The EU Emissions Trading Scheme:
Allowance Prices, Trade Flows, Competitiveness Effects

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Abstract

The upcoming European Emissions Trading Scheme (ETS) is one of the more controversial climate policy instruments. Predictions about its likely impact and its performance can at present only be made to a certain degree. As long as the National Allocations Plans are not finally settled the overall supply of allowances is not determined. In this paper, we will identify key features and key impacts of the EU ETS by scanning the range of likely allocation plans using the simulation model DART. The analysis of the simulation results highlights a number of interesting details in terms of allowance trade flows between member countries, of allowance prices, and in terms of the role of the accession countries in the ETS.

Keywords: EU emissions trading scheme, Kyoto targets, computable general equilibrium model, DART

JEL classification: D58, F18, Q48, Q54

1. Introduction

When the European Emissions Trading Scheme (ETS) for CO_2 will start in 2005, it will be known as one of the more controversial climate policy instruments. It is designed to achieve an economically efficient reduction of CO_2 from major energy-intensive installations. Currently it covers around 15 000 installations in the European Union which are responsible for roughly 45 percent of all CO_2-emissions in the EU. As of today, there is considerable uncertainty about the impact of this trading scheme when it is in full operation and when the commitments of the member states of the EU to the Kyoto-Protocol will need to be met in 2012. Consequently, speculations sprout about winners and losers among the member states, about costs to different sectors within members states as well as about the question as to which member state will be a net-seller and which one a net-buyer of emission allowances. Also, the range of prices for emission allowances is still wide open. In fact, many statements about the likely outcome of the ETS are more based on the desire to further ones commercial interest than on a balanced analysis of the evidence available so far. Existing quantitative simulation studies (Böhringer 2002, Capros et al. 2000 & 2002) only analyze preliminary scenarios of the ETS that, for example, do not include the accession countries or account for different likely allocation modes.

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Predictions about the likely impact and the performance of the European ETS depend on the details of the allocation of emission rights within each member state. As long as the National Allocation Plans of the member states are not finally settled the overall supply of CO_2-emission allowances is not determined. This obviously influences the price level for allowances. In addition, allocation rules that differ between member states will also influence trade flows. These issues of allocating the caps will be discussed below in greater detail. The second uncertainty concerns the fact that the impact of the EU ETS will exercise its full force in 2012. It is therefore necessary to assess the ETS in the light of the EU economy in the future; to be precise we choose 2012. This will be done with the help of the DART-model (Klepper et al. 2003), a computable general equilibrium model calibrated for the enlarged EU.

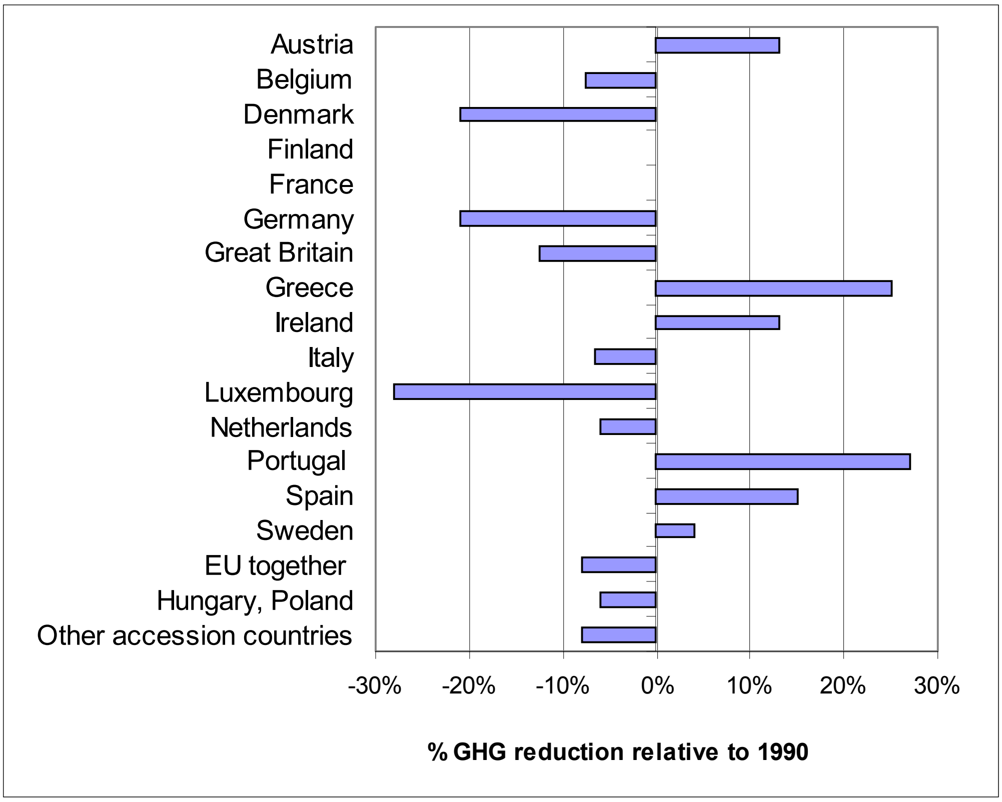
Nevertheless, it is possible to identify key features and key impacts of the EU ETS by scanning the range of likely allocation plans and by using a simulation analysis with the DART-model. This approach at the moment ignores some institutional details of the ETS such as the possibility for using the flexible mechanisms set out in the Kyoto-Protocol, i.e. Joint Implementation (JI) or the Clean Development Mechanism (CDM) which can potentially offer further inexpensive abatement options. It also ignores intertemporal issues such as banking and borrowing. Despite these omissions, the analysis highlights a number of interesting details about the EU ETS in terms of allowance trade flows between member countries, of allowance prices, and in terms of the role of the accession countries in the ETS.

In the following, we first summarize the background of the EU ETS and the international climate policy commitments of the EU. We then describe the DART-model and the way in which the ETS is implemented in this simulation model. Finally, we discuss the results of the simulation exercises and draw some conclusions.

2. The European Kyoto Targets and the European Emissions Trading Scheme

In the Kyoto Protocol from 1997, the EU agreed to cut down their overall GHG emissions relative to the 1990 level by 8 percent in the period from 2008 to 2012. In 1998, the EU differentiated this target between their different member states in the so-called EU Burden-Sharing Agreement. The idea was that cohesion member states such as Spain, Portugal, Ireland and Greece are given lighter burdens, compared to richer member states. They are thus allowed to increase their relatively small emissions while other EU member states stabilize or reduce emissions. The Eastern European accession countries that will join the EU in May 2004 and presumably in 2007 are not included in the Burden-Sharing Agreement but have their own individual Kyoto targets. The targets of all EU member states and accession countries are shown in figure 1.

Figure 1 — EU Kyoto Targets According to the Burden-Sharing Agreement



To reach the European commitments at minimal costs a European Emissions trading scheme (ETS) for CO_2 was designed that is at the heart of this paper.[1] The ETS will start in 2005 and all member states of the European Union will be required to impose binding, absolute caps on CO_2 emissions of facilities in energy activities, the production, and processing of ferrous and non-ferrous metals, the mineral industry and the pulp, paper and board production. The first trading period until 2007 is seen as a test for the second period from 2008-2012 that coincidences with the first Kyoto commitment period.

Even though an important step, the EU ETS alone cannot guarantee a cost effective reduction as it only covers the energy intensive industrial sectors and only one of the greenhouse gases, CO_2. The overall costs of the Kyoto target also depend on the emission reductions that are achieved in sectors and gases not covered by the ETS. If, for example, fearing negative competitiveness effects, the member states generously endow the sectors inside the ETS with emission permits, this implies that more emission reductions are necessary outside the trading scheme. To guarantee the cost effectiveness of the EU Kyoto strategy, the allocation of permits to the ETS has thus to account for the abatement costs and abatement potentials in non-ETS sectors and for non-CO2 greenhouse gases.

The allocation of permits to the ETS is subject of the so-called National Allocation Plan (NAP) that, according to the EU directive, each member state has to prepare before the beginning of each of the two trading periods from 2005-2007 and 2008-2012. For the first period, the NAP has to be submitted by the end of March 2004. In the NAP, each country has to determine the total quantity of allowances in the ETS and to decide how it intends to allocate them to individual operators. The directive also mentions explicitly that the total quantity of allowances has to be consistent with the Kyoto emission targets of each country and with the assessments of actual and projected progress towards fulfilling the member States contributions to the Community's commitments. This is stressed again in the communication from the Commission on guidance to assist the Member states in establishing their NAPs (European Commission 2004). Within three month the Commission can reject a plan and ask for changes to be made. In a final step, each Member State has to take its final decision on the NAP.

To help the Member States establish the NAPs the EU Commission has published a "Non-Paper" (European Commission 2003) in which a step-by-step process to develop a NAP is outlined. The paper suggests that the first step should be to establish the share of the total allowable emissions under the Kyoto Protocol that will be allocated to the installations covered by the trading scheme in a top-down economy-wide analysis. In a next step, it is then suggested to collect data from the single installations and companies in a bottom up approach. The allocation of permits to each individual sector is finally determined based on current, historical or average emissions for a certain year. We will address possible allocation modes in section 3.2 in more detail.

We will ignore in the following the problem of non-CO_2 gases and focus on the question of reductions inside the ETS versus reductions outside and discuss the implications of the different allocation approaches. In addition, we will look at the role of the accession countries. Bulgaria, the Czech Republic, Hungary, Poland, Slovenia, Slovakia and Romania, Malta and Cyprus as well as the three Baltic States will become official members of the EU.[2] As EU members, these countries will also enter the EU ETS. This will influence the costs of achieving the European Kyoto target in two ways. First, Eastern Europe offers abatement opportunities that are much cheaper than in the current EU. Second, due to the economic recession in the 90ies, Eastern Europe's emissions are now below their Kyoto target. Selling some of their excess emission allowances (called hot-air) into the European ETS would further drive down the permit price and the economic costs in Western Europe.

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1 For a summary of the EU directive (European Union 2003) that establishes the ETS see e.g. Gagelmann and Hansjürgens (2002).

2 Except for the candidate countries Bulgaria and Romania these countries will join the EU in Mai 2004. For Bulgaraia and Romania accession to the EU is scheduled for 2007, the beginning of the second trading period of the ETS.

3. Simulating the Effects of the EU Emissions Trading Scheme

An assessment of the likely allocation and welfare effects of the ETS requires at least two modeling steps. The first consists of the setting up of an appropriate economic model with which the European economy can be simulated for the time in which the trading scheme will be in full force. The second step involves the design of policy scenarios, which are likely to arise between today and the time at which the Kyoto-Commitments are to be met. As a simulation tool, we use the DART-model (Klepper et al. 2003) which will be shortly characterized. We then derive the emission caps for the different member states that need to be met by 2012.

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 simulation of the European ETS, it is calibrated to an aggregation of 16 regions. Table 1 illustrates the 9 countries or group of countries of the EU including the accession countries of Eastern Europe and the other 7 world regions.

Table 1 — Regions in DART

BEN	Belgium, Luxembourg, Netherlands
DEU	Germany
FRA	France
GBR	United Kingdom
ITA	Italy
SCA	Denmark, Finland, Sweden
SEU	Greece, Portugal, Spain
REU	Austria, Ireland
ACC*	Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia
Other regions	
USA	United States of America
FSU*	Former Soviet Union
OAB	Other Annex B-countries (not in EU)
MEA	Middle East, North Africa
CPA	China, Hong-Kong
IND	India
ROW	Rest of the World

*The region ACC includes Bulgaria and Romania for which the accession in 2007 is planned but not decided. It excludes the Baltic Countries, which are aggregated in region FSU. This is due to the regional disaggregation of the current GTAP data set. This inconsistency has only a small effect since it distorts CO_2-emissions of ACC by less than 5 percent.

In each region or country, the economy is disaggregated into 12 sectors. 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, we believe it to be sufficiently close. In addition, it also covers about 45 percent of the CO_2-emissions.

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.

Table 2 — Sector Structure in DART

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

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).[3]

3.2 Integration of Policy Scenarios in DART

The simulation of the ETS requires first a determination of the emission caps for the EU member states. Table 3 shows the Kyoto targets for each region or country based on the EU

[3] For more details about DART see e.g. Springer (2002) or Klepper et al. (2003).

Burden-Sharing Agreement to the Kyoto-Protocol (also see Figure 1).[4] The cap on country groups is the emission weighted average. The first column represents the percentage reduction required relative to 1990. The second column is derived from the business-as-usual (BAU) run of DART up to 2012 and represents the reduction required in 2012 relative to the BAU in 2012.

The BAU is calibrated to the climate policy measures enacted up to the 2001. Hence, it includes the impact of policies such as the German eco-tax or the national emissions trading schemes. From 2002 on, BAU keeps these policies in place but does not include any new climate policies.

Table 3 – EU Kyoto Targets Relative to 1990 and 2012 Emissions

	% Reduction target relative to	
Country/Region	1990 (Burden Sharing)	2012 (BAU in DART)
SCA	-5.1	-7.7
DEU	-21.0	-11.3
GBR	-12.5	-12.9
BEN	-7.4	-24.0
FRA	0.0	-11.3
ITA	-6.5	-15.9
SEU	+18.4	-11.9
REU	-4.1	-31.4
EU15	-8.0	-14.2
ACC	-7.0	Hot-Air of ca. 165 Mt CO_2

So far, only the economy-wide emission targets have been computed. The ETS, however, requires targets, which are set for the sectors involved in the trading scheme. The European Directive leaves it up to the member states to determine within their National Allocation Plans (NAP) which proportion of the emission reduction is to be supplied by those sectors participating within the ETS, and which proportion is supplied from the rest of the economy. The Commission of the EU suggests three modes of allocating targets in its non-paper (European Commission 2003):

- The “historical emissions approach” (HIS)
- The “forecasting approach” (FUT)
- The “least cost approach” (LC).

4 ACC does not participate in the burden-sharing.

In the historical approach, the total number of allowances allocated to the ETS installations is determined by multiplying the share of emissions of ETS installations in a particular base year (e.g. 2000) with the total allowable emissions in the economy. This approach together with the choice of a recent base year penalizes sectors or industries, which have engaged in early action prior to the base year. In the forecasting approach, allowances are allocated according to the business-as-usual shares expected at some future point in time, for example the end of the first commitment period to the Kyoto-Protocol in 2012. This system would in some way reflect the expected needs of faster and slower growing sectors in the economy.

Finally, the least cost approach tries to take into account the fact that CO_2-abatement activities carry substantially different costs in different sectors. From an efficiency point of view, this would not matter if all emission sources were to participate in the trading scheme. However, since abatement costs will equalize only within the ETS, there is a danger that the historical and the forecasting approach may lead to strong differences in marginal abatement costs between the sectors within ETS and those outside the ETS. The least cost approach tries to take account of this inefficiency by dividing the cap between ETS and Non-ETS sectors in such a way that the different abatement cost levels are recognized. Hence, the least-cost approach allocates relatively few allowances to sectors with low abatement costs.

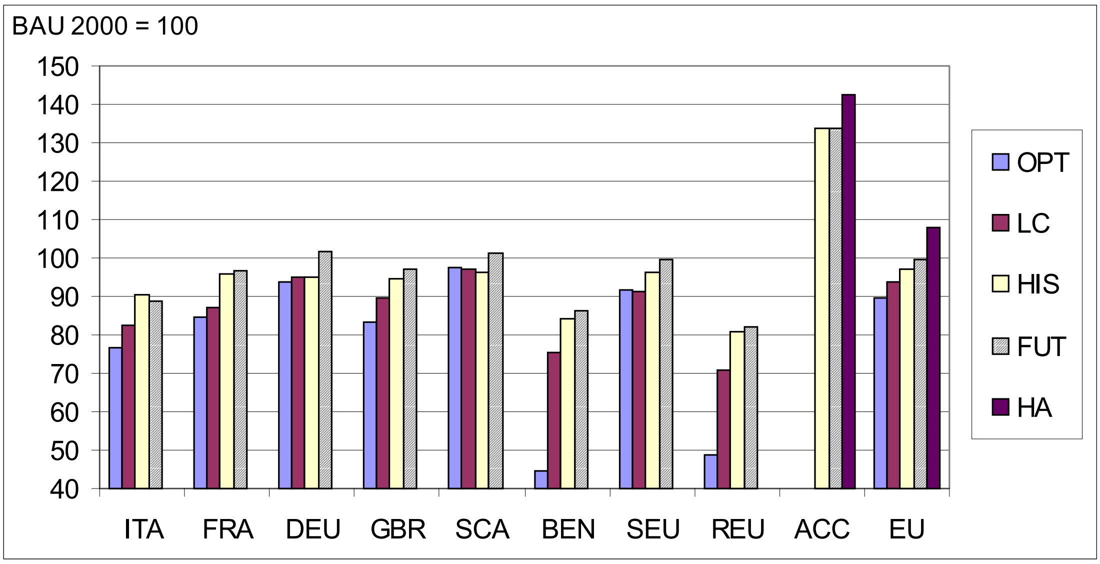
The three allocation modes have been implemented in DART in the following way: For the historical allocation mode the share of the ETS-sectors in 2000 has been derived from the BAU run which includes climate policy measures taken up to 2001. In the forecasting mode, the BAU run was extended up to the year 2012 and the shares of that year are used to compute the division of allowances between the ETS installations and those outside. For the least cost approach, we compute for each country or region an efficient abatement scenario, which meets the caps of the Kyoto-Protocol in 2012. This can equally well be done with a uniform national CO_2-tax or a comparable nation-wide emissions trading scheme. The resulting emission shares in 2012 are used to determine the allocation of allowances to the different sectors in the ETS. This approach leads to a unilaterally efficient allocation of allowances. Hence, there would be no permit trade within a country. However, as soon as trading starts between member states only those sectors participating in the ETS can gain from trading.

Figure 2 summarizes the allocation of allowances to the ETS sectors in the different countries/regions according to the three allocation rules compared to the business-as-usual emissions (BAU) in 2000. It turns out that under the least-cost allocation rule (LC) the lowest targets are allocated.[5] This results from the fact that the installations within the ETS have

[5] With the exception of SCA and DEU where HIS is slightly lower than LC targets.

lower abatement costs than those outside. Therefore, under a unilaterally efficient policy the ETS must accept a larger emission reduction than the sectors outside.

Figure 2 — Targets and BAU Emissions in ETS Sectors



Under the historical approach (HIS) the targets are slightly higher indicating that the ETS sectors have a somewhat larger share in emissions than that of the least-cost-approach. The two exceptions, Germany (DEU) and Denmark, Sweden, and Finland (SCA) are of special interest. They experience slightly lower targets in scenario HIS. Yet, this is only the case because the year 2001 was chosen whereas for earlier reference years the ETS sectors had a significantly higher share in emissions. This indicates that the ETS sectors in Germany and the Nordic countries have been engaged in early action to a larger degree than the other member states and the non-trading sectors within their countries. Finally, the ETS sectors would receive the largest amount of allowances under the forecasting approach, mainly due to the fact that in the business-as-usual scenario the emissions of these sectors grow faster than those outside.

A final distinction in the different scenarios needs to be made for the accession countries, i.e. the region ACC in the DART model. The region ACC has a Kyoto target of –7 percent reduction relative to 1990 for the year 2012. The business-as-usual run of DART computes 730 Mt CO_2 in 2012, which is 18.5 percent below the Kyoto-target. Hence, the accession countries possess hot-air in the order of about 165 Mt CO_2. In the policy simulations below we ignore the hot-air in most cases and assume that the emission targets are set at the business-as-usual level. If the hot-air is included, we assume that all hot-air is allocated to the trading sectors. We also concentrate in the following on the "least-cost" allocation rule for reasons that will be apparent in the discussion of the results in section 4.1.

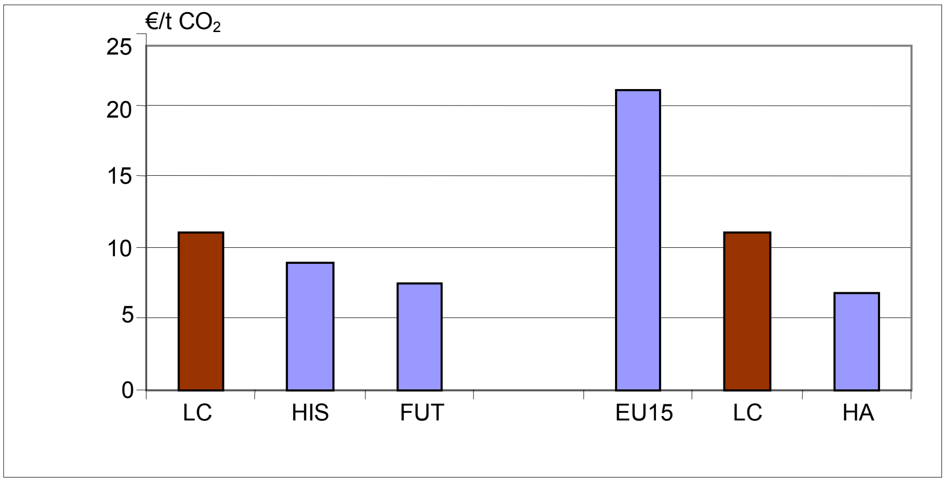
4. Simulation Results

In this section, we present the results from simulating the scenarios described in the previous section. We present the results of the DART-model for the year 2012 when the ETS is in full force and the Kyoto-targets under the EU burden-sharing agreement need to be met. We first report and discuss the results for the allowance prices. Then we show the trade in allowances across the EU. Finally, we take a look at the changes in sectoral output and the expected competitiveness and welfare effects.

4.1 Allowance Prices

One of the major outcomes of the EU ETS that will determine its allocation effects is a uniform allowance price, i.e. a price on CO_2, throughout the EU. Current estimates vary between 5 and 30€$_{2000}$/tCO_2. In the simulations with DART[6] the price in the central scenario turns out to be 11.1 €$_{2000}$/tCO_2. Over all scenarios, it varies between 6.8 and 21.0 €$_{2000}$/tCO_2. Figure 3 shows the allowance prices in the different scenarios. The first block indicates the prices under the three different allocation rules LC, HIS, and FUT as described in section 3. The second block compares permit prices if only the old EU-15 countries are trading, if all EU members trade but no hot-air is traded, and if the hot-air of the accession countries is also traded.

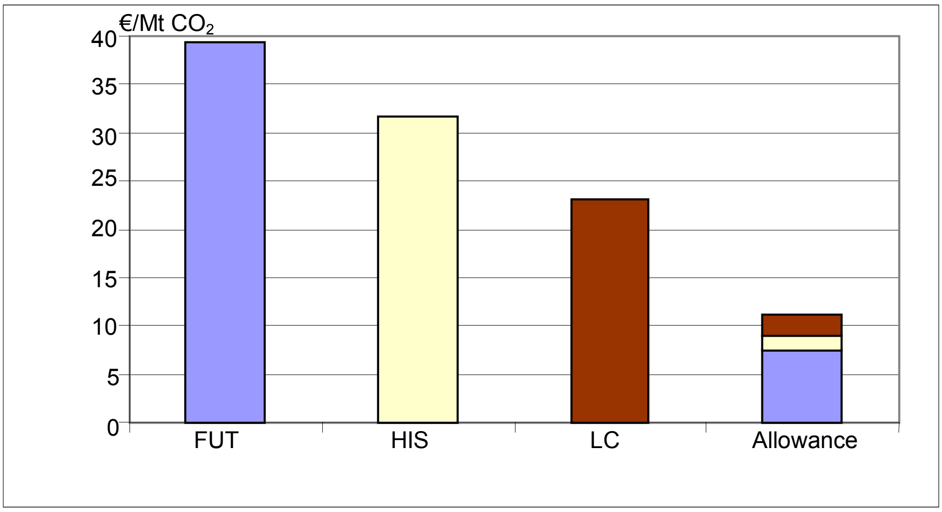
Figure 3 — Allowance Prices – Simulation for 2012



Stricter targets for the installations in the ETS naturally lead to higher allowance prices. As a result of the lax emission target for the ETS sectors under the forecasting approach (FUT) the price turns out roughly one third lower than under the least-cost approach (LC). The choice of a certain reference year for determining targets can have a considerable effect as the year 2000 in scenario HIS and 2012 in scenario FUT show. Figure 3 also illustrates the importance of the accession countries for the trading scheme. Trading among the old EU members only (EU15) would result in a permit price of 21 €$_{2000}$, whereas the low cost abatement options in the accession countries (LC) would bring prices down to 11 €$_{2000}$. If these countries also sell their hot-air (HA) they would bring down the allowance prices to slightly below 7 €$_{2000}$.

The future scenario (FUT) is based on expected business as usual emissions in 2012. Since the abatement cost functions in the sectors outside the ETS are much steeper than those of the sectors inside the allowance price of 7 €$_{2000}$ goes hand in hand with an average emission tax outside the ETS of almost 40 €$_{2000}$ (see Figure 4 that shows the emission weighted average tax that needs to be imposed in the different scenarios compared to the allowance price). Similarly, when the year 2000 emissions are chosen for the allocation of allowances permit prices of 9 €$_{2000}$ coexist with average emission taxes of almost 32 €$_{2000}$. In both cases, the allocation of emissions to the ETS is not based on abatement costs but only on actual or expected emissions. To the contrary, the comparison of average taxes and permit prices in the least-cost scenario (LC) indicates the efficiency gains from trading since the reference situation for the allocation of allowances was an efficient abatement structure. Hence, the divergence between the allowance price [11 €$_{2000}$] and the tax outside the ETS [23 €$_{2000}$] is a measure for the gains from trading across countries. In fact, these numbers tend to underestimate the gains from trading since it is unlikely that the climate policies pursued outside the ETS will be conducted through an efficient emission tax. Under other less efficient regimes the implicit taxes necessary for achieving the same emission target would be significantly higher thus increasing the divergence in abatement costs.

Figure 4 — Emission Weighted Average Tax Rates Outside the ETS Compared to the Allowance Price



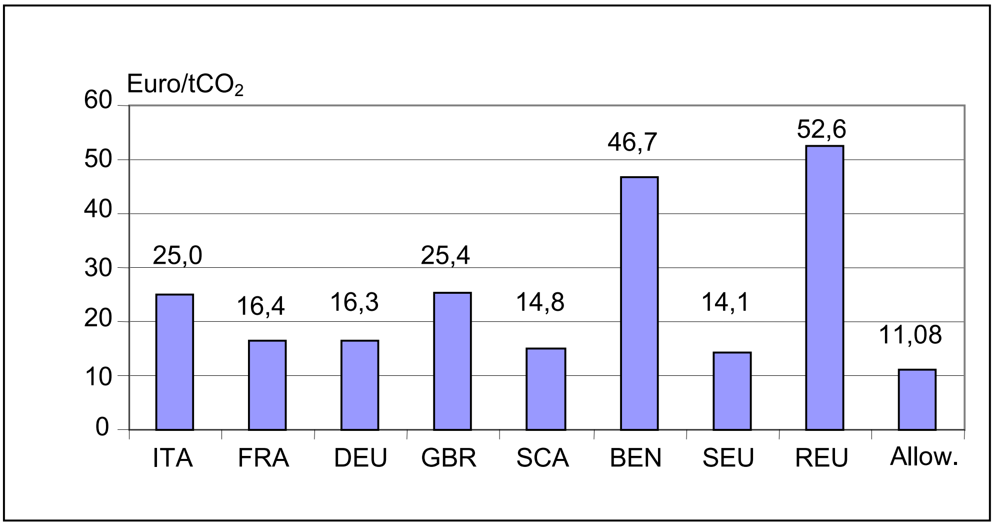
[6] We use an exchange rate of 1 €$_{2000}$ = 1.0971 US$ 1997 as the DART-model uses 1997 data.

The simulations clearly indicate the importance of the allocation rule of targets for the level of prices in the ETS but also for the burden of abatement costs that is subsequently imposed upon the sectors not participating in the ETS. In fact, under all three allocation rules there are strong incentives for sectors to participate in the ETS. The simulations also reveal that the least-cost allocation rule results in the smallest distortions between the sectors inside the ETS and those outside.

4.2 Trade in Emission Permits

Abatement costs for CO_2 vary not only within a country but to an even larger degree across countries. As can be seen in Figure 5, there are essentially four groups of countries with rather different marginal abatement costs for reaching their EU burden-sharing targets without emissions trading. The highest costs occur in the Benelux countries plus Ireland and Austria with around 50 €$_{2000}$/tCO_2. Italy and the UK have abatement costs of about 25 €$_{2000}$/tCO_2 whereas the other current EU countries (France, Germany, Southern Europe except Italy, and Scandinavia) cost amount to 14 to 16 €$_{2000}$/tCO_2. Finally, the accession countries, by definition, have zero cost of abatement as they have no binding target in 2012.

Figure 5 — CO_2-Taxes Under Unilateral Action



This is due to a number of factors such as the size of the emission cap relative to the BAU emissions, the availability of inexpensive abatement options, or to the availability of hot-air.

The ETS of the EU turns out to lead to a rather lopsided affair. The accession countries will export allowances to all other member states. Figure 6 illustrates the amount of allowances traded within the ETS. The only exporters are the accession countries (ACC). The overall amount of allowances available in the ETS under the “least-cost-principle” and without the inclusion of hot-air is 1620 Mt CO_2. Out of this 130 Mt CO_2 will be net exports from ACC, i.e. net trade amounts to roughly 11 percent of emissions in the ETS.

The accession countries with allocated allowances amounting to their business-as-usual emissions have available 480 Mt CO_2 of which they export 27 percent. These exports go predominantly to the large countries UK, Germany, and France but also to the Benelux Countries. However, relative to their domestic endowments Austria and Ireland combined will be the largest importers by having 33 percent of their consumed allowances imported. The Benelux Countries come in second with an import quota of 27 percent. In comparison, France and Germany import around 6 percent of the emission allowances consumed and the southern regions (SEU) and the Scandinavian member states (SCA) import only around 3.5 percent.

Figure 6 — Allowance Net Imports in the Emissions Trading System in 2012

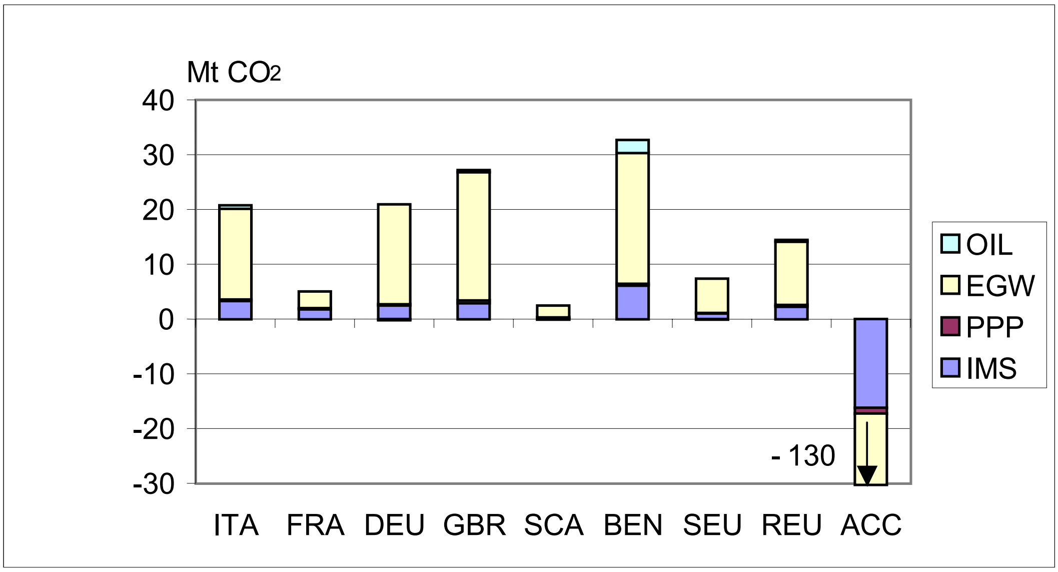
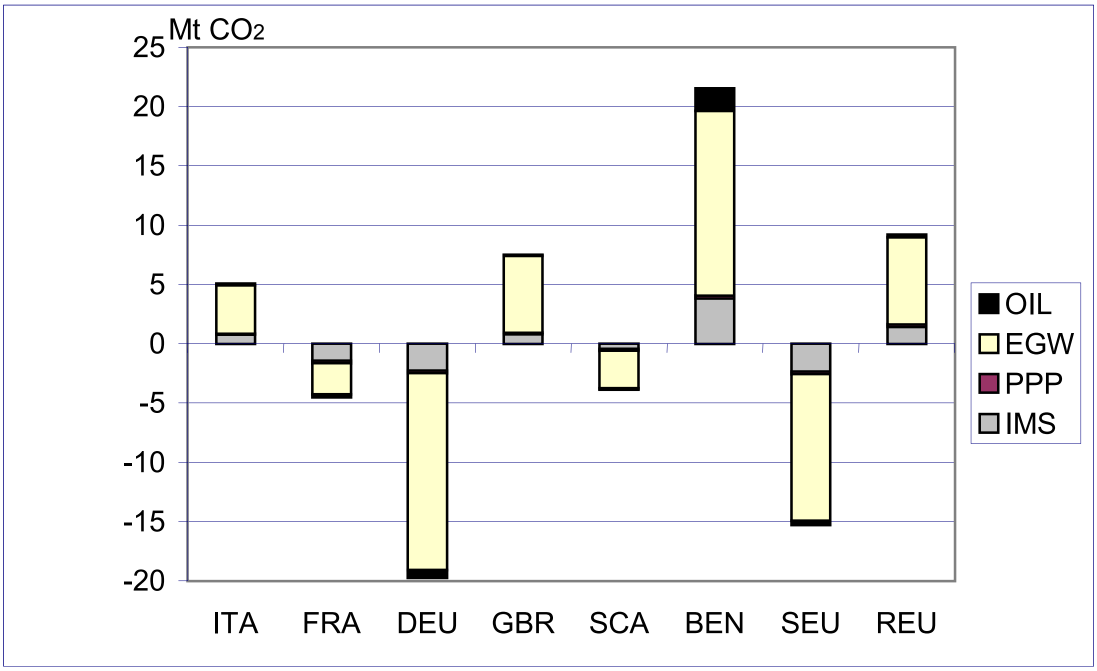


Figure 6 also shows that the trade in allowances will be dominated by the electricity sector (EGW). With the exception of France because of its large share of nuclear energy in electricity consumption, more than 75 percent of exports and imports will come from and go to the electricity sector. The rest is dominated by imports from the iron, metal and steel sector (IMS) with pulp and paper products (PPP) and refined oil products (OIL) almost negligible.

There have been speculations about the likely trade structure that would emerge without the accession countries. Figure 7 illustrates this case. Since the low cost option from the accession countries is not available, the above mentioned group of countries with the low abatement costs among the EU-15 (France, Germany, Spain, Portugal, Greece, Denmark, Finland, Sweden) would be exporters with most of the exports coming from Germany and the southern countries (except Italy). The largest importers would be the Benelux countries. This restricted EU-15 trading scheme would lower the marginal abatement cost from an average of 23 €$_{2000}$/tCO_2 in the no-trading case to 21 €$_{2000}$/tCO_2. These 2 €$_{2000}$/tCO_2 can be viewed as a measure of the efficiency gain from trading. In contrast, the permit price in the full trading scheme (including ACC) is only 11 €$_{2000}$/tCO_2. This illustrates the tremendous efficiency gains from including the ACC country group[7].

Figure 7 — EU-15 Trading Without the Accession Countries
Allowance Net Imports in 2012



4.3 Competitiveness Effects

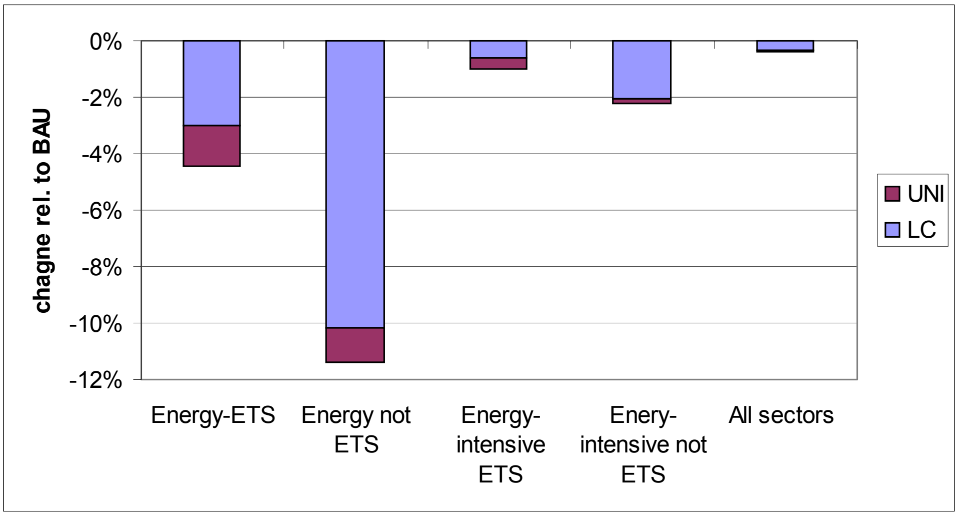
A major concern of policy makers and industry is that the ETS will have negative competitiveness effects for the participating sectors. There are three important points in this context. First, it should be clear that any competitiveness effects are not a result of the ETS but of the emission restrictions implied by the Kyoto target. The ETS is indeed lowering the negative effects of reaching this target compared to pure unilateral action (see section 4.2 and 4.4). Second, the simulation results show that altogether the competitiveness effects of the ETS and the Kyoto targets are relatively small. Finally, it is not true, that the competitiveness of sectors covered by the ETS is affected more than the competitiveness of the sectors outside.

The cross-country flows of CO_2-allowances from the accession countries towards the West indicate that the ETS will in the first place allow the energy-intensive installations within the trading scheme to reduce emissions and consequently production to a lesser degree than

[7] These permit prices reflect efficiency gains since they do not contain hot-air.

under a unilateral climate policy scenario (UNI) in which the EU burden-sharing targets need to be met independently. Simulations with the DART-model show that this is the case but it also carries over to sectors not included in the ETS. Figure 8 shows the output effect of the EU burden-sharing for the importing countries, i.e. the EU-15. We have selected the energy sectors in the ETS [Oil products (OIL), Electricity (EGW)], energy outside the ETS [coal extraction (COL), gas production and distribution (GAS)], energy-intensive sectors in the ETS [iron, metal and steel (IMS), pulp and paper products (PPP)], and energy-intensive sectors outside the ETS [chemicals (CEP), transport sector (MOB)]. The non-energy intensive sectors outside the ETS (AGR, TRN, OTH) are not included as output changes are negligible. In Figure 8 the output losses in LC are represented by the light grey bar, whereas the losses under UNI are the sum of the light and the dark grey bar. The dark grey bar thus shows the losses that can be avoided by implementing the emissions trading scheme.

Figure 8 — Sectoral Output Changes in the EU-15



The most remarkable result from comparing the ETS with a unilateral climate policy is the fact that all energy-intensive sectors gain from the ETS. Of course, the energy sectors and the energy-intensive industries inside the ETS can reduce their output losses by more than 50 percent. But these cost savings also carry over to the other energy-intensive industries to some extent.

Figure 8 also shows that the decreases in total output in the EU only by around 0.3 percent. The effects on all non-energy sectors are below 2 percent in each country. In the energy intensive sectors outside the ETS (chemical and mobility sector) there are two exceptions, which are the Benelux countries and the Rest of Europe. Here the output losses reach 11 and 5 percent. This is due to the comparatively high emission intensity of these sectors in the EU. For example, in the chemical sector in the Benelux countries, energy intensive fertilizer production plays an important role.

The losses are naturally higher in the energy sectors coal and gas whether they are covered by the ETS or not. The restrictions on CO_2-emissions naturally reduce demand for fossil energy sources and thus reduce output in those extraction industries. In addition, coal is the most emission intensive fossil fuel, which is substituted by low carbon energy under emission restrictions.

Finally, Figure 8 shows that the sectors inside the ETS clearly gain from an emissions trading scheme and are thus affected less from climate policy than the sectors outside the ETS. There are three reasons for this

(1) Competitiveness effects depend on the exposure of a sector to the world market. Some of the sectors most exposed to the world market such as the chemical sector are outside the ETS. The detailed sectoral data show indeed that in the unilateral scenario the chemical sector suffers more than the IMS and PPP sector inside the ETS.

(2) The sectors outside the ETS are indirectly affected by the emission restrictions inside the ETS as well. In another paper, Peterson (2003) shows that these indirect effects that originate from changes in gross energy prices and demand or from prices of intermediate inputs in some cases even dominate the direct effects from the ETS or the other climate policies.

(3) Reaching the Kyoto targets requires severe reductions outside the ETS as well. As shown already in section 4.1, taxes that are associated with these reductions are much higher than the allowance price. As a result, the sectors outside the ETS are affected more strongly than the sectors inside.

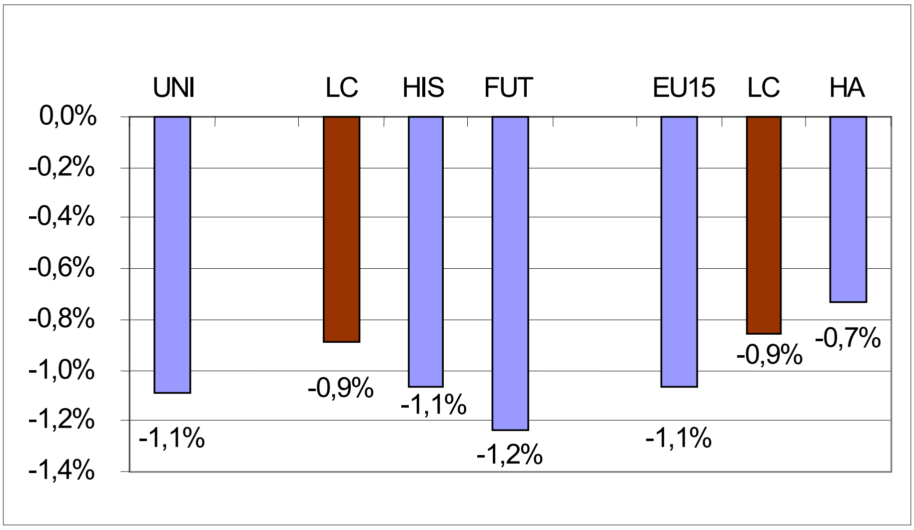
Finally it should be noted, that the strength of the effects differs between individual countries. Some of the main factors that influence this strength are discussed in the next section. In addition, the differences in the energy intensity as e.g. described for the chemical sector in the Benelux countries do play a role. For more details, see also Peterson (2003).

4.5 The Welfare Costs of Different EU Climate Strategies

The main goal of the EU emissions trading scheme is to reduce the welfare costs of meeting the European emission targets. Figure 9 shows the aggregated EU welfare changes relative to the BAU scenario in the different trading scenarios compared to a scenario where the individual commitments are reached unilaterally by a uniform, country specific CO_2 tax (UNI).

First, if optimally designed, the ETS leads indeed to cost savings. While the EU on average loses 1.1 percent welfare under unilateral action, this reduces to 0.9 percent in scenario LC. One important result of our simulations is, though, that the goal of cost reductions is achieved only if the allocation of allowances to the ETS is geared to the least cost allocation.

Figure 9 — Welfare Loss in the EU Relative to BAU



Comparing the welfare impact of reaching the Kyoto-target unilaterally with the two other trading scenarios based on actual and expected emission shares reveals no welfare gain. Apparently, the welfare gains from trading within the ETS are offset by the distortions created through the divergence of abatement costs between sectors inside and outside the ETS. These distortions are not present in the unilateral scenario, which is created under the – admittedly unrealistic – assumption of a uniform national CO_2-tax. Nevertheless, the results clearly indicate that distortionary allocation plans can quickly eliminate the gains from trading in the ETS.

Figure 9 also shows that without the cheap abatement options in the accession countries, the ETS would offer practically no efficiency gains. Again, the welfare gains from the trading regime are balanced by the distortions emerging from the difference in abatement costs between ETS installations and emitters outside the ETS. If we include the hot-air of the accession countries in the ETS, the welfare losses can be reduced to 0.7 percent. However, this gain is due to the fact that the overall amount of emissions is substantially higher than in the trading scheme without hot-air.

Turning to the economic costs for the individual EU member countries, these can differ considerably. Figure 10 shows the welfare changes across countries for the UNI and the LC scenario. Again, the welfare cost under LC is the light grey bar and under UNI, it is the sum of the light and dark grey bars.

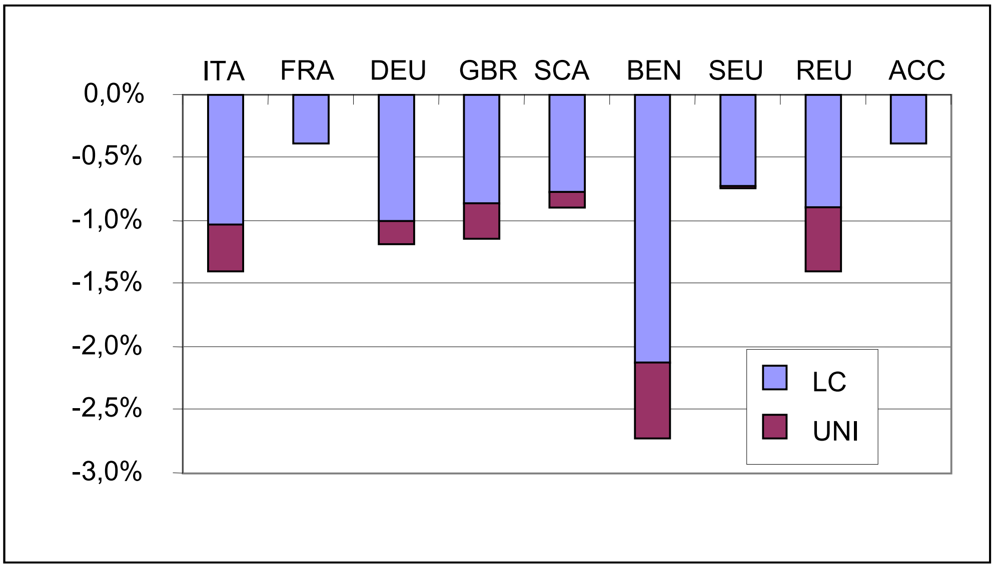
Except for France and the Southern European Countries (SEU) without Italy, all countries gain from importing allowances compared to a scenario without trading. The degree to which they gain depends on two factors:

- The strictness of the national Kyoto-target relative to the business-as-usual emissions, and
- the differences in abatement costs across different member states.

Both of these factors are illustrated by the implicit CO_2-taxes necessary to achieve the Kyoto-targets unilaterally (see Figure 5 in section 4.2). The largest gains from ETS accrue to the Benelux countries (BEN) and Austria and Ireland (REU) because they experience the largest difference between allowance price and unilateral tax rate.

France experiences no gains from trading in the ETS although it has the same implicit unilateral CO_2-tax as Germany, which can lower its welfare, costs from 1.2 percent to 1.0 percent. This is due to the fact that France is not trading many allowances because of its low emission intensity in the electricity sector. Hence, it can not reap large gains from trading as much of the emission reduction will need to take place outside the ETS.

Figure 10 — Welfare Loss Under the Least-Cost Allocation (LC) and Under Unilateral Reduction (UNI) Relative to BAU



A special case is that of the accession countries. It is surprising to see that these countries lose welfare compared to the BAU scenario (0.4 percent) even though they do not need to reduce emissions and sell emission allowances. The income received through the export of allowances marks the gains from allowance trading. Yet, there are some costs as well. By joining the ETS, these countries now face an allowance price in all ETS sectors thus reducing their competitiveness. This shows up in the simulations as lower production and lower exports mainly in the energy intensive Iron, metal and steel sector (IMS) which traditionally has a comparative advantage on international markets. It also carries over to non-ETS sectors through higher input and energy prices coming from ETS-sectors.

By comparing the welfare loss to ACC in the ETS to the unilateral scenario (UNI) we can identify the impact of the ETS. Under UNI, the region ACC experiences a welfare gain of 0.1 percent. This gain comes from the indirect effects of low cost abatement options. ACC exports energy-intensive products to the rest of the EU because their production cost including the emission constraint rise more than those in ACC. The introduction of the trading scheme raises allowance prices in the ACC such that the comparative advantage of the energy-intensive sectors is reduced. This trade effect can not be compensated by the income received from exporting allowances, as the volume is too small. However, if the ACC would use some of their hot-air, they could reduce allowance prices thus reducing the burden to their ETS sectors and at the same time increase the income from exporting allowances. In fact, with a supply of 25 percent of the hot-air available the welfare loss could be reduced to zero. Larger amounts of hot-air would even lead to a welfare gain for ACC of 0.8 percent relative to BAU:

5. Summary and Conclusions

The upcoming EU emissions trading scheme (ETS) for CO_2 evokes ambiguous reactions. Proponents advertise its contribution to the minimizing of the cost of meeting the European Kyoto targets. Opponents such as some policy makers and industry fear that it will have negative competitiveness effects for the participating sectors. So far, both positions have been based more on interested speculations than on sound modeling results. Indeed, the eventual results of the ETS are difficult to predict as long as the National Allocation Plans of the EU member states are not determined. In this paper, we have used the DART-model to simulate the ETS under different likely allocation plans. The results reveal new details about the likely allowance prices, about allowance trade flows as well as about cost savings and competitiveness effects that differ considerably across different allocation modes.

The first striking result is that the accession countries will be the only countries selling allowances, even without hot-air being included in the simulations. Their low cost abatement opportunities reduce the costs of reaching the European Kyoto targets considerably. This is for instance reflected in the difference between the allowance price (in the year 2012 when the ETS is in full operation) of 11 €$_{2000}$/t CO_2 if the accession countries are included in the ETS and 21 €$_{2000}$/t CO_2 if the accession countries would not participate.

The second main finding concerns the division of the costs of reaching the Kyoto targets between the sectors inside the ETS and those not participating. Given the Kyoto targets, the share of emissions allocated to the ETS automatically determines the emission reductions that are necessary in the sectors that do not participate in emissions trading. The optimal, cost minimizing allocation would be one that equalizes the marginal abatement costs of the

Kyoto target across all EU economies, e.g. through a trading scheme including all CO_2 emissions. Since the ETS covers only the energy-intensive industries overall efficiency can not be reached. However, the efficiency gains from the ETS depend strongly on the allocation plan that allocates the caps to the ETS and the non-ETS sectors. If the allocation plan is not based on abatement costs, but on actual or expected emissions the efficiency gains from trading allowances are partially or even completely offset by the distortions created between the ETS and the non-ETS sectors. In particular, the simulations show that such an allocation mode would in general lead to a higher amount of allowances allocated to the ETS than a least-cost approach. This, in turn, implies lower allowance prices (7 $€_{2000}$/t CO_2 instead of 11 $€_{2000}$/t CO_2) but also higher taxes in the non ETS sectors (on average 39 $€_{2000}$/t $CO_{2\text{ instead}}$ of 23 $€_{2000}$/t CO_2). As a result the ETS under historical or under expected emission shares does not lead to a welfare gain. Only the allocation rule with least-cost reductions clearly improves efficiency and creates welfare gains. These simulation results are based on the assumption of an efficient climate policy in the sectors outside the ETS. If, as it is to be expected, current inefficient instruments are tightened instead of being replaced by efficient ones, the distorting effects would be even larger thus further limiting the positive contribution of the ETS to overall welfare. However, this is not due to defects of the ETS itself but to the lack of a broader coverage of the ETS across all emitting sectors.

Turning to the competitiveness effects it should be clear that it is not the trading scheme that imposes new restrictions but the Kyoto-target itself. The ETS is only a means to achieve this target at higher or smaller social cost. If the ETS were to be introduced throughout the EU and if it would cover all sectors it would lead to considerable welfare gains compared to a situation where the Kyoto-targets need to be reached unilaterally. Even though this is not the case, under the least cost allocation (Scenario LC) there are still gains to be made from trading. One of the most remarkable simulation results is, that indeed all sectors gain from trade – not only the sectors participating in emissions trading. In addition, the overall competitiveness effects of the Kyoto-targets can become quite small with the ETS. In our simulations, total output in Europe decreases by less than 0.5 percent compared to a business as usual scenario. Output in all non-energy sectors falls by less than 2 percent. Only the fossil fuel and energy sectors naturally face higher losses. Finally, it is not true that the competitiveness of the ETS sectors is affected more than the competitiveness of the sectors outside. To the contrary, ETS sectors gain considerably from the cheap abatement opportunities in the accession countries. This gain is represented by the differences between the allowance price of 11 $€_{2000}$/t CO_2 in the ETS and the average tax outside the ETS of 23 $€_{2000}$/t CO_2.

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