The EU Emissions Trading Scheme and its Competitiveness Effects upon European Business Results from the CGE Model DART

Sonja Peterson

Kiel Institute for World Economics
Department of Environmental and Resource Economics
Duesternbrooker Weg 120, 24105 Kiel, Germany
speterson@ifw-kiel.de

Abstract

The upcoming EU emissions trading scheme will not only affect the cost structures and competitiveness of the sectors covered directly by the trading scheme, but – through changes in energy demand and thus energy prices – will also have repercussions on the entire EU market. As Europe is closely tied to the rest of the world by international trade, it will also change the position of European business on the world markets and is likely to influence international energy prices as well.

So far, research has been mainly confined to a qualitative analysis of the EU. Few studies – mainly focussing on Kyoto trading and not the EU scheme – have tried to give quantitative results. Other EU specific studies estimate abatement costs of emission reductions and prices, but ignore international effects. Against this background, the aim of this study is to assess the range of possible implications of the trading scheme using the computable general equilibrium model DART that accounts for European and international linkages. As a result, it is possible to estimate the direct economic costs for the European business as well the trade and competitiveness effects in a globalizing world.

Keywords: Emissions trading, EU, competitiveness, computable general equilibrium model

1 Introduction

If nothing unexpected happens, an EU-wide trading scheme for CO_2 emissions (further on denoted as ETS) will start in May 2005. The EU directive requires each member state to impose binding, absolute caps on 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. Altogether, around 10,000 industrial sites, responsible for about 45% of the EU CO_2 emissions, will be allocated emission allowances and be able to trade emissions from 2005 onwards. Countries are free to include other sectors. The first trading period until 2007 is seen as a test for the second trading period from 2008-12 that also belongs to the first commitment period of the Kyoto Protocol. For a summary of the EU directive, see Gagelmann and Hansjürgens (2002).

It is clear that this single largest market for emissions will affect the cost structures and competitiveness not only of the sectors covered directly by the ETS but – through changes in energy demand and thus energy prices – will have repercussions on the whole EU market. As Europe is closely tied to the rest of the world by international trade and as the ETS covers sectors where international competition is strong, it is especially important to account for international effects: The ETS will change the position of European business, whose main players are in fear of losing competitiveness in the world markets due to higher energy prices. In addition, international linkages imply that the effects of the EU ETS for European business depend on climate policies in other major economies, e.g. the USA, which may or may not undertake emissions reductions and participate in international Kyoto emissions trading.

Many existing studies only estimate abatement costs of emission reductions and permit prices for different emissions trading regimes, ignoring international effects (e.g. Capros and Mantzos 2000a,b; Capros et al. 2002). General equilibrium studies on emissions trading in the EU either focus on Kyoto trading (Viguier et al. 2003; Zhang 2002) or analyse scenarios that are not very close to the trading regime as it is outlined in the EU directive (e.g. Böhringer 2002). Even though the details of the ETS and especially the amount of emissions allocated to it are still not entirely clear, it is now possible to simulate the ETS more realistically. The aim of this paper is to assess the range of possible competitiveness effects of the ETS for European business accounting for European and international linkages. Section 2 defines competitiveness and analyses the different international effects. Section 3 and 4 then attempt to assess the implications of the ETS quantitatively, using the computable general equilibrium (CGE) model DART. DART is designed for analysis of international climate policies and is especially able to capture general equilibrium and international effects on energy prices as well as on the different sectors in the different regions. Section 5 concludes.

2 Emissions trading and competitiveness in a globalizing world

The impact of environmental regulation (including emission targets) on competitiveness has received considerable attention in the last few years (Jenkins 1998). In the context of emissions trading and environmental policy in general, the discussion centres on so-called international industry level competitiveness, which is best defined in relation to the respective industry in other countries. This competitiveness consists of the ability of specific industries to compete for market share with businesses located in other countries, which affects the location of production across countries (Sinner 2002). Thus, it is usually related to performance in international trade and in trade theory; this kind of competitiveness is denoted comparative advantage. The main concern with environmental policies is that production may be shifted to countries with less strict environmental standards (Sinner 2002). The effect that energy-intensive industries, due to emission restrictions within a certain region, move to non-abating regions with increasing emissions is denoted ’leakage effect’.

Measures of industry level competitiveness are usually based on total or net exports (= exports minus imports) and then adequately normalized (Jenkins 2002). They are generally referred to as Revealed Comparative Advantage (RCA) and there are different RCA indices (see for example Balance 1988). For this paper the RCA of commodity X is defined as the logarithm of the ratio of the value of exports to the value of imports of commodity X normalized/divided by the ratio of the value of all exports in one country to the value of all its imports. Other relevant variables for industry level competitiveness effects are sectoral output, sectoral exports, market shares and gross and net energy prices (Klepper 2003).

Turning to the effects of the European ETS on industry level competitiveness, the driving forces are the energy prices. Compared to the business as usual (BAU) scenario without any European emission restrictions, the ETS increases gross energy prices in the sectors covered by the ETS and implies a change in relative prices of the goods produced. The substitution effect decreases demand for energy and for energy intensive goods. This lowers net energy prices, not only in Europe, but since Europe is responsible for a considerable share of world energy demand, in the rest of the world as well. On the other hand, sectors not covered by the ETS face higher prices for intermediate inputs from sectors subject to emission constraints. In addition, emission restrictions decrease European income (income effect) leading to lower domestic and import demand. Via the same mechanisms, the policy of the remaining countries can influence the European economies. In fact, the competitiveness effects of emissions trading schemes in general depend largely on the coverage of the scheme and the extent to which foreign governments follow a similar policy for regulating emissions (Klepper 2003). As a result, the magnitude and – in sectors not covered by the ETS and in the non-EU countries – also the overall direction of the effects depends to a large degree on the magnitude of reductions in regions outside the European ETS. Summarized, a multilateral emissions trading regime, like the EU scheme, leads to the following:

a restructuring of demand and production towards less energy-intensive goods in the participating countries, an overall reduction in production and a shift of energy-intensive production to the non-participating countries. At the same time, even though all firms face the same permit price in the trading scheme, the effect on industries in different countries differs since the CO_2-intensity of economic sectors may vary widely between economies (Klepper 2003).

Naturally, these effects become stronger with increasing emission restrictions. For this reason the number of permits allocated to the ETS in each European country makes a big difference. In addition, the ETS is only one part of the European strategy towards reaching its Kyoto target. If and how this overall target is reached – in the sectors covered by the ETS as well as in the sectors outside – has thus a large impact as well. Yet, what will happen, particularly in the sectors not covered by the ETS is quite unclear.

Another important issue is the choice of the counterfactual (Klepper 2003). Evaluating the EU ETS always implies a comparison to some other scenario. This counterfactual scenario is usually a BAU scenario in which there are no additional climate policy measures that go beyond the current state of regulation. Against a BAU scenario the European ETS induces economic costs. An alternative approach is to assess the efficiency gains of the ETS by comparing it to a policy alternative that achieves the same emission target but with a different policy instrument. Compared to unilateral action, for example, a European ETS is less costly.

Existing empirical studies are mostly concerned with environmental stringency of taxes but not explicitly with emissions trading. Most studies cannot find significant competitiveness effects of conventional environmental expenditures of firms, and the competitiveness of an industry rather depends on general conditions such as the trade intensity, labour costs, exchange rates and innovation (Shin 2003; Barker and Johnstone 1998). On the other hand, competitiveness effects may become more important as it is not only likely that future climate polices induce higher economic cost than past measures but also they are pervasive throughout the economy and require a fundamental restructuring of the economy (Barker and Johnstone 1998).

In this paper, the computable general equilibrium model DART will be used to quantify the different effects of the European ETS under different reduction scenarios.

3 Simulation of competitiveness effects of the EU emissions trading scheme

3.1 The DART model

The DART (**D**ynamic **A**pplied **R**egional **T**rade) Model is a multi-region, multi-sector recursive dynamic CGE model of the world economy. Here, it is used with an aggregation covering 17 regions and 12 sectors (which are summarized in Table 1) and the production factors labour, capital, land and natural resources. The economic structure is fully specified for each region and covers production and final consumption. Each market is perfectly competitive. Output and factor prices are fully flexible. For each region, the model incorporates two types of agents: producers distinguished by production sector and the final consumer, which comprises a representative, household and the government.

The DART model is recursive-dynamic, and thus solves a sequence of static one-period equilibria for future time periods. The major driving exogenous factors of the model dynamics are population change, the rate of labour productivity growth, the change in human capital, the savings rate, the gross rate of return on capital, and thus the endogenous rate of capital accumulation. The savings behaviour of regional households is characterized by a constant savings rate over time. The static part of the DART-Model is currently calibrated to the GTAP5 database that represents global production and trade data for the year 1997. In addition, the elasticities of substitution for the energy intermediate goods coal, gas and crude oil are chosen to reproduce the emission projections of the EIA (EIA 2002). For a more detailed description of the DART-Model, see Springer (2002), Klepper et al. (2003).

Table 1. Dimensions of the DART-Model

Country/Region		Production Sectors	
GBR	United Kingdom	Energy	
DEU	Germany	COL	Coal
FRA	France	GAS	Natural Gas
ITA	Italy	CRU	Crude Oil
SCA	EU-Scandinavia	OIL	Refined Oil Products
BEN	Benelux	EGW	Electricity
SEU	Spain, Portugal, Greece		
EEU	Eastern Europe	Non Energy	
REU	Rest of EU	IMS	Iron Metal Steal
EFT	Norway, Iceland, Switzerland	PPP	Pulp & Paper Products
USA	USA	CEP	Chemicals Products
FSU	Former Soviet Union	AGR	Agricultural Production
PAO	Rest Annex B	TRN	Transport Industries
MEA	Middle East, North Africa	MOB	Transportation
CPA	China, Hong-Kong	Y	Other manufactures & services
IND	India		
ROW	Rest of the World	CDG	Savings Good

3.2 Formulation of policy scenarios

As the sectoral definitions in GTAP are hard to translate to those of the EU directive, and as it is not possible to separate installations that fall below the capacity thresholds, the European ETS is approximated by including the sectors IMS, PPP, OIL, CRU and EGW (see Table 1). They cover in the model about 45% of total

EU emissions, which is close to the estimated 46% of the actual trading regime. As discussed above, there are a number of conceivable scenarios that differ with respect to the countries that undertake emission reductions, the emission targets and how the targets are reached. In this paper, the analysis has to be confined to the comparison of only a few scenarios that highlight possible outcomes.

Besides the BAU scenario with no emission reductions, there are three scenarios of EU emissions trading. In the first, most lax scenario (ET-0), the European countries only restrict their emissions in the sectors covered by the ETS. In a second scenario (ET-K), all European regions also control their emissions in the sectors not covered by the directive to reach their overall Kyoto targets. This is intended to highlight the role of emission reductions in other sectors. While there are no emission reductions in the remaining countries in these first two scenarios, in the third scenario (AXB) the other Annex B countries also reach their Kyoto target. As it is not yet clear how Kyoto trading can be linked to the EU trading regime, it is assumed that the targets are reached unilaterally with unilateral CO_2-taxes.

The CO_2 targets in all scenarios are chosen in line with the Kyoto targets as specified in the EU Burden Sharing Agreement, that is, the Kyoto Protocol itself. Sinks are not accounted for. For scenario ET-0, the target for the sectors included in the ETS is calculated by multiplying the sectoral emission share for DART's calibration year 1997 by the Kyoto target. This so-called historical approach is advocated by the European Commission (2003) as one possibility for defining targets. For the Eastern European countries, it is assumed that none of their excess emissions ("hot-air") is available in the ETS and the target is equal to the benchmark emissions. The question for scenario ET-K is how to define the sectoral targets outside the ETS. Some studies assume equal percentage reductions in all sectors. This leads to unrealistic high abatement costs in some sectors including the mobility sector and the gas sector. For this reason a least cost approach – also advocated by the EU Commission (2003) – is assumed for all European regions. To generate the least-cost targets, DART is first run under the EU Kyoto constraints with internal emission trading in every European region. The resulting sectoral emissions are then used to set the targets in and outside the ETS. Figure 1 shows the emissions targets in the different scenarios compared to the BAU emissions. As the sectors outside the ETS have comparable high marginal abatement costs relative to those in the ETS, the least-cost emission allocation to the EU ETS used in the scenarios ET-K and AXB implies stricter emission targets for the sectors inside the ETS than the historical approach used in scenario ET-0. Altogether, 5% fewer emission rights are allocated to the EU ETS under the least-cost allocation than under the historical approach. Figure 1 also shows that, because of the Burden Sharing Agreement, the ETS sectors in Germany, Great Britain and the Benelux countries face the largest absolute emission reductions.

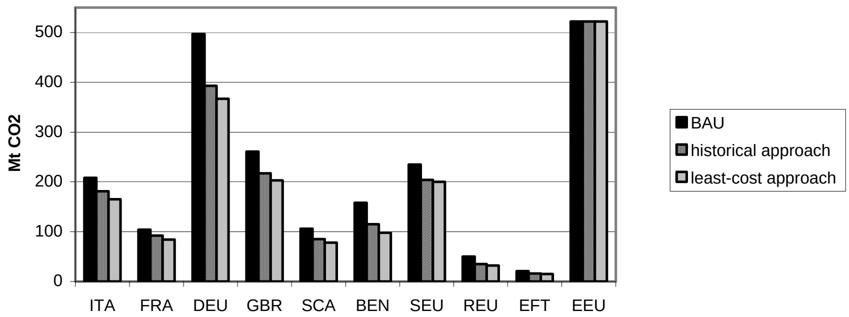

Fig. 1. BAU Emissions and Emission Targets of the ETS Sectors

In the sectors outside the ETS the targets are reached by a uniform regionally differentiated CO_2-tax[1]. The same assumptions are used for scenario AXB. Emission reductions always start in 2005 and continue linearly until the target is reached in 2012. Table 2 summarizes all scenarios[2] **.**

Ta**ble 2.** Policy scenarios analysed with DART

BAU	Business as usual; no emission reductions
ET-0	EU emissions trading in the sectors that are covered by the EU directive. The sectors not covered by the directive do not face any emission targets. The targets are calculated using the historical approach. No hot-air is included in the ETS. There are no emission restrictions in the remaining, non-European countries.
ET-K	The same as ET-0, but the sectors not covered by the EU directive also face emission targets that are achieved by uniform regional CO_2-taxes. The targets are calculated using the least cost approach.
AXB	The same as ET-K, but now the other Annex B regions restrict their emissions to reach their Kyoto target by means of a uniform (regional) CO_2-tax.

4 Simulation results

All results that are reported are for the year 2012, the end of the second trading period.

[1] This means that each region in the DART model individually sets a tax that is the same for all sectors outside the ETS in this DART region.

[2] Note that the BAU scenario does not account for measures to reduce CO_2 emissions that were implemented after the calibration year 1997, such as the German Ecotax. Including these measures would reduce the difference between the BAU scenario and any of the three ETS scenarios.

4.1 Permit prices and permit trade

One of the major outcomes of the EU ETS that will determine its competitiveness effects and that is of major interest to decision makers is the permit price. Current estimates vary between 5 and 30€ /tCO_2. In the simulations with DART[3] the price turns out to be 8.5€ /tCO_2 in scenario ET-0, 12.5€ /tCO_2 in scenario ET-K and 14.5€ /tCO_2 in scenario AXB. The first reason for this variation is that the emission target in scenarios ET-K and AXB is stricter than in scenario ET-0 (see Figure 1). The second reason originates from the differences in energy prices in the scenarios. The higher the emission restrictions in and outside the EU, the lower the world energy demand and the lower the energy prices in and outside the EU (see Appendix). Other things equal, lower energy prices imply an increased energy demand and increased emissions in the ETS sectors. Thus, the same target can only be achieved with increased shadow prices. As overall emission restrictions increase by moving from one scenario ET-0 to ET-K to AXB, so do permit prices.

Turning to permit trades, the simulation results show that the discussion concerning who is selling and who is buying permits in Western Europe becomes entirely redundant when the Eastern European countries join the ETS. Even though there is no hot-air allowed in the scenarios, Eastern Europe is basically the only seller of permits. Assuming that each sector receives permits in accordance with its historical emission shares, that is, the least-cost emission shares, Figure 2 displays the resulting net permit purchases in the different regions and sectors across the three scenarios. Eastern Europe (EEU), which is not included in the figure, sells the remaining emission rights.

What happens in Eastern Europe is that the highly emission-intensive electricity sector cuts down its production by 15 to 20% relative to BAU, depending on the scenario. Instead, electricity imports increase by 30 to 55% relative to BAU. Some of the electricity emissions are thus shifted to other countries. The resulting disposable permits of the electricity sector amount to almost 90% of total permit sales of Eastern Europe. To a smaller degree, the same happens in the other energy intensive sectors inside the ETS: they cut down production in order to reduce their emissions and sell permits, and domestic supplies are substituted by imports. As regards the hot-air, the sectors outside the ETS do not face any emission restrictions in Eastern Europe, the factors previously employed in the ETS now move to the sectors outside the ETS where output increases.

[3] Assuming an exchange rate of 1.0971 US$ in 1997 = 1€ in 2000.

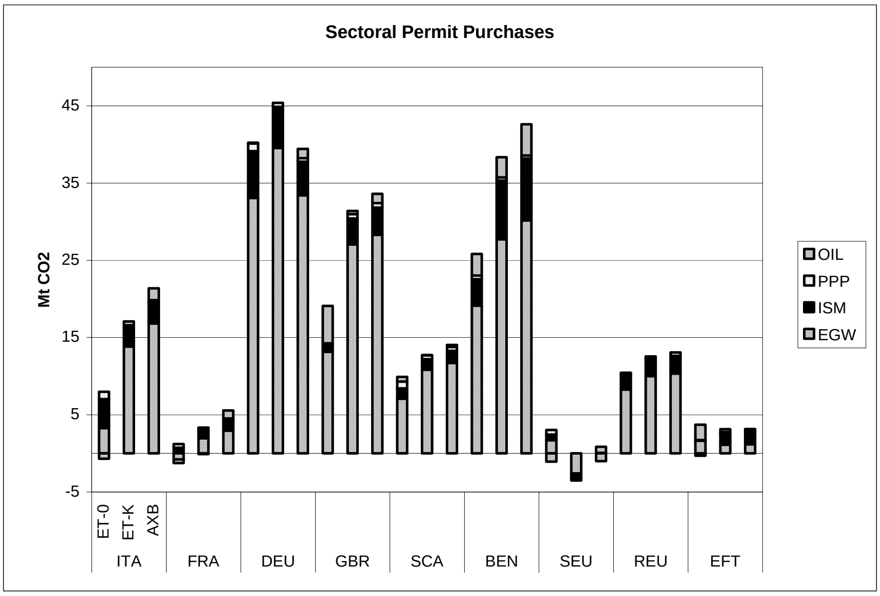

Fig. 2. Sectoral Permit Purchases in $MtCO_2$ in 2012

4.2 Scenario ET-0

The aim of the rather unrealistic scenario ET-0 with no emission reductions outside the ETS is to separate the "partial effects" of the ETS per se from those that include the reduction policies in the non-ETS sectors. The simulation results[4] show that the ETS as a stand-alone measure only has small macroeconomic effects. Welfare and GDP remain practically unaffected. Total output of the energy and energy intensive sectors taken together falls by less than 1% in all European regions except Eastern Europe. International competitiveness of EU business, as measured by the RCA (see Appendix), is hardly affected. As the European regions are mainly trading among themselves, the RCA in the sectors that are responsible for over 95% of exports (the non-energy sectors and in EFT also the crude oil sector) remains almost constant.

What is more interesting is that the indirect effects of the ETS that come through changes in gross energy prices and demand or prices of intermediate inputs tend to dominate the direct effects that are determined by whether a sector is covered by the ETS or not. In other words, the sectors covered by the ETS are not necessarily affected more considerably than the sectors not covered by the ETS.

[4] Results regarding sectoral output changes, the price of the energy aggregate and the RCA are reported in the Appendix. More detailed results e.g. regarding exports are available from the author upon request.

As coal is the most emission-intensive fossil fuel and is, moreover, mostly used for generating electricity, the coal sector exhibits the largest reductions in output, even though the sector is not covered directly by the ETS. As a result, coal output in the EU decreases by 6.5%. In the electricity sector, whose emissions are restricted, EU output decreases only by around 3%.

Another examples are the pulp and paper sector and the chemical sector. Both are energy intensive sectors, but the chemical sector outside the ETS is affected more considerably by the ETS (on average –0.3% output compared to BAU) than the pulp and paper sector (on average –0.2%).

4.3 Scenario ET-K

The EU ETS is only part of the European strategy for reaching the European Kyoto target. In scenario ET-K, it is assumed that the Kyoto targets will be reached efficiently by a regional CO_2-tax and that the reductions in and outside the ETS are determined in a cost-effective manner (least-cost allocation). The results in Table 3 show that the necessary CO_2-taxes are much higher than the permit price in all regions except Southern Europe. The reasons are that the sectors covered by the ETS are, in general, sectors with comparatively low abatement costs and that the ETS leads to an equalization of marginal abatement costs in the ETS sectors throughout Europe.

Table 3. Permit Prices and CO_2-tax in €/tCO_2 in scenario ET-K in 2012

Permits	Regional CO_2-tax								
in ETS	ITA	FRA	DEU	GBR	SCA	BEN	SEU	REU	EFT
12.5	22.8	16.6	21.6	26.4	25.6	46.8	11.2	48.9	46.9

Clearly, the sectors outside the EU ETS are thus affected more considerably than the sectors inside, which profit from the cheap abatement possibilities- especially in Eastern and Southern Europe. While the energy intensive sectors inside the ETS, for example, lose on average less than 1% in output compared to the BAU scenario, the chemical and mobility sector outside the ETS lose 2 to 2.5%.

4.4 Scenario AXB

Scenario AXB is again a stylised and rather unrealistic scenario (the USA, for example, will most likely not reach their Kyoto target in 2012), but it is intended to shed some light on the role of the non-European countries. The main effect of emission reductions in the other Annex B countries is that European energy prices decrease relative to the energy prices in the scenario with unilateral emission reductions. As a result, some production of energy intensive goods is shifted from the other Annex B countries to the EU, and European energy intensive sectors in scenario AXB gain in competitiveness compared to scenario ET-K. Looking at the RCA's (see Appendix) of the chemical sectors and the iron, metal, steel sectors, which are energy intensive, reveals that the major exporting regions such as Germany, Great Britain, the Benelux countries and the EFTA countries gain in competitiveness compared to scenario ET-K. For example, in the chemical sector in Great Britain, the RCA in scenario AXB is even higher than in the BAU scenario. The negative effects of the European emission restrictions are thus offset by the gains in competitiveness. The effects of scenario AXB can also be seen in Figure 3, which shows the relative changes in the combined output of the energy sectors and energy intensive sectors (IMS, PPP, CEP and MOB) in all three ETS scenarios. The decrease in output in scenario AXB is much less than in scenario ET-K. Some countries like France and the EFTA countries can even increase their output relative to the BAU scenario. Altogether, the EU is better off in scenario AXB than in scenario ET-K and profits from the emission reductions outside Europe.

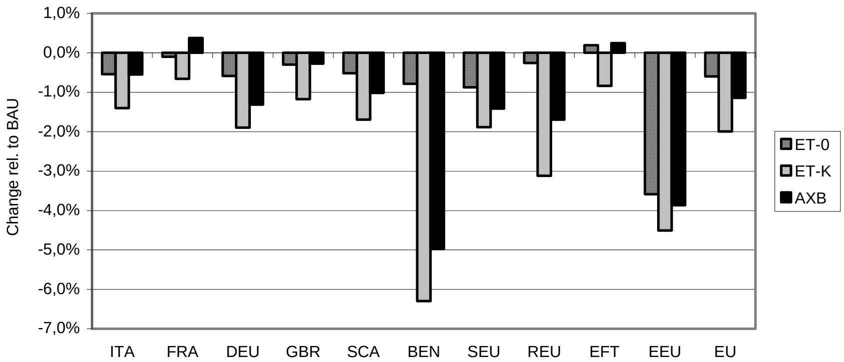

Fig. 3. Changes in Total Output of the Energy and Energy Intensive Sectors in 2012

4.5 Regional differences – the electricity and chemical sectors

What clearly matters for the strength of the effects in the different EU regions, are the emission intensities. Here, we take the electricity sector and the chemical sector as an example. Figure 4 shows the output changes in the three scenarios of these two sectors.

In the case of the electricity sector, the two most exceptional cases are those of France and the EFTA countries that include Norway and Iceland. In both regions electricity generation does not mainly depend on CO_2-intensive coal as in the rest of Europe, but in the case of Norway and Iceland it is generated by hydropower and in the case of France by nuclear power. As a result, the overall emission intensity of electricity is almost zero in EFT and still exceptionally low in France. As a result, the electricity sectors in both regions are not seriously affected by the EU ETS. They can even increase their output of low CO_2-intensive electricity within the more restricted overall world emissions. In scenario AXB, French electricity output is 1.7% higher than in the BAU scenario and electricity output in EFT even 7.3% higher. The electricity sectors in both regions are only buying low quantities of permits. Another special case is Eastern Europe. Here, emission intensity is still quite considerable in all sectors so that it is cheaper to reduce production and to sell permits (see also paragraph 4.1). It becomes clear though, that sectoral output is not always a good measure of competitiveness, as it ignores the fact that the sectors gain from selling their permits.

In the chemical sector, the large output loss in the Benelux countries is striking. The reason for this is the large CO_2-tax that is necessary to reach the overall Kyoto target in the Benelux countries combined with the comparatively high emission intensity which is, for example, about twice the emission intensity of the Scandinavian chemical sectors. Note also, that these results are based on the assumption of a regional uniform CO_2-tax in the sectors outside the ETS. Moving away from the least-cost scenario, the result would become even more pronounced.

Figure 4 illustrates once again the major differences between the three scenarios. While the ETS as a stand-alone measure has relatively small effects, output changes are larger in scenario ET-K. In scenario AXB, the energy intensive sectors might even gain from an improved competitiveness.

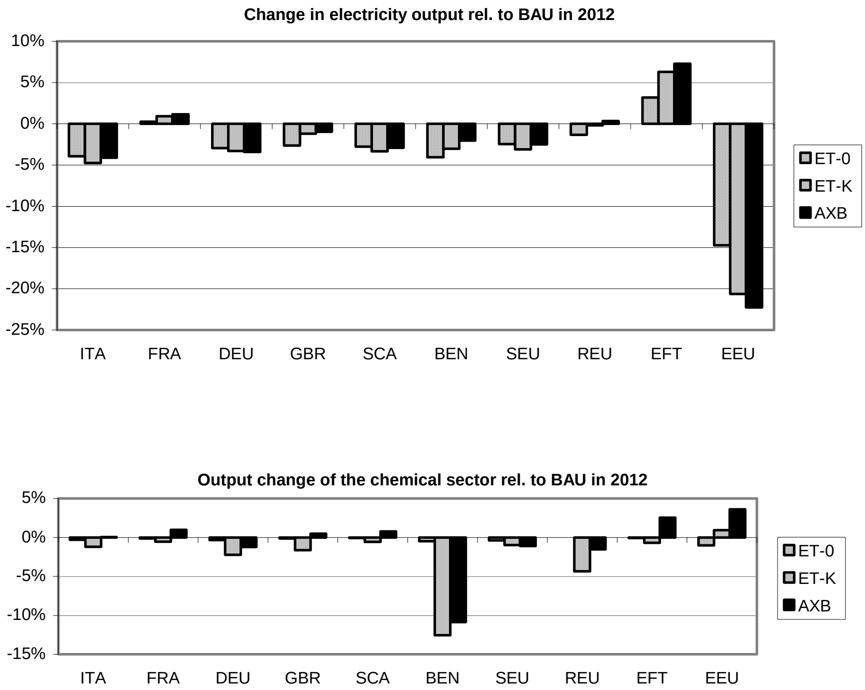

Fig. 4. Changes in the output of the electricity and chemical sectors relative to BAU

5 Summary and conclusions

The upcoming EU emissions trading scheme (ETS) will have – directly or indirectly – repercussions on the whole EU market. This article discusses the likely competitiveness effects of the EU ETS for European Business taking into account the effects that occur due to European and international linkages. Major determinates of the strength and sometimes even the direction of the effects are (a) the amount of emissions that are allocated to the sectors inside the ETS, (b) the treatment, i.e. the magnitude of reductions in the sectors not covered by the ETS and (c) the magnitude of emissions reductions in the rest of the world. For a specific EU country, the strength of the effects is also determined by the sectoral emission intensities and, especially, the emission intensity of the electricity sector.

To quantify the effects, the computable general equilibrium model DART was used. DART covers the major European regions and 10 other major world regions. The 11 energy and production sectors include the sectors covered by the EU ETS. Besides the business as usual scenario (BAU), three emissions trading scenarios were analysed that differ in the dimensions listed above. In a first scenario, there are no emission reductions in sectors or regions outside the EU ETS. The amount of emission rights allocated to the ETS is calculated by multiplying each region's Kyoto target with the historical (year 1997) emission share of the sectors included in the ETS. In a second scenario, the sectors outside the ETS are taxed with a regionally uniform CO_2-tax to reach the overall Kyoto target in each country. The allocation to the ETS follows a least cost approach. In the final scenario, the Annex B regions PAO and USA also reach their Kyoto target by means of a unilateral CO_2-tax.

The most striking result is that the only region to be selling permits is Eastern Europe, even though no hot-air is included in the simulations. Further, the simulation results show that the overall macroeconomic effects of the EU ETS alone are almost negligible. The only sectors that suffer from a loss of output and exports are the energy sectors, here primarily the coal and electricity sector. In addition, the sectors covered by the ETS are not necessarily affected more than the sectors outside the ETS, as indirect effects via changes in the prices of intermediate inputs dominate. The strength of the effects also depends on the sectoral emission intensity in each country. France and Norway/Iceland, which produce low CO_2 intensive electricity by using nuclear power, i.e. hydropower, can even profit from the ETS. The energy-intensive production sectors are not seriously affected in the first trading scenario. This is different if emissions are restricted in the sectors outside the ETS. As these are sectors with relatively high abatement costs; their gross energy prices rise considerably. As a result, these sectors suffer more than the sectors inside the ETS that profit from an equalization of marginal abatement cost across Europe. Nevertheless, as the lowest-cost approach allocates fewer permits to the ETS than the historical approach, and because the emissions restrictions in the sectors now subject to a CO_2-tax have repercussions on the sectors inside the ETS, the competitiveness effects in the ETS sectors increase as well.

If the other Annex B countries of the Kyoto Protocol also reduce their emissions, energy-intensive production is, to some degree, shifted from the other Annex B regions to Europe. Thus, Europe benefits from emission reductions in other regions and EU welfare increases compared to a scenario involving no foreign emission restrictions.

Summarized, the simulations show that under current likely scenarios of permit allocation, the EU emissions trading regime alone will have only small competitiveness effects on the European Business and only a negligible effect on the macroeconomic performance of the EU. Only if the ETS is part of the EU strategy to reach the Kyoto targets, do the effects increase . Nevertheless, if the emissions are also restricted outside the ETS, the sectors inside the ETS profit from the cheap abatement opportunities (especially in Southern Europe and Eastern Europe) and are affected less than the sectors outside the ETS. The strength of the effects depends to a large degree on the CO_2-intensity of sectoral production in each country. If other countries such as the USA and the rest of the Annex B countries decide to restrict their emissions as well, the non-energy sectors gain from a reduction in a shift of production. Overall, the EU is better off.

Nevertheless, there remain a large number of open questions. These include: the actual national allocation plans and the associated amount of reductions in and outside the trading scheme, the role of hot-air in and outside Europe, the role of the non-European countries and the role of the flexible Kyoto mechanisms. The current analysis is only capable of showing a range of possible outcomes. Once further information is available, it can be updated.

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Appendix – detailed simulation results for selected regions

More detailed results can be obtained from the author upon request.

Table A-1. Percentage Change in the Price of the Energy Aggregate PE in 2012 relative to the BAU scenario in 2012 in the Non-Energy Sectors in Selected Regions

	ITA	FRA	DEU	GBR	SCA	BEN	SEU	REU	EFT	EEU	PAO	USA	FSU
							ET-0						
EGW	11.1	4.3	12.0	10.7	12.5	12.9	11.4	9.9	2.6	20.5	-0.5	-0.3	-0.1
IMS	6.1	4.6	6.4	6.4	6.0	8.3	5.5	5.4	1.8	15.1	-0.3	-0.1	-0.1
PPP	5.7	3.6	5.1	5.2	4.3	5.6	5.1	3.8	1.7	13.8	-0.2	-0.1	-0.1
TRN	3.6	0.6	3.3	2.4	2.6	2.1	2.9	2.3	0.0	8.5	-0.1	-0.1	-0.1
MOB	0.5	0.6	0.8	0.6	0.3	0.3	0.6	0.6	0.6	1.2	-0.2	-0.2	0.0
CEP	1.4	0.6	1.3	0.9	1.0	0.9	1.1	0.9	0.4	2.7	-0.2	-0.1	0.0
AGR	2.2	0.6	2.2	2.2	1.4	1.8	1.7	1.4	0.4	3.4	-0.2	-0.1	-0.1
Y	3.1	0.6	2.0	1.8	2.0	1.2	2.2	1.7	0.3	6.9	-0.2	-0.1	0.0
							ET-K						
EGW	15.6	5.9	16.6	9.0	18.3	15.5	16.1	15.1	3.0	29.9	-0.9	-0.5	-0.7
IMS	8.3	6.1	8.5	4.9	8.4	9.7	7.5	7.8	1.8	21.6	-0.5	-0.3	-0.7
PPP	7.3	4.7	6.7	3.3	6.0	5.8	6.8	5.5	1.6	19.7	-0.4	-0.3	-0.7
TRN	9.4	5.6	7.7	7.6	8.6	17.0	6.5	11.2	5.3	11.9	-0.4	-0.2	-0.7
MOB	8.8	6.9	11.4	11.3	15.0	18.2	6.2	23.0	19.9	1.1	-0.7	-0.6	-0.6
CEP	9.5	7.1	11.2	10.8	12.5	19.7	6.3	23.7	16.9	3.2	-0.6	-0.4	-0.6
AGR	9.9	6.6	9.8	8.0	13.3	24.2	6.2	21.5	15.9	4.4	-0.5	-0.3	-0.6
Y	9.6	5.7	9.7	8.5	9.7	17.3	5.9	16.5	11.1	9.5	-0.4	-0.3	-0.6
							AXB						
EGW	14.1	5.1	17.9	8.2	18.0	14.0	14.8	15.9	2.7	32.3	60.2	53.9	-2.8
IMS	6.6	4.3	8.3	4.1	6.7	8.4	5.0	6.2	0.8	22.7	26.0	27.1	-2.7
PPP	6.7	3.7	6.5	2.6	5.5	5.2	4.7	4.8	0.2	20.5	21.6	23.9	-2.9
TRN	9.0	7.0	8.8	7.6	9.2	17.2	8.2	12.1	5.5	11.7	24.0	22.0	-3.4
MOB	6.0	4.6	10.7	9.5	16.4	16.9	7.4	23.1	20.6	-3.6	38.4	45.3	-3.8
CEP	7.6	5.7	11.6	9.5	13.5	19.4	7.6	24.8	17.5	0.0	32.6	35.1	-2.8
AGR	8.7	5.9	10.7	7.8	15.0	26.0	7.3	23.6	16.6	1.5	30.2	26.7	-3.2
Y	9.0	5.3	10.0	7.6	10.3	16.6	6.5	17.4	11.4	8.3	22.0	26.0	-2.7

Table A–2. Percentage Change in Total Sectoral Output in 2012 relative to the BAU scenario in 2012 in the Non-Energy Sectors in Selected Regions[5]

	ITA	FRA	DEU	GBR	SCA	BEN	SEU	REU	EFT	EEU	PAO	USA	FSU	EU	NEU
								ET-0							
COL	-28.4	-3.2	-8.3	-4.4	-3.3	-1.1	-4.9	-3.0	-3.0	-6.3	-0.7	-0.4	-0.6	-6.5	-0.4
OIL	-2.6	-1.1	-1.6	-0.6	-0.4	-1.9	-1.4	-1.7	-1.5	-1.6	0.1	0.1	0.5	-1.4	0.2
GAS	-1.7	-0.5	0.0	-0.1	-3.3	-0.6	-5.6	-3.1	-0.8	-0.6	-0.2	0.0	0.0	-0.8	-0.1
EGW	-3.9	0.3	-2.9	-2.6	-2.8	-4.1	-2.4	-1.3	3.2	-14.7	0.1	0.1	0.0	-3.0	0.3
IMS	-0.4	0.0	-0.4	-0.1	-0.8	-1.2	-1.3	-0.1	0.3	-5.6	0.2	0.2	0.8	-0.7	0.2
PPP	-0.2	0.0	-0.2	0.0	-0.5	0.0	-0.4	-0.3	0.0	-0.7	0.0	0.0	0.1	-0.2	0.0
CEP	-0.3	-0.1	-0.3	-0.1	-0.1	-0.5	-0.4	0.0	-0.1	-1.0	0.1	0.1	0.1	-0.3	0.1
*In the sectors CRU,Y,AGR,TRN and MOB the changes are below 0.4% in all regions															
								ET-K							
COL	-39.5	-5.8	-14.2	-9.2	-5.2	-1.9	-7.5	-6.3	-5.3	-9.3	-1.1	-0.6	-0.8	-10.6	-0.7
CRU	-0.5	-0.3	-0.4	-0.5	-0.5	0.0	-0.1	-0.7	-0.3	-0.3	-0.2	-0.1	-0.2	-0.4	-0.2
OIL	-5.1	-3.2	-5.8	-4.1	-3.5	-6.9	-4.0	-8.1	-7.7	-1.8	0.5	0.6	0.8	-4.7	0.6
GAS	-16.6	-24.3	-0.9	-3.7	-22.0	-13.4	-52.4	-47.0	-18.7	-1.5	-0.8	0.0	-1.1	-12.7	-0.8
EGW	-4.7	0.9	-3.3	-1.2	-3.3	-3.0	-3.1	-0.2	6.3	-20.6	0.2	0.2	2.1	-3.1	0.4
Y	-0.1	-0.1	-0.1	-0.1	0.0	0.5	-0.1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	0.0
IMS	-0.9	-0.4	-0.8	0.1	-1.4	1.0	-2.0	0.2	1.6	-8.5	0.1	0.1	1.4	-0.9	0.2
PPP	-0.5	-0.3	-0.6	0.0	-0.9	1.1	-0.8	-0.5	0.4	-1.3	0.0	0.0	0.2	0.0	0.0
AGR	-0.4	-0.2	-0.1	-0.1	-0.5	-1.7	0.0	-0.9	-1.0	0.6	0.0	0.0	0.2	0.0	0.0
TRN	-0.7	-0.4	0.0	-0.1	0.2	1.5	-0.6	0.9	0.3	-0.6	0.0	-0.1	0.0	0.0	0.0
MOB	-0.9	-1.4	-2.1	-1.5	-2.2	-7.2	-1.9	-4.7	-5.0	0.9	0.3	0.5	0.5	0.2	0.4
CEP	-1.2	-0.6	-2.2	-1.6	-0.6	-12.6	-1.0	-4.3	-0.7	0.9	0.7	0.6	1.7	0.6	0.7
								AXB							
COL	-68.8	-12.1	-19.0	-14.5	-9.6	-5.4	-13.0	-10.2	-11.4	-14.0	-9.7	-36.4	-2.4	-15.5	-16.7
CRU	-2.2	-1.7	-1.8	-2.2	-2.2	0.0	-0.4	-2.1	-2.1	-1.6	-2.6	-3.6	-1.4	-2.1	-2.0
OIL	-0.4	1.6	-2.2	-2.1	0.0	-1.2	-0.5	-3.1	-9.5	1.6	-14.1	-13.4	2.3	-1.1	-3.2
GAS	-26.4	-37.6	-2.4	-6.6	-38.0	-19.3	-76.7	-56.0	-26.4	-3.3	-31.9	-2.4	-2.6	-19.0	-6.9
EGW	-4.1	1.2	-3.4	-1.0	-2.9	-2.0	-2.5	0.3	7.3	-22.3	-6.6	-8.6	4.3	-2.9	-3.3
Y	-0.2	-0.2	-0.2	-0.2	-0.2	0.2	-0.1	-0.2	-0.5	-0.1	-0.3	-0.1	-0.3	-0.2	-0.2
IMS	-0.7	-0.4	-0.8	0.6	-0.5	1.6	-1.3	0.5	2.7	-9.2	-3.2	-1.7	4.2	-0.6	-0.1
PPP	-0.4	-0.3	-0.6	0.1	-0.7	1.2	-0.6	-0.4	0.8	-1.5	-1.1	-0.9	0.7	-0.3	-0.4
AGR	-0.3	-0.3	-0.1	-0.1	-0.6	-2.1	-0.1	-1.1	-1.1	0.8	-1.2	-1.4	0.9	-0.4	-0.4
TRN	-0.6	-0.5	0.1	0.2	0.7	1.7	-0.6	1.2	0.4	-0.4	-2.0	0.0	0.4	0.0	-0.4
MOB	0.5	0.4	-0.9	-0.4	-1.1	-4.4	-1.5	-3.2	-3.2	2.9	-2.6	-5.5	2.0	-0.6	-1.1
CEP	0.0	1.0	-1.2	0.5	0.8	-10.9	-1.1	-1.5	2.5	3.6	-5.8	-3.7	4.1	-0.9	-0.5

[5] The large changes in the GAS sectors in SEU and REU most likely stem from mistakes in the data base.

Table A–3. RCA in 2012 in Selected Regions (absolute values)

	ITA	FRA	DEU	GBR	SCA	BEN	SEU	REU	EFT	EEU	PAO	USA	FSU
BAU													
COL	-5.21	-3.46	-2.25	-2.16	-5.66	-4.27	-4.33	-5.86	-1.87	1.23	0.39	3.06	0.88
CRU	-5.10	-4.09	-3.21	0.71	-1.47	-5.15	-5.78	-5.74	2.89	-4.83	-1.37	-3.46	1.82
OIL	-0.22	-0.07	-1.48	1.57	0.04	0.36	-0.42	-1.34	0.04	0.03	-0.52	0.30	1.64
GAS	-6.19	-3.45	-3.24	-0.14	0.70	0.88	-10.54		2.64	-6.57	0.32	-3.32	0.85
EGW	-3.48	2.73	0.07		-0.02	-1.17	0.41	0.68	1.21	-0.01	1.53	-1.46	-0.16
Y	0.35	-0.06	-0.04	-0.04	-0.07	-0.12	0.12	-0.08	-0.32	0.04	0.01	-0.08	-0.98
IMS	-0.15	0.06	0.19	0.20	0.01	0.25	0.02	-0.01	0.21	0.55	0.39	-0.26	1.11
PPP	-0.07	-0.16	0.10	-0.20	1.53	-0.12	-0.05	0.05	-0.36	-0.15	0.41	0.40	-0.41
AGR	-0.55	0.32	-0.42	-0.31	0.19	0.36	0.18	0.40	-0.77	-0.03	-0.66	0.74	-0.84
TRN	-0.22	0.39	0.63	-0.10	0.00	-0.10	0.12	-0.39	-1.56	-0.18	0.63	-0.04	-1.21
MOB	-0.32	-0.36	-0.93	-0.23	-0.35	-0.13	0.59	0.13	-0.58	0.77	-0.35	0.29	0.27
CEP	-0.13	0.13	0.36	0.31	-0.13	0.24	-0.47	0.45	0.61	-0.27	0.08	0.59	-0.51
ET-0													
COL	-5.21	-3.26	-1.63	-1.89	-5.50	-4.12	-3.81	-5.70	-1.69	1.88	0.35	2.90	0.68
OIL	-0.23	-0.10	-1.51	1.55	0.03	0.34	-0.45	-1.36	0.02	0.02	-0.51	0.31	1.65
GAS	-6.20	-3.45	-3.24	-0.06	0.71	0.90	-10.56		2.67	-6.51	0.32	-3.32	0.83
EGW	-3.61	2.81	-0.02		-0.09	-1.29	0.34	0.70	1.36	-0.53	1.62	-1.38	-0.07
IMS	-0.16	0.06	0.18	0.20	0.00	0.24	-0.01	-0.02	0.22	0.46	0.39	-0.25	1.13
ET-K													
COL	-5.21	-3.05	-1.27	-1.55	-5.45	-4.04	-3.57	-5.43	-1.36	1.36	0.32	2.82	0.61
CRU	-5.05	-4.06	-3.16	0.78	-1.44	-5.08	-5.73	-5.62	3.02	-4.80	-1.37	-3.46	1.78
OIL	-0.24	-0.11	-1.51	1.59	0.07	0.39	-0.46	-1.35	0.06	0.01	-0.52	0.30	1.62
GAS	-6.22	-3.49	-3.07	0.88	0.53	1.31	-11.17		2.74	-6.52	0.31	-3.35	0.77
EGW	-3.67	2.83	-0.06		-0.13	-1.28	0.30	0.69	1.42	-0.76	1.65	-1.36	-0.03
IMS	-0.17	0.05	0.18	0.21	-0.01	0.27	-0.02	-0.01	0.24	0.41	0.39	-0.25	1.15
MOB	-0.34	-0.39	-0.98	-0.27	-0.39	-0.26	0.54	0.06	-0.58	0.84	-0.33	0.32	0.31
CEP	-0.15	0.13	0.33	0.29	-0.13	0.15	-0.48	0.41	0.61	-0.23	0.10	0.62	-0.47
ABX													
COL	-5.88	-3.18	-1.60	-1.82	-5.62	-4.14	-3.81	-5.60	-1.47	1.92	1.83	5.67	0.21
CRU	-5.14	-4.12	-3.21	0.71	-1.50	-5.15	-5.77	-5.71	3.02	-4.88	-1.22	-3.13	1.67
OIL	-0.19	-0.07	-1.48	1.55	0.11	0.42	-0.39	-1.30	0.00	0.03	-0.69	0.37	1.52
GAS	-6.63	-3.58	-3.08	0.95	0.17	1.28	0.00		2.68	-6.64	0.47	-2.81	0.69
EGW	-3.60	2.85	-0.06		-0.11	-1.22	0.36	0.72	1.46	-0.81	1.14	-2.01	-0.04
IMS	-0.16	0.05	0.18	0.22	0.00	0.27	0.00	0.00	0.27	0.40	0.26	-0.32	1.22
MOB	-0.29	-0.33	-0.94	-0.22	-0.36	-0.20	0.56	0.10	-0.62	0.92	-0.40	0.12	0.39
CEP	-0.12	0.15	0.35	0.33	-0.11	0.17	-0.48	0.44	0.64	-0.18	0.09	0.48	-0.41

The changes relative to BAU in the sectors not reported are negligible
RCA of region R and commodity X = log[(exports of X/imports of X)/(all exports of R/all imports of R)]