI projects. These can range from a few €-cent per tCO_2e up to more than 1000 €/tCO_2e depending on the project size and type. There is evidence that transaction costs should not be more than 25% of proceeds from permit sales in order to make a project viable (Michaelowa et al. 2003). At current credit prices this would give a cost threshold of roughly 1 to 3 €/tCO_2e.

An important influence for the demand for CDM and JI credits is the so-called supplementarity requirement. As laid out in the Marrakech Accords to

1. For current trends see e.g. www.pointcarbon.com

2. The EU Linking Directive allows an unrestricted use of CDM and JI credits within the ETS. Governments though, are required to consider the issue of supplementarity (see below) and can set limits for the use of CDM and JI.

the Kyoto Protocol "the use of the mechanisms [International Emissions Trading, CDM, JI] shall be supplemental to domestic action and that domestic action shall thus constitute a significant effort […]". It was in fact the EU that insisted on the inclusion of this requirement and also unsuccessfully pressed for a limit implying that not more than roughly 50% of the reduction should be imported (see Langrock and Sterk 2004 for a detailed discussion). Table A1 in the appendix includes the calculations of the EU for the maximum amount of credits that are allowed based on the above-mentioned definition.

2.3. The Role of Hot-Air

In addition to the project-based mechanism, the Kyoto-Protocol allows the transfer of AAUs (Assigned Amount Units under the Kyoto Protocol) between Annex B countries. As far as trade between countries with a binding cap is concerned, this option is of minor importance since the project credits are perfect substitutes and can in many cases be obtained at lower prices. This is not the case for countries, which do have a cap that is above their expected business-as-usual emissions in 2012. These excess emission rights are called hot-air. The countries with hot-air are mainly the countries of the Former Soviet Union and to a smaller degree the Eastern European countries. In an extreme scenario where these countries sell all their hot-air, most models, including DART (Klepper and Peterson 2003) predict that the excess supply of allowances is so large that the carbon price falls to zero. Thus, the Kyoto targets can be reached at zero cost, however without any emission reduction in the Annex B countries. Such a scenario is not very likely though. Different studies have estimated that it is optimal for the hot-air countries to restrict their sales of hot-air to around 40% (Haites and Seres 2004, Klepper and Peterson 2003). If some of the hot-air is supplied on the market, the use of CDM and JI credits will be reduced and international carbon prices will fall.

The role of this Kyoto-trading for the ETS is rather limited since AAUs cannot be used by installations inside the ETS. In addition, the governments of the member states have committed themselves to a strict definition of supplementarity and have opposed the use of hot-air for achieving the Kyoto-targets. Hot-air is therefore not considered in this paper.

3. SIMULATING THE ETS AND THE ROLE OF CDM AND JI

To assess the effects of the current NAPs and the potential role of CDM and JI credits for the European Union, we use the DART-model (Klepper et al. 2003). After a short characterization of the model we derive the policy scenarios used in this simulation study.

3.1. The DART Model

The DART (Dynamic Applied Regional Trade) Model is a multi-region, multi-sector recursive dynamic CGE-model of the world economy. For the

Table 1. Regions in DART

European Union			
AUT	Austria	IRE	Ireland
BEN	Belgium, Luxembourg	ITA	Italy
DEU	Germany	NED	Netherlands
DNK	Denmark	PRT	Portugal
ESP	Spain	SWE	Sweden
FIN	Finland	UK	United Kingdom
FRA	France	HUN	Hungary
GRC	Greece	POL	Poland
XCE*	Bulgaria, Czech Republic, Rumania, Slovakia, Slovenia		
Other Annex B Countries		**Non-Annex B Countries**	
USA	United States of America	MEA	Middle East, North Africa
AUS	Australia	LAM	Latin America
FSU*	Former Soviet Union	CPA	China, Hong-Kong
OAB	Rest Annex B (Canada, Iceland, Japan, New Zealand, Norway, Switzerland)	IND	India

*XCE includes Bulgaria and Romania for which the accession in 2007 is planned. It excludes the Baltic Countries, which are aggregated in region FSU, as well as Malta and Cyprus, which are aggregated in region ROW. This is due to the regional disaggregation of the GTAP5 data set. This inconsistency has only a small effect since it distorts CO_2-emissions of ACC by less than 5%.

Table 2. Sector Structure of the Economies

ETS-sectors		**Other sectors**	
OIL	Refined Oil Products	COL	Coal Extraction
EGW	Electricity	GAS	Natural Gas Production & Distribution
IMS	Iron, Metal, Steel	CRU	Crude Oil
PPP	Pulp & Paper Products	CEP	Chemical Products
		AGR	Agricultural Products
		TRN	Transport Industries
		MOB	Transportation Services
		OTH	Other Manufactures & Services

simulation of the European ETS, it is calibrated to an aggregation of 26 regions. Table 1 lists the 17 countries or group of countries of the EU including the accession countries of Eastern Europe and nine other world regions that represent the rest of the world. In each region or country, the economy is disaggregated into 12 sectors (Table 2). Four of these sectors participate in the ETS. Although there is no perfect match between the installations subject to the ETS and the sectoral structure of DART, the deviations are relatively small.

The economy in each region is modeled as a competitive economy with flexible prices and market clearing. There exist three types of agents: a representative consumer, a representative producer in each sector, and regional governments. All regions are connected through bilateral trade flows. The DART-model has a recursive-dynamic structure solving for a sequence of static one-period equilibria. The major exogenous drivers are the rate of productivity growth, the savings rate, the rate of change of the population, and the change in human capital.

The model is calibrated to the GTAP5 database that represents production and trade data for 1997. The elasticities of substitution for the energy goods coal, gas, and crude oil are calibrated in such a way as to reproduce the emission projections of the EIA (EIA 2002). For a more detailed description of the DART model, see Springer (2002) or Klepper et al. (2003).

3.2. Policy Scenarios for the ETS

For assessing the likely impact of the recently introduced emissions trading scheme and project-based mechanisms, a "business-as-usual" (BAU) reference scenario is determined. This BAU scenario includes the climate policy measures introduced until the year 2002. Hence, it includes the impact of policies such as the German eco-tax or the national emissions trading schemes. From 2003 on, BAU keeps these policies in place but does not include any new climate policies. The implications of the BAU scenario for the NAP targets are discussed in section 4.1. The BAU scenario is then compared to several policy scenarios with which an assessment of the mix of current policies can be made.

The first scenario (NoCDM) consists of simulating the impact of the NAPs and the European ETS without the use of CDM and JI credits. The targets in the non-ETS sectors are reached by a uniform, but regionally differentiated CO_2-tax. This scenario helps to illustrate how the burden of the Kyoto targets is distributed between the ETS and the non-ETS in the different national NAPs. It also serves as a reference for the impact of the project based mechanisms.

The second scenario (LimCDM) is designed to capture the national climate policies with respect to CO_2 based on both the ETS and the project-based mechanisms. It incorporates the governmental plans concerning CDM and JI credits as far as they have been made public. Thus, there is no restriction for the use of CDM and JI in the ETS, while the national governments only import limited amounts of CDM and JI credits. Furthermore, we assume that all CDM and JI projects are associated with transaction cost of 3 €/tCO_2 which is above the estimated long run transaction costs of around 1€/tCO_2 but far below the transaction costs in some of the smaller projects. Further assumptions, e.g. concerning the CDM and JI demand from the remaining Annex B countries, are described in the Appendix. Scenario LimCDM illustrates the contribution of the project-based mechanism to the Kyoto targets given the ETS within the EU. The results of both scenarios NoCDM and LimCDM are discussed in section 4.2.

The third scenario (NoLim) derives the optimal solution by letting the ETS work without restrictions and by allowing all sectors the use of CDM and

JI credits to the degree they wish. Finally, in the last scenario (SUP) the optimal emission reductions and CDM/JI purchases for the non-ETS and ETS sectors are restricted by the supplementarity requirements in each region. All scenarios and their assumptions are explained in detail in the Appendix.

4. SIMULATION RESULTS

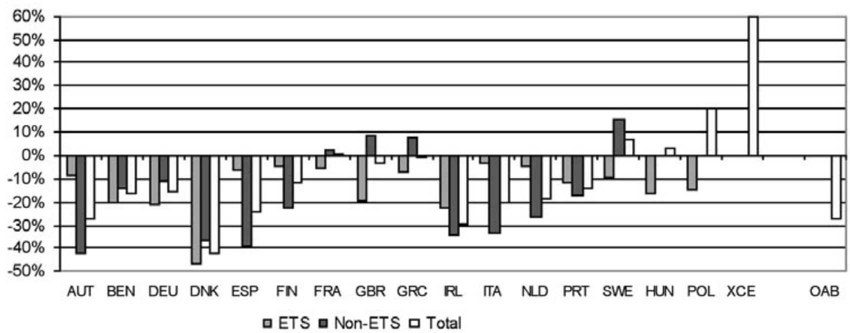
The simulation results for the different scenarios are derived from running the DART-model over the entire period from 1997 to 2012 when the Kyoto targets will be binding. In order not to overload the presentation we display only the results for 2012 in the subsequent figures and tables. All prices are denoted in EUROS of the year 2000.

4.1. Implications of the BAU Scenario

Whereas Figure 1 presents the necessary reductions of CO_2-emissions relative to the emissions in 2002, the reduction requirements should actually be determined by computing the difference between the BAU-emissions in 2012 and the emission caps of that year as given by the Burden Sharing Agreement of the EU. Figure 2 illustrates these results. For each country/region the necessary reduction relative to BAU are decomposed into those within the ETS and those outside the ETS. In addition, the overall reduction requirements between 2002 and 2012 are shown.

Since the emissions of the ETS sectors grow faster than the emissions of the non-ETS sectors in the BAU scenario, the targets from the NAPs imply that considerable reduction efforts in the ETS sectors are needed in order to meet the targets in 2012. Nevertheless, the reduction requirements in the non-ETS sectors are in most cases larger than in the ETS. It is therefore likely that the NAPs create an imbalance in the allocation of the Kyoto targets to the ETS sectors and those outside the ETS. This is analyzed in the following sections.

Figure 2. CO_2-Reduction Necessary to Meet the Kyoto Targets Relative to BAU in 2012



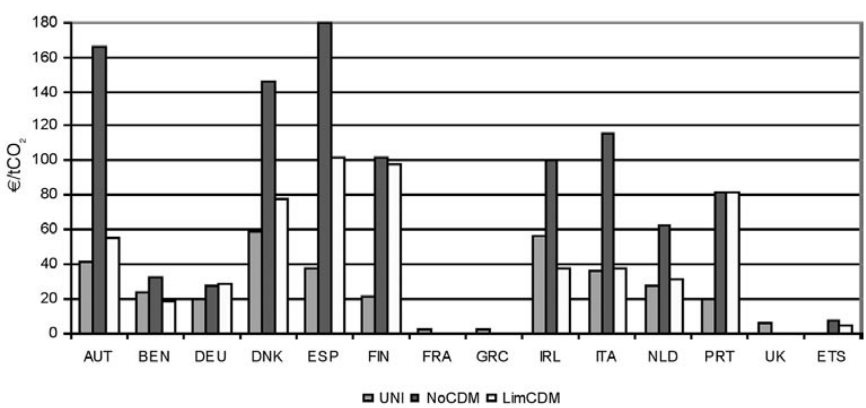
4.2. The Effects of the ETS with and without CDM and JI

The first simulations of the scenarios NoCDM and LimCDM (see section 3.2) analyze the effects of current NAPs and the role of CDM and JI. Scenario NoCDM looks at the outcome of the climate policy measures laid out in the National Allocation Plans (NAP) but leaves the project-based mechanism outside the system. There is emissions trading within the ETS and it is assumed that each government imposes an emission tax on all emissions outside the ETS at a level that makes sure that the Kyoto target is met. Scenario LimCDM keeps these assumptions but includes the option to engage in CDM and JI projects. Installations in the ETS are allowed to buy any quantity of credits they wish, while the governments buy only the amount of credits they have announced.

Whereas the ETS by itself is efficient since it equalizes marginal abatement costs in the energy intensive sectors across countries, distortions can still occur between the ETS-sectors and the rest of the economy within each country. The degree of that distortion, of course, depends on the amount of allowances allocated to the ETS relative to the Kyoto target and the underlying marginal abatement costs in the different sectors of the economy. Figure 3 illustrates this by displaying – for both scenarios NoCDM and LimCDM – the permit price (denoted by ETS) and the implicit tax for the emissions outside the ETS. In order to illustrate the distortions imposed by the generous allocation of allowances to the ETS, Figure 3 also shows in the light gray bars (denoted UNI) the marginal abatement costs (implicit tax) if each country were to meet its Kyoto target unilaterally. This illustrates how the burden of the abatement costs is distributed between the sectors in each member state.

It turns out that in the unilateral scenario the implicit taxes vary between 5 €/t CO_2 in France and Greece and around 60 €/tCO_2 in Denmark and Ireland.

Figure 3. Taxes and Allowance Prices in the Different Scenarios



The emission weighted average tax in the EU15 is around 20 €/tCO_2. This indicates both strongly varying reduction requirements in the EU15 member countries and a significant potential for welfare gains across member states through emissions trading.

The NoCDM scenario results in an equilibrium allowance price of 7.9 €/tCO_2. This low permit price is partly due to the efficiency gains from trading but also due to the generous allocation of allowances to the ETS. It is therefore not surprising that the implicit taxes outside the ETS rise far above the unilateral scenario UNI. In fact, the emission weighted average tax outside the ETS is 57.4 €/tCO_2, but reaches extremely high levels in countries like Austria, Denmark and Spain.

Some of these distortions can be alleviated through CDM and JI activities. The project-based mechanisms allow governments to relieve the pressure that is imposed on the non-ETS sectors by the generous allocation of emission allowances to the ETS. The average implicit carbon price in these sectors thus falls to 33.1 €/tCO_2. CMD and JI also lower the allowance prices within the ETS to 5.7 €/tCO_2 since cheap CDM and JI credits can be bought from companies in the ETS as well. CDM and JI thus reduce the inefficiencies imposed by the NAPs and narrow the gap between the allowance price in the ETS and the implicit taxes in the non-ETS sectors. This is especially true for those countries that plan to make considerable use of CDM and JI credits. Austria, Denmark, Belgium, Spain, Ireland, the Netherlands and Italy can reduce the marginal abatement cost in the non-ETS sectors by 40 to 70% compared to the NoCDM scenario. Where the governments only plan minor (or even zero) purchases of CDM and JI credits, the implicit taxes are not much affected. Altogether, the limited use of the project-based mechanisms still leaves implicit taxes in the non-ETS sectors at levels between 20 and 100 €/tCO_2, compared to the allowance price of 5.7 €/tCO_2. In addition, substantial differences in marginal abatement costs between countries remain in the non-ETS sectors.

Figure 4 shows the resulting welfare costs of the three scenarios UNI, NoCDM and LimCDM. Whereas a unilateral achievement of the Kyoto targets[3] would lead to an average welfare loss of 0.7% in the EU15, this loss rises to 1.8% when the ETS is introduced without using CDM and JI. This illustrates the trade off between efficiency gains through trading among member states and the intersectoral distortions within each economy. The efficiency gains from the ETS are apparently netted out for many countries by the distortions imposed by the inefficient allocation of internal caps to the ETS and non-ETS-sectors. A comparison of Figure 3 with Figure 4 supports this. Countries with a large divergence between allowance price and implicit tax in the non-ETS sectors, such as Austria, Spain, and Italy experience a strong negative welfare effect through the ETS. In contrast, the ETS-sectors in France, Greece and the UK are more restricted than the non-ETS sectors, but due to the low level of restrictions the welfare effects are negligible. There is one country where the efficiency gains

3. With an efficient emission tax which, of course, does not reflect actual policies in the member states.

from the ETS outweigh the distortions from different marginal abatement costs, that is Denmark. The implicit tax in the unilateral scenario is 60 €/t CO_2 whereas the allowance price in ETS is less than 10 €/t CO_2. Denmark apparently benefits so strongly from trading that the distortions between sectors are outweighed by the low abatement opportunities in the rest of the EU.

The distortions imposed by the NAPs of the ETS can be alleviated by using credits from CDM and JI projects. The overall welfare costs of the LimCDM scenario in the EU are cut by more than half and fall to the level in the UNI scenario. Those countries that plan to acquire the largest amounts of CDM and JI credits can best reduce the negative welfare effects imposed by the NAPs. This is most obvious in Italy, Spain and the Netherlands that plan to acquire 20 to 50 $MtCO_2$ from CDM and JI projects p.a. As a result, Italy is even better off in LimCDM than under unilateral efficient action.

The trade with emission allowances in the ETS under the current NAPs turns out to be quite different from those that were expected by applying the allocation rules proposed by the EU Commission and which have been analyzed in Klepper and Peterson (2004).[4] While under the least-cost orientated emission targets the ETS turned out to be a rather lopsided affair in the sense that the accession countries would be the only exporters of allowances, Figure 5 shows for the comparable scenario NoCDM without the use of CDM and JI, that under the current NAPs nine of the EU15-countries become exporters as well.

While the exports of Austria, Finland, Portugal and Sweden would be negligible, France, Greece, the Netherlands, Italy and Spain would export 2 to 9 $MtCO_2$ in 2012. This is partly the case because these countries are close to meeting their Kyoto targets (France, Greece), but partly because of the generous allocation of allowances in the NAPs of The Netherlands, Italy and Spain that allow emissions in the ETS sectors to rise. Nevertheless, the main exporters of allowances are still the Eastern European countries.

Figure 5 shows the trade in allowances in absolute quantities and thus the size of a country dominates trade flows. For example, Germany's ETS sectors account for almost one quarter of the total European trading scheme. Hence, Germany is the largest importer with imports of around 50 $MtCO_2$ in 2012, followed by the UK with around 25 $MtCO_2$. This picture changes when one looks at the import shares of allowances relative to total emissions. Denmark and Ireland are – relative to their emissions – the largest importers with 38% and 19% of the emissions of the ETS sectors being covered by imported allowances. The ETS sectors in Germany and the UK import allowances for around 11% of their emissions.

Figure 6 illustrates where the supply of CDM and JI credits comes from. The worldwide trade flows are simulated with the scenario LimCDM. For better readability, the CDM and JI purchases of the EU15 are aggregated. Altogether,

4. Some differences also stem from the fact that in Klepper and Peterson (2004) some EU regions were aggregated. Also, the targets now account for reductions in other GHG, which was not the case in Klepper and Peterson (2004).

Figure 4. Welfare Effects Relative to BAU in the Different Scenarios

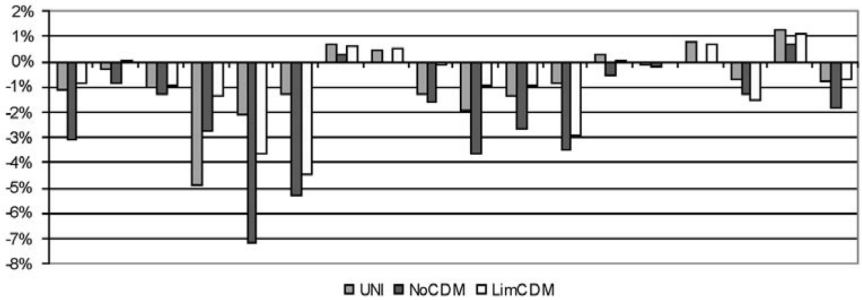
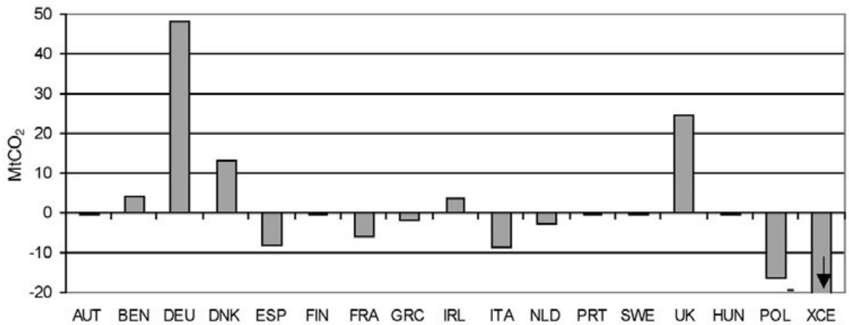


Figure 5. Trade in Allowances (Scenario NoCDM)



the EU15-countries acquire 238 $MtCO_2$ through CDM and JI projects. The region OAB (other Annex B countries that have ratified the Kyoto Protocol) are restricted to a maximum of purchases of another 200 $MtCO_2$. This is a little more then 50% of the reductions relative to the BAU-emission in 2012 that are necessary to reach the Kyoto target and thus an upper estimate of the supplementarity requirement.

The host-countries of CDM projects are China (with 63% of the CDM allowances), followed by the FSU, India and MEA who are responsible for around 8 to 15% of the worldwide supply.[5] Altogether, the size of the CDM and JI market is within the range of estimates presented in section 2.2. However, the distribution of CDM projects across developing countries does not reflect the currently planned projects that are mainly located in Latin America, while only few projects are hosted by China and India (Lückge and Peterson 2004).

5. Such results from top-down models are highly dependent on key assumptions (see section 2.2.). A recent study by the World Bank (2004) that is concerned with the CDM market in China finds a CDM market of only 164 $MtCO_2$ in 2010, again with a Chinese share of 50%. Sensitivity analysis though showed a Chinese CDM potential between 0 and 211 $MtCO_2$ at prices from 0 to 7.3 $/$tCO_2$. In addition, the study applied a bottom-up technology model, which identified a carbon reduction potential of 769 $MtCO_2$/year in the $13.60/$tCO_2$ range for China.

Figure 6. Sales and Purchases of CDM and JI Credits in LimCDM

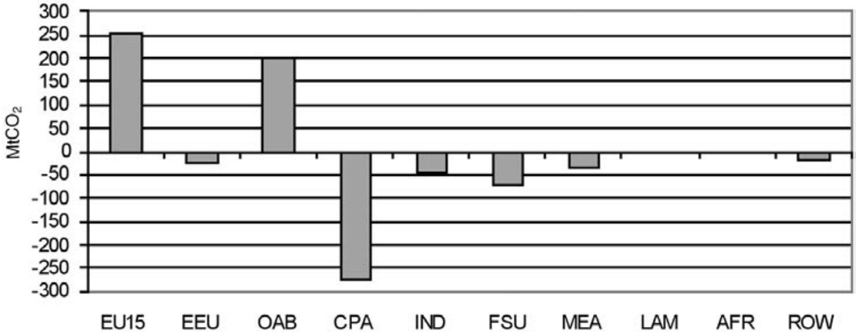


Figure 7. JI, CDM and ETS Credit Flows in the EU in LimCDM

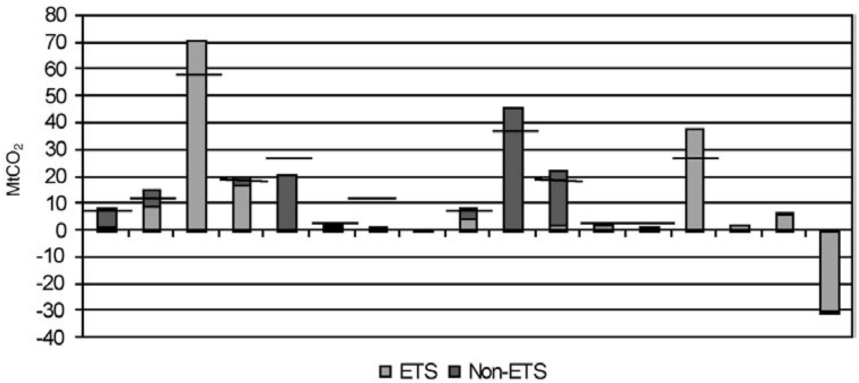


Figure 7 shows the allowance flows in the EU in more detail. Negative bars for the ETS sectors indicate that these sectors would sell allowances within the ETS. This is true only for the ETS sectors in the Rest of Eastern Europe (XCE) and Italy. Positive bars for the ETS sectors indicate that these sectors buy allowances, either within the ETS or as credits from CDM and JI projects. The sales inside the ETS are rather small (around 31 $MtCO_2$), most of the allowances (around 125 $MtCO_2$) originate from CDM and JI projects. The ranking of buyers remains quite the same as in the scenario NoCDM without CDM and JI, only that due to cheap CDM and JI credits all countries except Italy and the rest of Eastern Europe become importers of credits.

Negative bars for the non-ETS sectors stand for JI projects in Annex B countries. Only 0.7 $MtCO_2$ JI reductions would be undertaken in Eastern Europe. This is due to the cheap abatement opportunities in the developing countries and sensitive to the level of transaction costs associated with the project-based mechanisms. The positive non-ETS bars finally show the governmental purchases of CDM and JI credits as announced in the NAPs (altogether around 112 $MtCO_2$).

As discussed in section 2.2, the Kyoto Protocol requires that the use of CDM and JI shall be supplemental to domestic action. The EU has voted for a strict definition of this supplementarity criterion, and continues to stress its importance. It is thus an interesting question how the CDM and JI purchases shown in Figure 7 compare to the limits set by the supplementarity requirement. For this reason, estimates of these limits (as calculated by the EU, see section 2.2) are added as horizontal lines.

Figure 7 shows that there is little need to further restrict the CDM and JI purchases in the ETS in order to stay within the limits of the supplementarity criterion in most countries. The limits are exceeded in Italy and The Netherlands where the governments plan to acquire large amounts of CDM and JI credits. The only countries that might have to significantly restrict their ETS sectors in the use of CDM and JI are Germany and the UK. On the other hand, there is almost no potential for larger government purchases of CDM and JI credits. Overall, most countries come close to the supplementarity limit with the given plans to purchase CDM and JI credits and without controlling their ETS-sectors.

Altogether three main conclusions can be drawn from these scenarios:

1. The project-based mechanism lead to some cost savings compared to a situation without emission reductions abroad.
2. The current hybrid European climate strategy is not efficient since it drives a large wedge between the marginal abatement cost in the ETS sectors (given by the allowance price) and the marginal abatement costs in the non-ETS sectors (given by the implicit tax necessary to reach the overall Kyoto targets).
3. In most countries staying within the supplementarity criterion would not allow to close this wedge by additional governmental purchases of CDM and JI credits, at least not without restricting the use of those credits for the ETS sectors.

4.3. Making Optimal Use of CDM and JI

In the last section, it was illustrated that even a restricted use of CDM and JI can reduce the costs of meeting the European Kyoto targets considerably. In this section we remove the restriction on the governmental use of the project based mechanisms and also ignore the supplementarity requirements to analyze the cost minimizing use of CDM and JI in the scenario denoted NoLim.

In this case, the unrestricted use of CDM and JI throughout Europe leads to an equalization of carbon prices worldwide. Thus, the wedge between the implicit tax in the non-ETS sectors and the allowance price in the EU ETS is closed. The only exceptions are those countries that do not need to reduce emissions in the non-ETS sectors, which are the UK, France, Greece, Sweden and the Eastern European countries. Here, the implicit carbon tax is zero. The international carbon price would be 6.8 €/tCO_2.[6] It turns out that the unrestricted use of the project-based mechanisms implies that the European Kyoto targets can be reached almost without any negative welfare effects. In fact, in almost all countries the welfare changes relative to business-as-usual are close to zero (see Figure 10).

Figure 8 shows the international allowance flows under the NoLim scenario. Again, the EU15 is for better readability aggregated to one region. Compared to the LimCDM scenario, the European purchases of CDM and JI credits have increased by more than 70% to 400 MtCO_2. The other Annex B countries have more than doubled their demand. Altogether, the project-based mechanisms now have a volume of around 880 MtCO_2. China remains the single largest host country of CDM and JI projects as before in the LimCDM scenario.

Figure 9 shows the allowance flows in the EU25. Since the higher demand for CDM and JI credits has driven up the price of CDM and JI allowances, the purchases of the ETS sectors have overall decreased by 40% compared to the LimCDM scenario. They now sum up to 94 MtCO_2. In contrast, the sales of allowances within the ETS have increased by 45% to 52 MtCO_2. The governmental purchases to be used in the non-ETS sectors are on average 2.5 times larger than in scenario LimCDM and reach 270 MtCO_2. The largest relative increases can be seen in Germany, followed with some distance by Finland, Italy and Ireland. The Eastern European countries now sell 7.7 MtCO_2 JI credits.

Except for France, Greece and Sweden, no country meets the supplementarity requirement in this scenario. It turns out to be optimal to buy 1.4 to 2.5 times as much CDM and JI credits than allowed by the supplementarity criterion. This implies that only minor emission reductions (2 to 5% relative to BAU in 2012) are undertaken domestically.

The optimality of the NAPs is not an issue if there is an unrestricted use of CDM and JI credits. In this case, the same single international price will emerge independent of the allocation to the ETS, and from an allocational point of view, the NAPs are irrelevant. The allocation to the ETS sectors determines though, how much CDM and JI credits are bought by governments and how many enter the ETS. Thus, it is a question of how the cost of meeting the Kyoto targets are distributed between the governments and thus tax payers on one side and the industry on the other side.

Instead of searching for an optimum through unrestricted CDM and JI activities given the allocation of allowances to ETS and non-ETS sectors, one can seek the optimal allocation of allowances to the ETS sector given the supplementarity requirement. In this scenario, SUP, there is full European

6. Theoretically, the countries with a zero implicit carbon tax could supply JI credits. This possibility is excluded for the EU15 countries, since there is no empirical evidence for this to take place. In addition, the amounts supplied would be negligible. In Eastern Europe, the model allows for JI (see Figure 11).

Figure 8. Sales and Purchases of CDM and JI Credits in NoLim

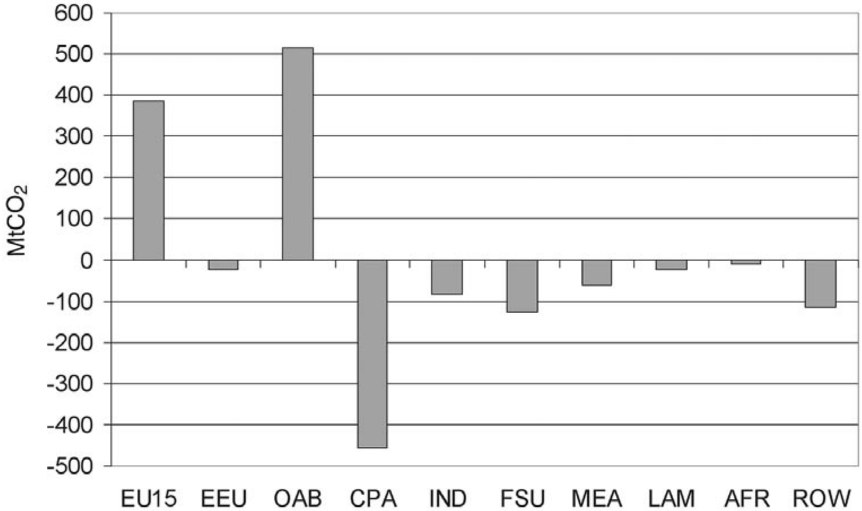
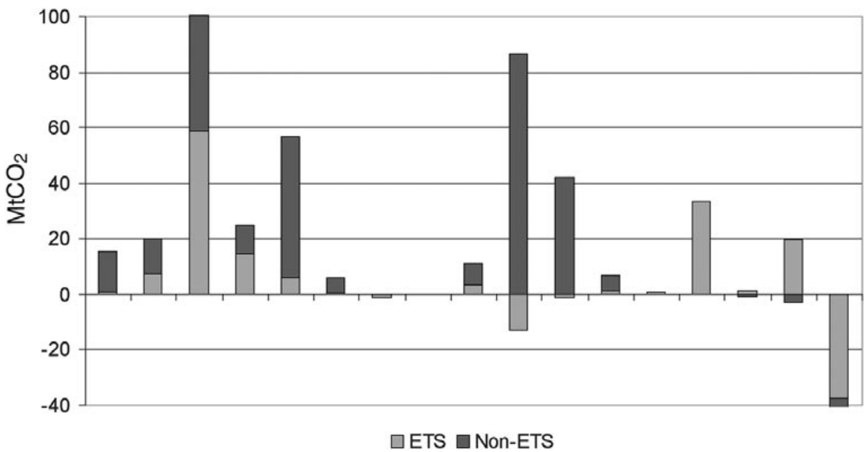


Figure 9. JI, CDM and ETS Credit Flows in the EU in NoLim



emissions trading in all sectors and limited purchases of CDM and JI credits to stay within the limit of the supplementarity requirement. This results in cost minimizing emissions in the non-ETS and ETS sectors, which can then be compared to the current targets. This is done in Table 3. Table 3 reports in the first three columns the composition of emissions between ETS and non-ETS sectors and the allocation of project credits to these sectors. The numbers are derived

Table 3. Comparison of Current Policies to Optimal Policies (in percent)

	Emissions in LimCDM rel. to Kyoto target			Optimal emissions rel. to Kyoto target		
	(1) ETS = target +CDM/JI	(2) Non-ETS = target + CDM/JI	(3) Total CDM/JI	(4) ETS	(5) Non-ETS	(6) CDM/JI
AUT	58.0= 55.1 + 2.9	59.1= 44.9 + 14.2	17.1	48.8	69.0	17.8
BEN	36.0= 29.8 + 6.2	78.1= 70.2 + 7.9	14.1	32.0	76.6	8.5
DEU	53.1= 44.5 + 8.6	55.5= 55.5 + 0.1	8.6	47.9	59.3	7.1
DNK	90.6= 50.9+ 39.6	57.9= 49.1+ 8.9	48.5	71.1	71.8	42.9
ESP	56.6= 56.4 + 0.2	52.2= 43.6 + 8.6	8.8	46.0	65.6	11.6
FIN	67.7= 64.9 + 2.9	35.6= 35.1 + 0.5	3.3	61.3	43.3	4.6
FRA	22.8= 22.5 + 0.2	77.5 = 77.5 + 0.0	0.2	24.4	75.6	0.0
GRC	52.3= 51.6 + 0.6	48.4 = 48.4 + 0.0	0.6	54.9	45.1	0.0
IRL	62.5= 49.0+13.4	62.9= 51.0+ 11.9	25.3	49.2	66.2	15.4
ITA	52.0= 52.2 - 0.2	60.4= 47.8 + 12.6	12.4	44.4	65.2	9.6
NLD	42.6= 41.7+ 0.9	66.8 = 58.3 + 8.5	9.4	35.6	71.7	7.3
PRT	56.2= 52.2 + 3.9	47.8= 47.8 + 0.0	3.9	49.1	55.8	4.9
SWE	30.2= 28.5 + 1.8	71.5= 71.5 + 0.0	1.8	34.6	63.0	0.0
UK	40.8= 34.5 + 6.3	65.5= 65.5 + 0.0	6.3	41.4	59.8	1.2

(1)+(2)-(3) = 100%. (4)+(5)-(6) = 100% (Sweden overcomplies with Kyoto). For Sweden, UK and France the suppl. criterion is non-binding.

from the LimCDM scenario for 2012 that projects current policy objectives as outlined in the NAPs. Columns 4 to 6 show the same numbers for the SUP scenario where emissions can be freely traded between all sectors but the supplementarity restrictions on project credits are kept economy wide.

A comparison of columns 1 and 4 reveals that most governments not only have endowed the ETS sectors too generously with emission permits. In addition, according to their announced government purchases of CDM and JI credits they allocate too many project credits to the ETS sectors. Only France, Greece, Sweden, and the UK did not oversupply their ETS sectors. An extreme case is Denmark in which - because of a relatively small endowment with allowances – the ETS sectors would buy large amounts of project credits. The maximum share of CDM and JI credits under the supplementarity restriction is shown in column 6. Compared to the expected purchases of credits (column 3) Denmark, Ireland, and the UK would have difficulties to meet these targets because of large purchases of ETS installations. Countries like Austria and Italy that have given generous endowments of allowances to the ETS sectors will stay well under the supplementarity limit because of little demand from these sectors.

Figure 10. Welfare Effects of the Scenarios LimCDM, NoLim, and SUP (Relative to BAU)

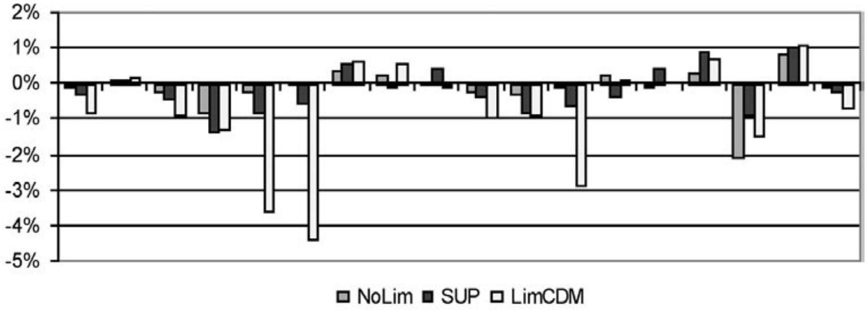


Figure 10 finally shows the welfare implications of the optimal strategy under supplementarity (SUP) compared to the current situation (LimCDM). It includes also the welfare effects of an unrestricted use of CDM and JI (NoLim).

The optimal allocation of allowances and CDM/JI purchases in the SUP scenario leads only to minor welfare effects relative to a BAU scenario (-0.2% in the EU15) and comes very close to the minimal welfare losses under a scenario without any restrictions on the CDM/JI purchases. Thus, the supplementarity requirement slightly increases the welfare costs associated with meeting the European Kyoto targets. However, it is more important to reduce the inefficient distribution of reduction requirements between ETS and non-ETS sectors because this could avoid the large welfare losses associated with the current allocation in the NAPs. Or in other words, reducing the intersectoral distortions within an economy is more important than reducing the distortions between economies.

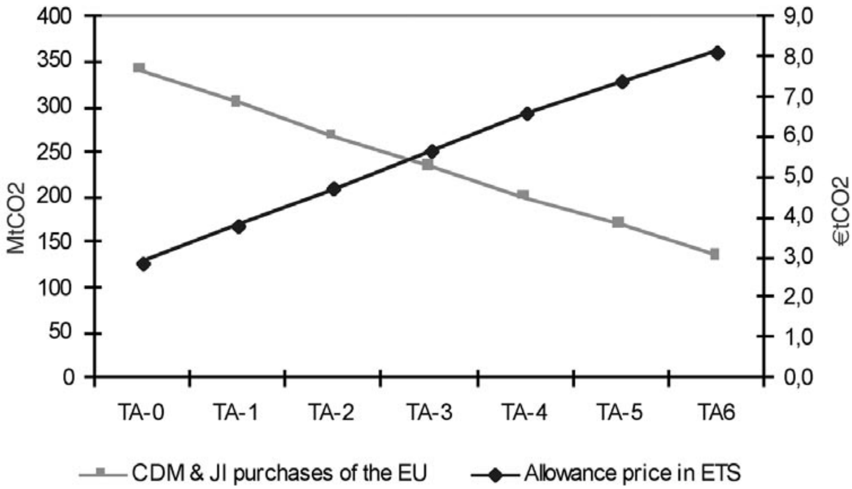
4.4. Sensitivity Analysis with Respect to Transaction Costs of CDM and JI

One critical assumption in this study is the level of transaction costs associated with CDM and JI projects. It was assumed that the level is 3 €/tCO_2. For a sensitivity analysis the LimCDM scenario has been run with different levels of transaction cost ranging from 0 to 6€/tCO_2.

Since different transaction costs primarily show up in the international allowance markets, Figure 11 shows the CDM and JI purchases of the EU as well as the allowance price in the ETS. The CDM and JI purchases are shown on the left axis. They fall linearly with rising transaction costs. The allowance price in the ETS is shown on the right axis. It rises almost linearly with rising transaction cost.

The amount of CDM and JI purchases decreases by 60% when the transaction costs are raised from 0 to 6 €/tCO_2. The allowance prices increase by only 5.2 €/tCO_2 when the transaction costs are increased to 6.0 €/tCO_2 since the reduced CDM and JI demand offsets some of the increase in costs.

Figure 11. EU Purchases of CDM and JI Credits and ETS Allowance Prices under Different Transaction Costs



5. SUMMARY AND CONCLUSIONS

In this paper, we have analyzed the effects of the different climate policy initiatives within the EU member states and of the European emissions trading scheme (ETS) by focusing on the allocation effects of meeting the European Kyoto targets in 2012. The analysis is based on the current National Allocation Plans (NAPs) as finalized for the first trading period. Special attention is given to the role of CDM and JI projects within the national climate strategies.

The most significant finding of the simulations is the strong distortions that are apparently introduced by having the ETS exist parallel to other policy measures in the non-ETS sectors. Although we have not attempted to model the inefficiency of policies within the non-ETS sectors and have used a fictious emission tax, the difference in marginal abatement costs between the two parts of the economy is tremendous and would be even larger if it were possible to model the actual policies for the non-ETS sectors in the member states.

The current NAPs generously endow the ETS sectors with emission rights and thus require large emission reductions outside the ETS sectors – either domestically in the non-ETS sectors or abroad making use of CDM and JI credits. In the first simulation without the use of CDM and JI credits it becomes apparent that the NAPs drive a large wedge between the allowance price in the ETS and the implicit tax necessary for reaching the Kyoto targets in the non-ETS sectors. This distortion is important enough to make the welfare costs of meeting the Kyoto targets even larger than under an efficient unilateral emission tax, which does not exploit the differences in the abatement costs within the EU. Without the project mechanisms

CDM and JI, all efficiency gains from the European emissions trading are netted out by the distortions created between the ETS and the non-ETS sectors.

CDM and JI projects help to reduce the cost of meeting the European Kyoto targets. We have analyzed the current situation where the use of CDM and JI credits is unrestricted for the ETS sectors, but were the government purchases are restricted to the official plans. In this scenario, there still remains in most countries a large difference between the allowance price in the ETS of 5.7 €/tCO_2 and the implicit tax necessary to achieve the necessary reductions in the non-ETS sectors of 30 to 110 €/tCO_2.

Thus, while the use of CDM and JI drives down the allowance price in the ETS by one third and reduces the wedge between implicit tax outside the ETS and the allowance price, the distortions created by the uneven NAPs cannot be eliminated. Indeed, the welfare costs of meeting the European Kyoto targets are larger than under an emission tax imposed unilaterally by each member state.

The supplementarity condition of the Kyoto Protocol that requires the major part of the emission reductions to be realized domestically has large implications for the efficiency and the cost of the EU climate strategy. Whereas the current policies will have a welfare loss of close to 1% in 2012 relative to "business-as-usual" policy, an unrestricted trading in project credits and allowances would result in an allocation where the Kyoto targets can be met with hardly any welfare costs. Altogether, given the current NAPs, the European ETS sectors would buy around 126 MtCO_2 of CDM and JI credits and the governments would purchase an additional 107 MtCO_2. On the other side, only minor amounts of allowances (36 MtCO_2) would be traded within the ETS. The only sellers of allowances are in this case some Eastern European countries and Italy.

The best strategy to reduce the costs of the current European climate strategies is to include more sectors and gases and to allow for an unrestricted use of CDM and JI. If this is not feasible, it is at least beneficial to reduce the burden for the non-ETS sectors. This can be achieved by setting stricter targets for the ETS installations and by restricting the use of CDM and JI for the ETS installations. The first measure directly reduces the necessary emission reductions outside the ETS and can be implemented by setting stricter targets in the NAPs for the second trading period from 2008-2012. The second measure allows governments to reduce the burden of the non-ETS sectors by purchasing larger amounts of CDM and JI credits while staying within the limits of the supplementarity criterion. For this reason, the provision for restrictions is already made in the EU linking directive that governs the use of CDM and JI credits within the ETS.

The simulations show that a more efficient climate strategy – even given the supplementarity requirement – could achieve the European Kyoto targets at low costs. Compared to a "business-as-usual" scenario the welfare in the EU15 is only reduced by 0.2% compared to 0.7% under the current plans. Finally, even under an optimal allocation of allowances there are distributional issues that need to be resolved. Basically, the decision of who is allowed to use the restricted amount of CDM and JI credits determines how the costs of meeting the Kyoto targets are distributed between the governments and thus tax payers on one side and industry on the other side.

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APPENDIX

A1. Assumptions to Implement the Kyoto Protocol and the EU-ETS Targets

- Since DART only includes CO_2-emissions, we used official emission data from the EIA and IEA to calculate the Kyoto target as the CO_2 target that has to be achieved after planned reductions (see below) in non-CO_2 GHG are taken into account. The resulting CO_2 target is calculated relative to 2002 CO_2-emissions and also implemented in DART relative to 2002 emissions.
- Reductions in non-CO_2 GHG were taken from NAP were available (Germany -6.9%, UK -40.9%, Netherlands -26.5%, Denmark -6.1%, Finland -10% relative to 2002 levels). In the remaining EU15-countries as well as in Hungary and Poland and OAB a 10% reduction relative to 2002 was assumed, which is the median of the available plans.
- The allocation of permits to the ETS sectors and the reported historical ETS-emissions were used to derive for each country the ETS targets for 2005-2007 resp. 2012 relative to ETS-emissions in 2002. These targets relative to 2002 ETS-emission were implemented in DART, since there is not always a perfect match between the DART ETS-emissions and those reported in the NAPs.
- For the region XCE that does not match the former accession countries without Poland and Hungry exactly, it was assumed that emissions in the ETS follow the BAU path.
- Where available we used targets for 2012 (DEU, DNK, GBR, IRL, NLD). In the remaining regions, we assume a reduction of 3% relative to the 2007 target, which is the median reduction of those plans having a 2012 target.
- Data on plans for CDM and JI are taken from Lückge and Peterson (2004). These data were updated for Austria, Denmark, Italy and Luxemburg based on EU Commission (2004a, b, c).

A2. Scenarios that were Run with the DART Model

Except for the BAU scenario, emission reductions resp. emissions trading always starts in 2005. The model is run until the year 2012, the end of the first Kyoto commitment period.

BAU
- business-as-usual

UNI
- Each EU25 country reaches its Kyoto target unilaterally by a uniform CO_2 tax.

NoCDM
- European ETS with targets as indicated above

- Uniform, regionally differentiated CO_2-taxes in non-ETS sectors in EU25 to reach individual Kyoto targets
- No use of CDM and JI

LimCDM
- Same as NoCDM but use of CDM and JI: full use in ETS and governmental use as indicated in NAPs
- The region OAB reaches Kyoto by internal emissions trading or equivalently a uniform CO_2 tax. The use of CDM and JI is limited to 200 MtCO_2 p.a.
- For CDM and JI credits transaction cost of 3 €/tCO_2 are assumed.

NoLim
- Same as LimCDM but unrestricted use of CDM and JI both in the ETS and on governmental level in the EU25 and the other Annex B regions.

SUP
- Inclusion of all sectors in the European ETS.
- The use of CDM and JI is restricted to the supplementarity requirement.
- For CDM and JI credits transaction cost of 3 €/tCO_2 are assumed.

Sensitivity Analysis
- Scenario LimCDM with transaction cost of 0 and 6 €/tCO_2.

Table A1. Emissions and Emission Targets in the EU15

Country	Emissions 2002 in $MtCO_2e$			Emissions in ETS in $MtCO_2$		Allocation to ETS sectors		CDM/JI in 2008-12; $MtCO_2e$ p.a.	
	CO_2	All GHG	Kyoto target	Information available	2002 (est)	2005-2007	2012	Government plans[d]	Max for supplementarity
Austria	70.5	85.0	67.9	31.7 in 2001	32.1[a]	32.7 p.a.	?	7	8.8
Belgium	146.3	150.0	134.3	70.22 in 2007	67.6[b]	64.4; 63.1; 62.55	?	8.2	11.8
Denmark	54.9	68.0	54.5	30.9 in 2002	30.9	40.2; 30.15; 30.15	24.7	3.7	17.9
Finland	54.3	82.0	77.0	40.9 in 2002	40.9	44.4; 45.9; 46.2	?	0.24	2.4
France	407.3	554.0	565.0	156.96 in 2001	150.2[a]	156.5 p.a.	?	0	11.8
Germany	838.3	1116.0	986.7	506.5 in 2002	506.5	498 p.a.	495	0.52	58.6
Greece	104.4	135.0	131.3	70.2 in 2002	70.2	71.26 p.a.	?	?	-
Hungary	56.1	86.0	95.5	29.4 in 2002	29.4	29.9 p.a.	?	0.0	-
Ireland	49.1	69.0	59.9	32% of total GHG	22.1c	22.3 p. a.	20.9	3.7	4.8
Italy	448.7	554.0	470.6	51% of total GHG	256.5[c]	232.5 p.a.	?	32.5 - 60.0	35.3
Luxemburg	10.3	11.0	9.4	2.5 in 2001	2.7a	3.52 p.a.	?	3.0	0.3
Netherlands	256.2	241.0	199.0	84.5 in 2000	86.8[a]	94.4 p.a.	95	20.0	17.2
Poland	268.4	358.5	530.6	184 in 2001	179.1[a]	246.7; 240.1; 226.4	?	0.00	-
Portugal	67.0	82.0	73.7	36.5 in 2002	36.5	38.9 p.a.	?	0.01	2.9
Spain	341.5	400.0	327.75	164.3 in 2002	164.3	172.31 p.a.	?	20.0	26.9
Sweden	54.9	70.0	74.88	20.2 in 2002	20.2	22.9 p.a.	?	1.0	1.5
UK	552.8	635.0	653.0	252.8 in 2002	252.8	245.3 p.a.	145.3	0.0	27.6

a. Assuming same CO_2-emission growth in ETS sectors than in whole economy.
b. Assuming CO_2-emissions growth in ETS sectors from 2002-07 is the same as CO_2-emission growth in whole economy from 1997-2002.
c. Assuming that this share holds for 2002.
d. See Lückge and Peterson (2004); European Commission (2004a,b,c).

Table A2. Carbon Prices and Traded Carbon Credits in the Different Scenarios

	CO_2 Prices in €/tCO_2					Net trade in Emissions in $MtCO_2$					
						NoCDM	LimCDM		SUP[d]	NoLim[e]	
	UNI[a]	NoCDM[b]	LimCDM[b]	NoLim	SUP[c]	ETS	ETS	Non-ETS	Total	ETS	Non-ETS
Austria	42.0	165.9	56.1	6.8	17.7	-0.1	1.4	7.0	8.8	0.9	14.4
Belgium + Luxemburg	24.2	32.4	11.4	6.8	13.1	4.4	8.8	11.3	12.1	7.4	12.6
Denmark	59.9	146.6	78.6	6.8	15.3	13.2	16.5	3.6	17.9	14.5	10.6
Finland	21.1	102.5	98.9	6.8	15.1	-0.4	1.5	0.2	2.6	0.6	5.2
France	2.7	-	-	6.8	2.6	-5.8	0.9	0.0	0.0	-1.5	0.0
Germany	20.1	28.2	29.4	6.8	12.1	48.3	70.4	0.5	58.6	58.8	41.8
Greece	2.8	-	-	6.8	2.9	-1.6	0.6	0.0	0.0	0.0	0.0
Hungary	0.9	-	-	6.8	3.7	-0.2	2.1	-0.1	-0.1	1.3	-1.0
Ireland	57.1	100.8	38.5	6.8	28.3	3.6	4.2	3.7	4.8	3.5	7.4
Italy	36.2	116.7	37.9	6.8	19.8	-8.5	-0.7	46.0	35.3	-13.1	86.5
Netherlands	28.5	62.9	31.7	6.8	18.0	-2.7	2.0	20.0	17.2	-1.6	42.2
Poland	-	-	-	6.8	7.7	-16.1	0.0	0.0	-8.0	1.3	5.3
Portugal	20.4	82.0	82.3	6.8	13.9	-0.3	2.3	0.1	2.9	19.6	-3.0
Spain	37.5	180.0	102.2	6.8	20.0	-8.2	0.5	20.0	26.9	5.9	50.8
Sweden	-	-	-	6.8	-	-0.3	1.1	0.0	-1.5	0.7	0.0
UK	6.9	-	-	6.8	5.6	24.9	38.1	0.0	7.2	33.2	0.0
Rest of Eastern Europe	-	-	-	6.8	0.9	-50.2	-30.3	0.0	-5.0	-37.6	-3.7
ETS	-	7.9	5.7	6.8	5.6	-	CDM/JI =125.7	CDM/JI =111.9	CDM/JI = 179.5	CDM/JI = 93.9	CDM/JI = 269.1
CDM/JI	-	-	5.7	6.8	5.6	-					

a. Regional tax covering all sectors.
b. Regional tax covering the non-ETS sectors.
c. Shadow cost of restriction on CDM imports.
d. Optimal allocation between ETS and non-ETS depends on ETS targets.
e. Given the current ETS targets.