WIFO
ÖSTERREICHISCHES INSTITUT
FÜR WIRTSCHAFTSFORSCHUNG

WORKING PAPERS

ETCLIP – The Challenge of the European Carbon Market: Emission Trading, Carbon Leakage and Instruments to Stabilise the CO2 Price

The EU Emission Trading Scheme: Sectoral Allocation Patterns and the Effects of the Economic Crisis

Claudia Kettner, Daniela Kletzan-Slamanig, Angela Köppl

408/2011

ETCLIP – The Challenge of the European Carbon Market: Emission Trading, Carbon Leakage and Instruments to Stabilise the CO2 Price

The EU Emission Trading Scheme: Sectoral Allocation Patterns and the Effects of the Economic Crisis

Claudia Kettner, Daniela Kletzan-Slamanig, Angela Köppl

WIFO Working Papers, No. 408
November 2011

E-mail addresses: Claudia.Kettner@wifo.ac.at, Daniela.Kletzan-Slamanig@wifo.ac.at, Angela.Koeppl@wifo.ac.at
2011/264/W/1209

Medieninhaber (Verleger), Hersteller: Österreichisches Institut für Wirtschaftsforschung • 1030 Wien, Arsenal, Objekt 20 • Tel. (43 1) 798 26 01-0 • Fax (43 1) 798 93 86 • http://www.wifo.ac.at/ • Verlags- und Herstellungsort: Wien

Kostenloser Download: http://www.wifo.ac.at/wwa/pubid/42953

The EU Emission Trading Scheme – Sectoral allocation patterns and the effects of the economic crisis

Claudia Kettner*, Daniela Kletzan-Slamanig*, Angela Köppl*

JEL codes: Q54, Q58

Keywords: climate policy, emissions trading, EU Emission Trading Scheme

Abstract

The European Emission Trading Scheme (EU ETS) is a key instrument in European climate policy and covers emitters from the energy and manufacturing sector. The ETS pilot phase (2005 – 2007) was characterised by an oversupply of emission allowances mainly due to the 'generous' allocation of allowances by Member States. For the second trading phase (2008 – 2012) the European Commission aimed at increasing the stringency of the overall emission cap and took a more active role in approving Member States' National Allocation Plans. Due to the decline in economic activity and emissions in the course of the economic crisis, the cap, however, was only stringent in 2008 whereas 2009 and 2010 both showed a long position for EU total. Differences in national and sectoral caps are found for all years.

In this paper, we analyse differences in allocation patterns, i.e. in the stringency of the cap and in the spread between installations, until 2010. We focus on general sectoral allocation patterns and perform an in-depth analysis for three emission intensive sectors: 'power and heat', 'cement and lime' and 'pulp and paper'. Furthermore, we discuss the impact of the economic crisis on the emissions of these sectors in detail.

*WIFO, Austrian Institute for Economic Research

Introduction

The EU Emission Trading Scheme (EU ETS) that covers emitters from the energy generation and manufacturing sector came into effect in 2005. Phase 1, the pilot phase, ran from 2005 to 2007, the second phase covers the Kyoto commitment period 2008 to 2012. The EU ETS is a key instrument in European climate policy. The first trading phase was, however, characterised by an overall long position, i.e. a surplus of allowances, mainly due to the 'generous' allocation of allowances by Member States. For the second trading phase the European Commission aimed at strengthening the environmental effectiveness of the trading system and took a more active role in approving the Member States' National Allocation Plans. At the beginning of the second trading phase it was thus expected that the cap would represent a binding emission limit for the regulated installations. For 2008 this was the case when a short position – verified emissions exceeding allocated allowances – could be observed for the EU total. Due to the external shock of the financial crisis and the associated decline in economic activity and emissions in the regulated installations the cap, however, was only stringent in 2008 whereas 2009 and 2010 both showed a long position for EU total.

Differences in allocation patterns, i.e. in the stringency of the cap and in the spread between installations, have been analysed on Member State and sector level (see Anderson and di Maria (2011), Ellerman et al. (2010), Trotignon and Delbosc (2008), Ellerman and Buchner (2008) and Kettner et al. (2008) for an assessment of the first trading phase and Kettner et al. (2010) for an analysis of the period 2005 to 2008). In this paper, we extend the analysis of allocation patterns until 2010. We assess sectoral allocation patterns focussing on three emission intensive sectors: 'power and heat', 'cement and lime' and 'pulp and paper'. Furthermore, we discuss the impact of the economic crisis on the emissions of these sectors in detail.

The structure of this paper is as follows: We start with presenting the essential design elements of the EU ETS in the first and the second trading phase. Subsequently, we present our method for the analysis of allocation patterns based on the concept of short and long positions. We then analyse the empirical evidence on allocation patterns for the years 2005 to 2010 highlighting differences between the first and the second trading phase and discuss the impact of the economic crisis on a selection of emission intensive sectors. The final section concludes.

The design of the EU Emission Trading Scheme in Phase 1 and Phase 2

The EU ETS is a key instrument in European climate policy and covers 40% of total European greenhouse gas emissions (and 50% of CO_2 emissions respectively). Directive 2003/87/EC established the legal framework for greenhouse gas emission allowance trading in the European Union which started in 2005. In the first trading period (2005 – 2007) and the second trading period (2008 - 2012) CO_2 emissions from eight installation types are covered by the EU

ETS[1]. Seven activities that have to be included in the EU ETS by the Member States are explicitly specified: mineral oil refineries, coke ovens, production and processing of ferrous metals, cement and lime production, glass production, ceramics production as well as the production of pulp and paper. The most important category of installations included in the EU ETS is, however, combustion installations with a rated thermal input exceeding 20 MW. This category of installations does not only include installations from the energy sector, but also combustion activities in industrial sectors such as the food or chemical industries.

The EU ETS is the biggest cap-and-trade scheme worldwide. In the first two trading phases the Member States were responsible for allocating emission allowances to sectors and installations via National Allocation Plans. The National Allocation Plans had to follow certain criteria[2] defined in the emissions trading directive (2003/87/EC) and needed to be approved by the European Commission. Given the experience from the pilot phase the EU Commission took a more active role in evaluating and revising Member States' National Allocation Plans for the second trading period. On average proposed national allocations were cut by 10.4% in the Commission review. Only the caps of four EU Member States (Denmark, France, Slovenia and UK) were not revised. Caps proposed by the new Member States were most strongly corrected downward (see Capoor and Ambrosi, 2008). Several Member States objected the revisions by the European Commission (Kettner et al., 2010). For Poland and Estonia the demanded cuts in the national caps were annulled by a judgement of the European Court of 23 September 2009 (Case T-183/07 EC Commissions vs. Poland; T-263/07 EC Commission vs. Estonia). In the post-Kyoto period (2013 – 2020) the national caps will be replaced by an EU wide ETS cap (see Kettner et al. 2010).

EU Allowances (EUAs) issued by the Member States for the pilot phase were only valid in the period 2005 to 2007, i.e. no banking between the trading phases was possible and at the end of the first trading phase unused allowances became worthless. EUAs issued for the Kyoto commitment period (2008 - 2012) but not submitted for compliance in contrast may be banked and used in the post-Kyoto period running from 2013 to 2020. Grandfathering was the predominant allocation method in the first and second trading phase: At least 95% of allowances in the first trading phase and 90% in the second trading phase had to be distributed to the installations free of charge in accordance with their historical emissions as defined in the Emissions Trading Directive (2003/87/EC). The remaining share of allowances could be auctioned by the Member States. For the post-Kyoto period auctioning is defined as the dominating allocation method in Article 10 of Directive 2009/29/EC. Installations from

[1] For the second trading period France and the Netherlands unilaterally included also installations emitting nitrous oxide (Capoor and Ambrosi, 2008). Furthermore aviation will be included in the EU ETS from 2012 on (Directive 2009/29/EC).

2 The criteria include consistency with the Member State's emission target and projected progress towards fulfilling the target, considerations regarding the activities' (technical) potential for reducing emissions, consistency with other Community legislation and policy instruments, avoidance of unduly favouring certain undertakings (related to State aid provisions), provisions for new entrants, and early action (see Kettner et al. 2008).

sectors that are exposed to carbon leakage according to Commission Decision 2010/2/EU will, however, receive free allocation based on EU-wide sectoral benchmarks.[3]

Method of data analysis

Basis for the analysis of the impact of the EU ETS are verified emissions and allocated allowances. The Community Independent Transaction Log (CITL) registers allocated allowances and verified emissions on installation level. Each year in spring verified emissions for the previous year are published in the CITL. This information is complemented by allocated free allowances by installation[4]. Since April 2011 allocation and emissions data are available in the CITL for the years 2005 to 2010. Since 2006, WIFO collects these data and assigns it to sectors using information from the Member States' National Allocation Plans for the first and the second trading phase. The database contains more than 10,000 installations. For approximately 9,000 installations allocated allowances and emissions are available for all years. The WIFO database allows a comprehensive ex-post analysis of the performance of the EU ETS, i.e. to identify differences or similarities in allocation patterns between EU Member States, sectors and different types of installations.

The analysis of allocation patterns is based on the indicators developed in Kettner et al. (2007):

- the **short position** and the **long position** of an installation as the difference between allocated allowances and verified emissions
- the **gross long position** of a sector or a country as the sum of all long positions of the installations of a sector or a country
- the **gross short position** of a sector or a country as the sum of all short positions of the installations of a sector or a country
- the **net long position** of a sector or a country as the balance of the gross long and the gross short position if the balance is positive, i.e. if the gross long position exceeds the gross short position
- the **net short position** of a sector or a country as the balance of the gross long and the gross short position if the balance is negative; i.e. if the gross short position exceeds the gross long position

With the four indicators – gross long, gross short, net long and net short – the differences between allocated allowances and actual emissions, the allocation discrepancies, can be calculated in tonnes or in percent of allocated allowances. A net short position indicates that the emission cap was binding, while a net long position indicates a non-binding cap.

[3] Details on changes in the design of the EU ETS between the second and the third trading phase are e.g. discussed in Kettner et al., 2010.

[4] Allowances that were auctioned by the Member States or distributed to new entrants are not recorded in the CITL.

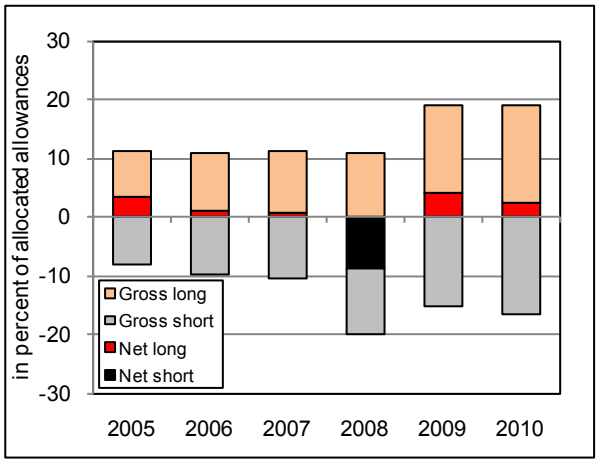
Stringency of the allocation caps

The stringency of the emission cap can be interpreted as indication of the environmental effectiveness of the emissions trading system. This question is addressed in the following section where we present the results of our analysis of allocation discrepancies in the EU ETS. The analysis is based on data on allocated allowances and verified emissions for the period 2005 to 2010 for 25 Member States; separate analyses are carried out for the two trading periods. Bulgaria and Cyprus are not included in the analysis as data on verified emissions for these countries are not yet available for all years. As Romania joined the EU ETS not until 2007, for Romania values for 2007 are used for the analysis of the first trading phase instead of average values for the period 2005 to 2007.

EU wide cap

In the pilot phase and the second trading period the overall cap of the EU ETS is the result of the national emission caps set by Member States in their National Allocation Plans. In the ETS pilot phase (2005 - 2007) substantial over-allocation of emission allowances was observed in most EU Member States and the overall EU emission cap was not stringent for any year. Due to rising emissions in the EU ETS[5] over the period 2005 to 2007 the surplus of allowances or the net long position declined, however, from year to year: While the EU ETS was in a net long position of 3.4% in 2005, for 2006 and 2007 a net long position of 1.23% and 0.79% was observed respectively (Figure 1).

Figure 1. Stringency of the EU-wide cap



Source: CITL; authors' own calculations.

[5] Allocation of the sample of installations remained, constant with two exceptions: Denmark reduced the amount of allowances allocated to the power sector in 2006 by 25% compared to 2005 (see Kettner et al., 2008); Spain did no longer assign allowances to gas and oil fired power plants in 2007.

For the second trading phase the European Commission took more influence in the Member States' National Allocation Plans (see above). Most proposed national caps had to be adjusted downwards by the Member States after the European Commission's review process. With cuts of 47% to 56% the Baltic States faced the strongest adjustments (see Capoor and Ambrosi, 2008). For 2008, total allocated allowances were reduced by 285 Mt (14%) compared to the first trading phase (from 2,070 Mt to 1,785 Mt). EU ETS emissions, in contrast, only showed a minor decline of 4% between 2007 and the first trading phase (from 2,030 Mt to 1,994 Mt).

Table 1. Development of allocated allowances and emissions in the EU ETS by sector

	Allocation				Verified emissions			
	Phase 1 in m	**2008** in m	**2009** in m	**2010** in m	**Phase 1** in Mt	**2008** in Mt	**2009** in Mt	**2010** in Mt
EU	**2,070**	**1,785**	**1,785**	**1,791**	**2,030**	**1,944**	**1,713**	**1,745**
Cement and Lime	191	194	195	198	184	176	142	143
Ceramics	16	16	17	17	14	12	8	8
Glass	21	20	20	21	19	19	16	17
Iron and Steel	197	200	200	200	164	157	111	135
Non-specified	21	16	17	17	16	15	14	15
Other	197	204	208	209	166	176	159	168
Power and Heat	1,233	950	942	942	1,293	1,215	1,100	1,098
Pulp and Paper	41	40	41	41	32	32	29	31
Refineries	152	144	145	147	142	142	134	131

Source: CITL; authors' own calculations.

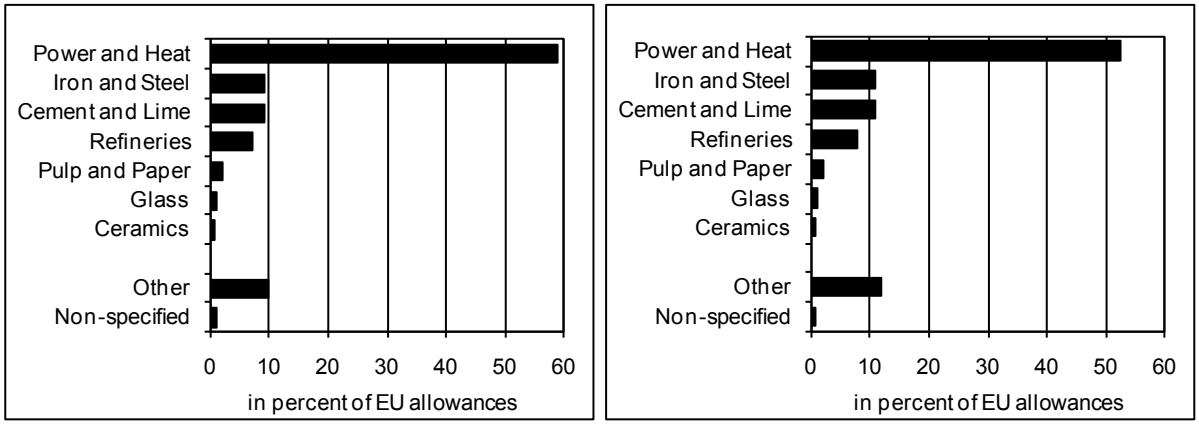
For 2008 the overall EU cap was binding with verified emissions exceeding allocated allowances on aggregate by 8.81%. Under the assumption of a regular development of economic growth and production activities this would suggest an increased incentive for emission abatement measures resulting from the cap and rising allowance prices. For 2009, however, a totally different picture was observed: The unexpected exogenous shock of the economic crisis to the sectors/installations in the trading system translated into a sharp drop in verified emissions. Allocation again exceeded verified emissions showing a net long position of 3.99%. Although 2010 already exhibits a recovery of the economy which also results in a modest rise in emissions, the EU wide emissions cap is again not binding, i.e. a net long position of 2.53%, is observed (see Figure 1).

Sectoral caps

In the following, we present our analysis of allocation patterns on sector level. We differentiate between the sectors 'power and heat', 'cement and lime', 'iron and steel', 'refineries', 'pulp and paper', 'glass' ,'ceramics' as well as 'other' sectors and 'non-specified' sectors. The category 'other' sectors comprises combustion installations from all sectors other than specified, e.g. in the textiles or food industries; the category non-specified includes all installations that we could not assign to a particular sector because of lacking specification in the National Allocation Plans.

With respect to allocated allowances the sector 'electricity and heat' dominates the EU ETS in both trading phases (see Figure 2). In the ETS pilot phase (2005 – 2007) amost 60% of the total allocated allowances accrued to this sector. The sectors 'iron and steel' and 'cement and lime' each accounted for approximately 9% of the total EU allowances. In the second trading period the power and heat sector's share in total EU allocation declined by approximately 6%. The shares of the other sectors in turn slightly increased, especially for the sectors 'iron and steel' and 'cement and lime'[6].

Figure 2. Sector shares in EU allocation in Phase 1 (left) und Phase 2 (right)

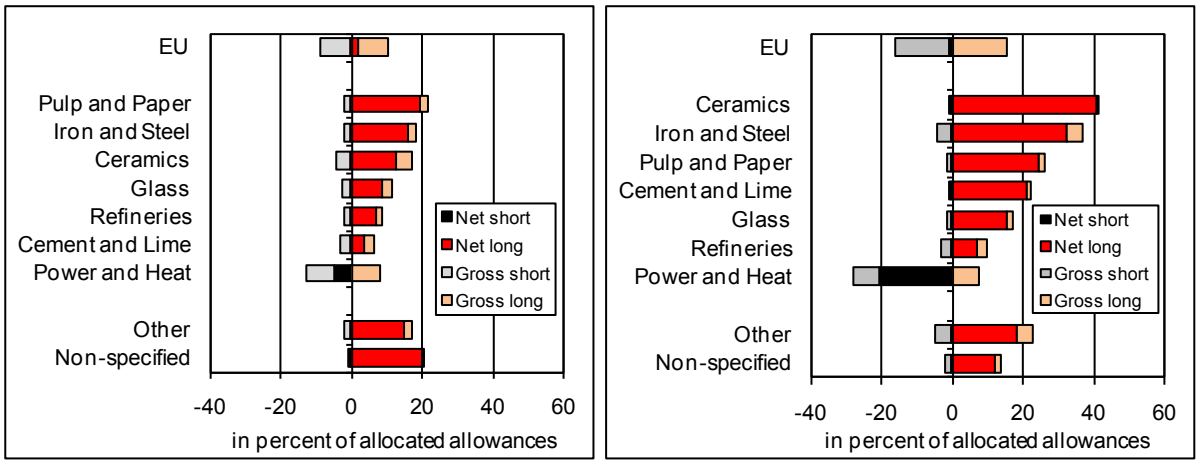


Source: CITL; authors' own calculations.

In Figure 3 the (sectoral) allocation discrepancies of the first and the second trading phase are compared. In the first trading period, the EU ETS on aggregate was in a net long position of 1.9% (40 Mt) which is the balance of a gross short position of 8.5% and a 10.4% gross long position. In the first three years of the second trading period, we observe a net short position of 0.8% (13.8 Mt) resulting from a 16% gross short position and a 15.3% gross long position. In both trading phases, the sector 'power and heat' has been the only sector in a net short position, i.e. only in this sector verified emissions on average exceeded allocated allowances. The net short position of the energy sector was even more pronounced in the second trading phase (20% compared to 5% in the EU ETS pilot phase) illustrating also its lower share in allowance allocation as described above. All other sectors in contrast showed rather pronounced net long positions in both trading periods, i.e. in these sectors allocation significantly exceeded verified emissions. The highest surplus of certificates is observed for the sectors 'ceramics', 'iron and steel' as well as for 'pulp and paper'.

[6] This implicitly shows the EU Commission's considerations of the threat of carbon leakage or a loss in competitiveness.

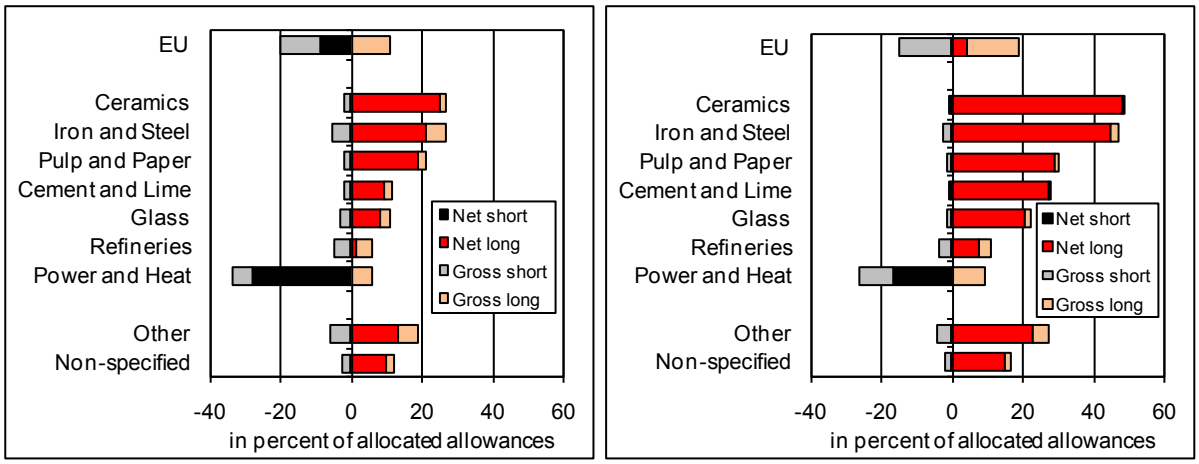
Figure 3. Long and short positions by sectors in Phase 1 (left) und Phase 2 (right)



Source: CITL; authors' own calculations.

The results of the first three trading years of the Kyoto period mirror different developments as discussed above: On the one hand, in 2008 the allocation of allowances was more restrictive than in the first trading period. On the other hand, in 2009 emissions declined considerably in the course of the economic crisis. Figure 4 illustrates differences in allocation patterns between 2008 and 2009 on sector level. The two years were chosen for illustration as they depict pronounced differences mainly due to the economic downturn. For 2010 the sectoral net positions resemble the pattern of 2009. It becomes obvious that in both years only the sector 'power and heat' was in a net short position. In 2009, the net short position of the sector, however, declined from 28% to 17%. The net long positions of the remaining sectors in contrast almost doubled between 2008 and 2009. In both years, the highest net long position is found in the sector 'ceramics' (24.9% in 2008 and 48% in 2009) followed by the sectors 'iron and steel' (21.2% and 44.6%) and 'pulp and paper' (19.1% and 28.9%). For 2010, although there was a slight increase in emissions, the cap is still non-binding resulting in a net long position of 2.9%.

Figure 4. Long and short positions by sectors 2008 (left) und 2009 (right)



Source: CITL; authors' own calculations.

Differences in allocation patterns, i.e. in the stringency of the cap, have already been anticipated before the start of the EU ETS as Criterion 11 in the design guidelines for the National Allocation Plans states that 'the plan may contain information on the manner in which the existence of competition from countries or entities outside the Union will be taken into account' (Directive 2003/87/EC). Sectoral differences in allocation patterns hence were analysed in different ex-ante and ex-post studies of the EU ETS. Kolhus and Torvanger (2005) e.g. showed sectoral differences in allocation that were motivated by competitiveness concerns. Ellerman et al. (2007) concluded that most Member States put a tighter cap on the energy sector because of competitiveness issues on the one hand and the sector's emission reduction potential on the other hand. This discussion is also reflected in the new design elements of the EU ETS for the post-Kyoto period defined by the new ETS directive (2009/29/EC). From 2013 on, preferential allocation rules will apply for sectors potentially affected by carbon leakage; i.e. allowances to these sectors will be distributed based on sector-specific benchmarks. For the other sectors the distribution of allowances will be based increasingly on auctioning (see Kettner et al. 2010).

Detailed evidence for selected ETS sectors

In the next section differences in allocation patterns on Member State level are discussed for three emission intensive sectors: 'power and heat', 'cement and lime' and 'pulp and paper'.

Power and heat

The sector 'power and heat' comprises more than 3,000 installations in all Member States. In the first trading phase on average 1,233 million allowances p.a. were allocated to installations in the sector 'power and heat'; annual emissions amounted to 1,293 Mt. Installations from Germany accounted for 28% of the total allocation to this sector, Poland for 14% and 10% of allowances accrued to installations in the UK and Spain respectively (see Figure 5 (a)). Differences in the share of allocated allowances do not only reflect differences in the sizes of

the countries but also differences in the structure of the energy sector: As electricity production in France is mainly based on nuclear energy whereas the German power sector relies heavily on coal, Germany's share in allocated allowances is eight times as high as France's.

On average, in the first trading phase the 'power and heat' sector was in a net short position in eleven countries (see Figure 5 (b)). The highest relative net short position arose in Spain with 50% where in 2007 no allowances were assigned to oil and gas power plants[7]. The highest net short position in absolute terms showed for the UK with 42 Mt. The energy sector installations of the remaining 14 countries were in a net long position in the first trading phase: The highest relative net long positions was observed for Lithuania (46%), the highest absolute net long position showed for the Czech Republic with 7 Mt.

In the second trading phase, on average 945 millions of allowances p.a. were allocated to the energy sector and 1,138 Mt of emissions were verified. As indicated in Figure 5 (c) the sector 'power and heat' was in a net short position in 17 out of the 25 countries. The highest net short position in percent of allocated allowances arose in Sweden with 140% as a strict cap was imposed on installations in the sector 'power and heat'[8]; the highest absolute net short position accrued to Germany with 91 Mt. Seven countries were in a net long position; the highest relative net long position showed for Slovakia with 34%, the highest absolute net long position accrued to Czech Republic with 5 Mt. Compared to the first trading phase a slightly higher spread of allocation discrepancies, i.e. more pronounced gross long and gross short positions, were observed within Member States. The overall spread of long and short positions remained, however, small within the sector.

Cement and lime

The sector 'cement and lime' comprises more than 480 installations from 23 Member States. No installations from Latvia and Malta are included in this sector. In the ETS pilot phase (2005 – 2007) on average 191 million allowances p.a. were allocated to installations in this sector; annual verified emissions from cement and lime production on average amounted to 184 Mt indicating the generous allocation for this sector on EU level. Spain, Germany and Italy together accounted for more than 46% of allocated allowances (see Figure 6 (a)). In the first trading phase, the sector 'cement and lime' was in a net short position in five countries. The highest relative net short position showed for Slovenia with 8% of the sector's allocated allowances, the highest absolute net short position showed for Italy with 1.6 Mt. In the remaining 18 countries the sector was in a net long position. The highest relative net long position was observed for the Netherlands with 24%, the highest absolute net long position

[7] In 2005 and 2006, Spain allocated a small number of allowances compared to the verified emissions of these installations.

[8] The reason for the restrictive allocation of allowances were the higher emission reduction potential in electricity and heat generation and that the sector is "not exposed to competition from other countries outside the European trading scheme to any significant extent" (Swedish Ministry of Sustainable Development, 2006, p. 28f).

accrued to the Polish 'cement and lime' sector with 2 Mt. In six countries, allocated allowances exceeded verified emissions for all installations in the sector in the first trading phase. The spread of allocation discrepancies is rather small for most Member States (see Figure 6 (b)).

In the second trading phase, on average 196 millions of allowances p.a. were allocated to installations in the sector 'cement and lime' and 154 Mt of CO_2 emissions were verified. The sector was thus in a net long position in all countries as illustrated in Figure 6 (c). The highest relative net long position accrued to Romania with 41%, the highest net long position in absolute terms showed for Spain with a surplus of 9 million allowances. In the first years of the second trading phase, in ten countries allocated allowances exceeded verified emissions for all installations in the sector 'cement and lime'. Overall, the spread of allocation discrepancies is negligible for most countries except for Austria, Slovenia and Slovakia.

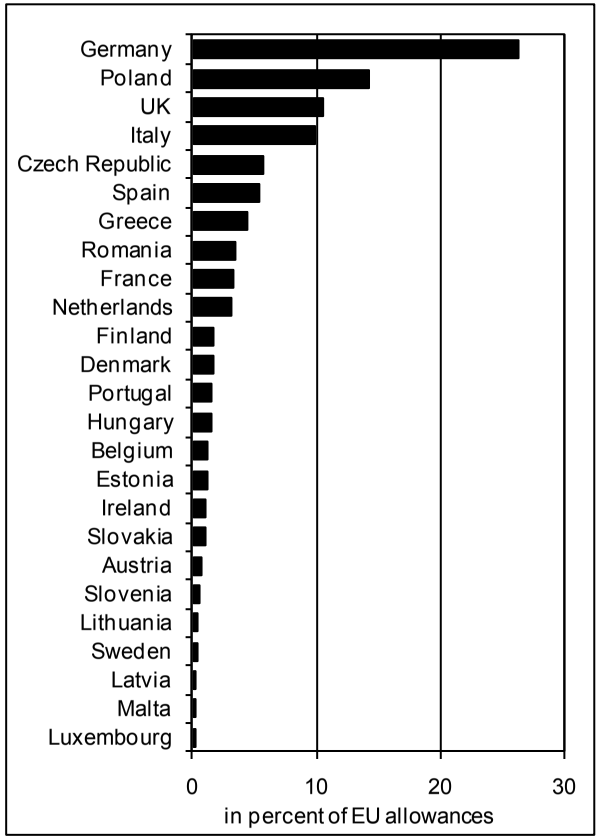
Pulp and paper

The sector 'pulp and paper' covers more than 700 installations in 22 EU Member States. For Luxembourg and Malta no installations are included in this sector; Ireland included one plant only for the first trading period. In the first trading phase, on average 41 million of EUAs p.a. were allocated to the sector, while only 32 Mt of CO_2 emissions were verified. As indicated in Figure 7 (a) more than 45% of the sector's allocated allowances accrued to installations in Germany, Spain and Italy. Pulp and paper production was in a net short position only in Italy and Latvia in the first trading period; in the remaining 20 countries the sector was in a net long position (see Figure 7 (b)). The highest relative net long position showed for Estonia with 42%, the highest absolute net long position accrued to the German installations with 2.3 Mt. In five countries, allocated allowances exceeded verified emissions for all installations in the ETS pilot phase. Generally, the spread of allocation discrepancies is again small within Member States.

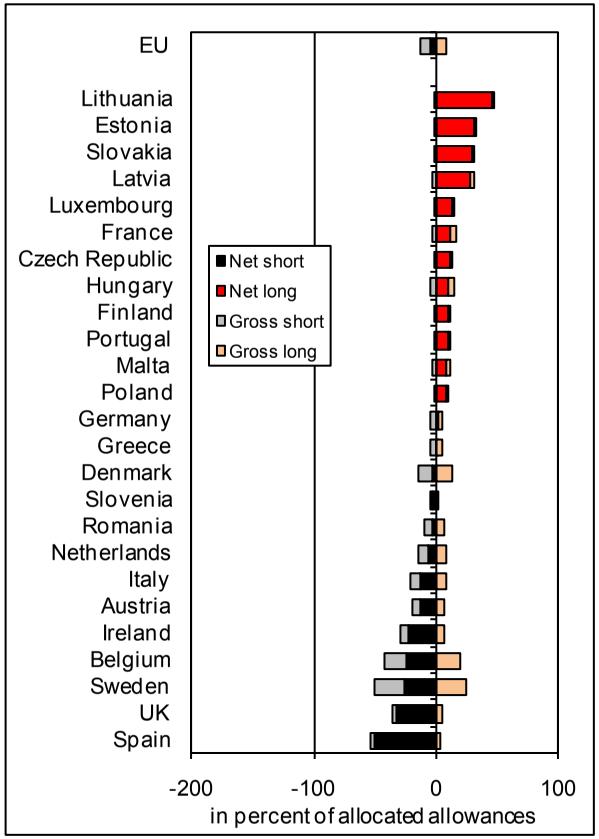
In the second trading phase, 41 million of allowances p.a. were allocated to installations in the sector 'pulp and paper' and 31 Mt of emissions were verified. For all countries, the sector is in a net long position in the second trading phase as indicated in Figure 7 (c). The highest relative net long position showed for Romania where allocated allowances exceeded verified emissions by 74%. The highest absolute net long position accrued to Germany with 1.7 million. In six countries, allocated allowances exceeded verified emissions for all installations in the period 2008 to 2010. The spread of allocation discrepancies within Member States decreased compared to the first trading phase. In the Kyoto commitment period, only for Estonia a considerable spread among installations is observed.

Figure 5. Power and heat

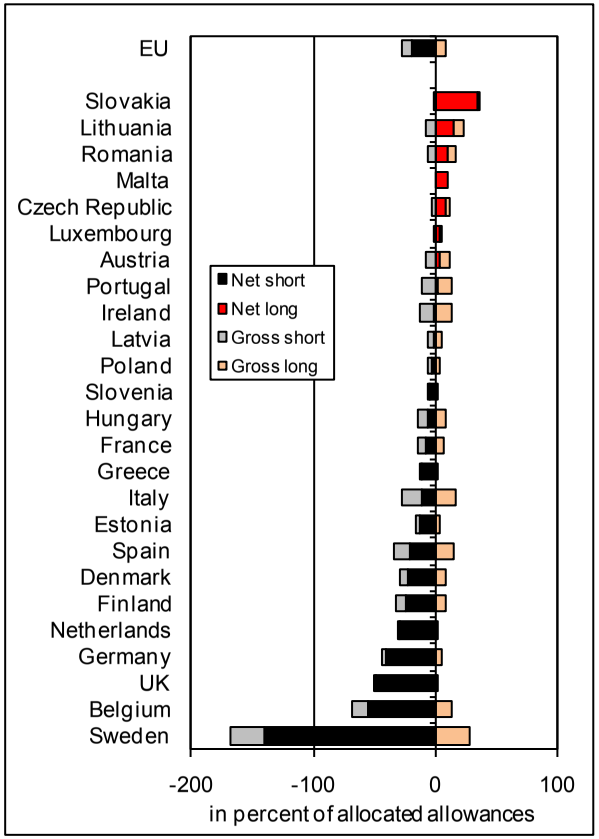
(a) Countries' shares in EU allocated allowances



(b) Long and short positions in Phase 1



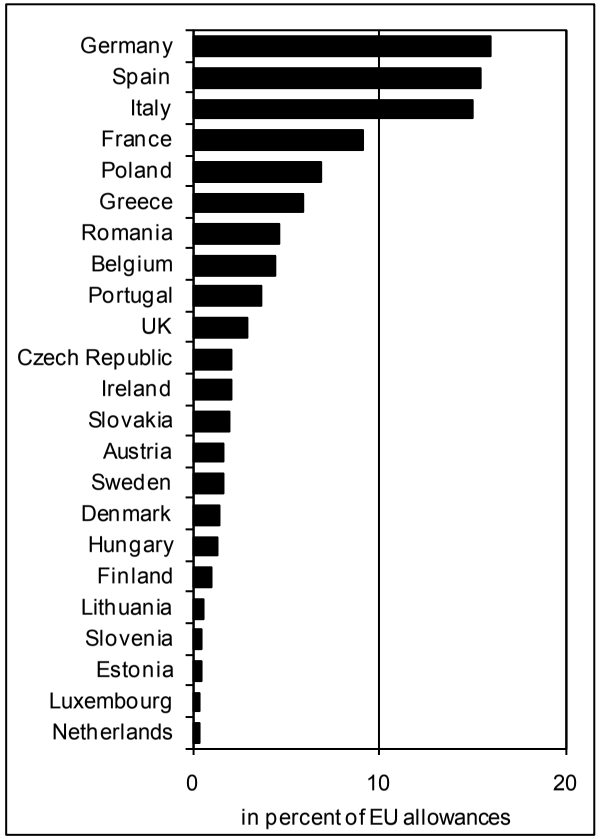
(c) Long and short positions in Phase 2



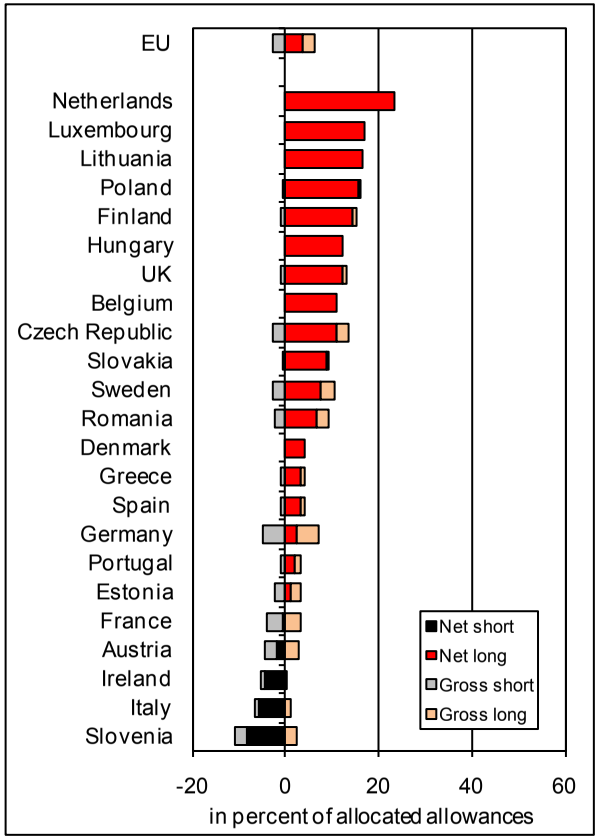
Source: CITL, authors' own calculations.

Figure 6. Cement and lime

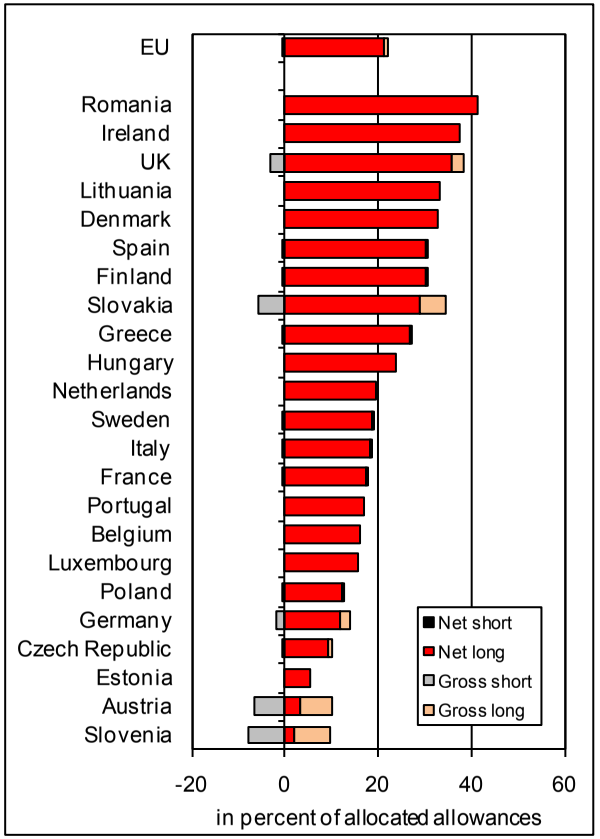
(a) Countries' shares in EU allocated allowances



(b) Long and short positions in Phase 1



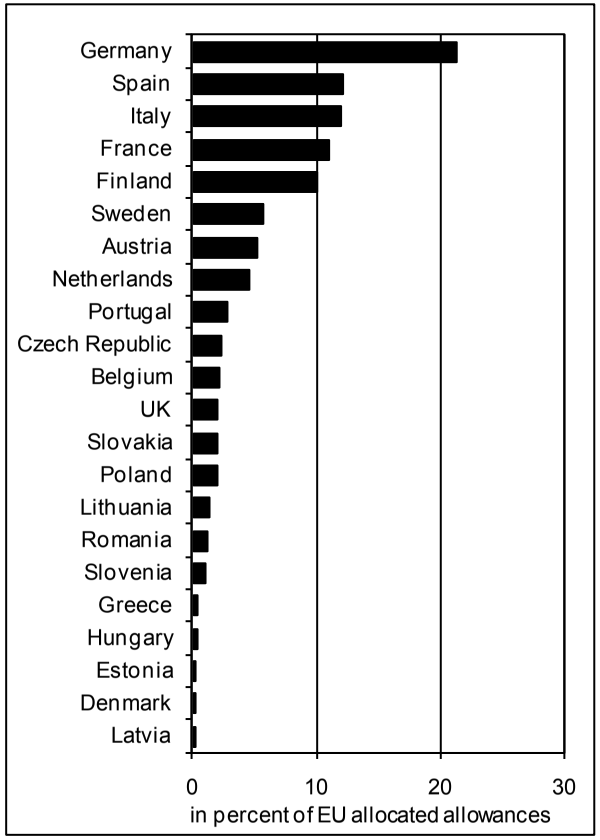
(c) Long and short positions in Phase 2



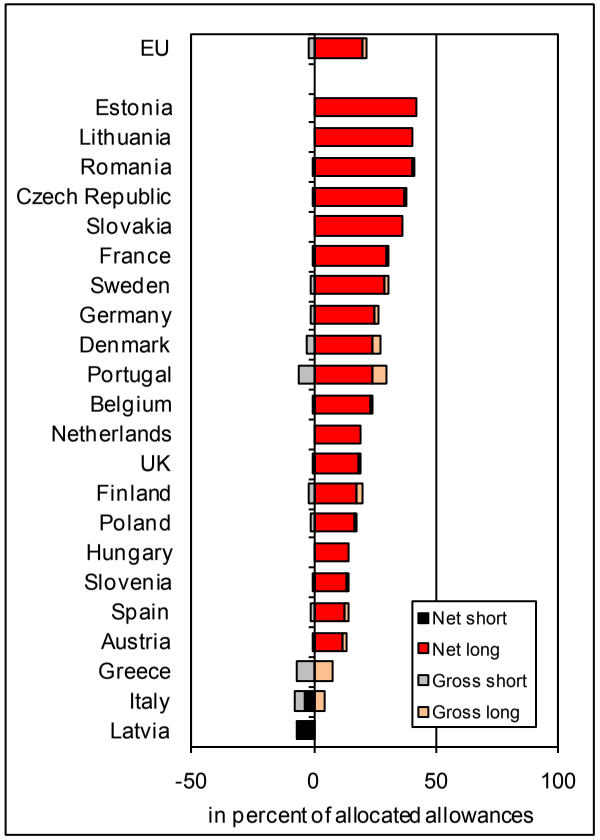
Source: CITL; authors' own calculations.

Figure 7. Pulp and paper

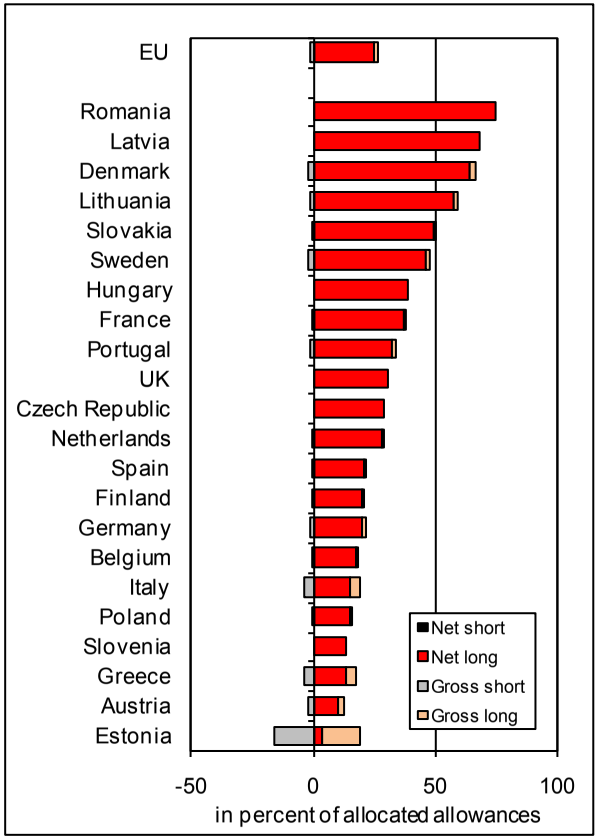
(a) Countries' shares in EU allocated allowances



(b) Long and short positions in Phase 1



(c) Long and short positions in Phase 2



Source: CITL; authors' own calculations.

The effects of the economic crisis on emission intensive industries

The EU Emission Trading Scheme was introduced with the objective of achieving emission reductions in the regulated sectors in a cost efficient way. Meanwhile there is a lively discussion in economic literature whether or not the EU ETS effectively achieved abatement or not. Several studies conclude that abatement has taken place despite the over-allocation of allowances (see e.g. Ellerman et al., 2010, Egenhofer et al., 2011, Anderson and di Maria, 2011). The analyses have, however, to be interpreted with caution given the uncertainty they related to the fact that actual emissions can only be compared to an assumed Business as Usual projection, i.e. estimates regarding the counterfactual no-policy case.

In this section we aim to contribute to this discussion by analysing the development in the selected energy intensive EU ETS sectors (as described above) in more detail regarding their production, energy use and CO_2 emissions.

However, we start by taking a look at the aggregate, macroeconomic level, i.e. the development of GDP, energy use, and emissions between 2005 and 2009 at the level of the total EU, the EU 15 and New Member States as well as Austria. In addition, we calculate the respective energy intensity (primary energy per unit of GDP) and emission intensity (CO_2 per unit primary energy). These intensities are related to principal options for reducing CO_2 emissions:

- the improvement of energy efficiency of total economic activity which is related to technological change and
- the improvement of emission efficiency of energy use which is achieved by substituting carbon intensive fuels by low carbon or renewable alternatives.

In a second step indicators are calculated for total manufacturing. We assess the development of gross value added, energy use, emissions as well as the resulting intensities. The separate analysis of manufacturing, which is chosen here as a proxy for the EU ETS sectors[10] on aggregate, is carried out to identify developments that differ from macroeconomic trends (e.g. different growth patterns).

In a third step, finally, the selected sectors power and heat generation, cement and lime production and paper and pulp production are analysed separately again taking into account the development in sectoral intensities in order to capture specific developments.

A special focus is put on the effects of the economic crisis in the year 2009. We analyse how the selected sectors were affected by the economic downturn and whether emission reductions in that year are only related to the drop in production or also to other factors.

[10] Energy generation cannot be included due to limited data availability, real gross value added for instance is only available for the aggregate of energy and water supply.

For the assessment various data sources are used: data on primary energy supply, final energy demand and economic variables (GDP, gross value added) are taken from Eurostat. CO_2 emission data stem from the UNFCCC National Inventory Reports 2011. Several limitations apply for the analysis. First, in contrast to the rest of the paper the period under consideration is 2005 to 2009 as no energy and emission data for 2010 are available yet. In addition, as mentioned before, manufacturing is chosen as a proxy for the EU ETS sectors as the CITL only contains information on allocation and emissions for the EU ETS installations but no energy or economic data. Furthermore, the EU ETS sectors cannot be readily identified from energy and economic statistics as the sectoral classifications differs. For instance energy generation cannot be separated from water supply. Limited data availability is also the reason why for all the three selected sectors both intensities cannot be calculated (e.g. the UNFCCC emission data base does not contain energy related emissions for cement and lime).

Macroeconomic development

In the following we discuss the pronounced impact of the economic crisis in 2009 compared to the years 2005 to 2008. As shown in Figure 8 in the period 2005 to 2008 real GDP increased by 7% in the EU-27 (6% in the EU-15, 10% in Austria, 18% in the New Member States). At the same time primary energy use remained largely stable, while CO_2 emissions decreased by 4% in the EU-15 and increased by 1% in the New Member States. Thus, energy intensity of the economies improved between 7.5% (EU-27 and EU-15) to 13% (New Member States). The emission intensity however decreased only slightly (by 2% in the EU-27, by 6% in Austria) indicating only a limited extent of fuel switch towards low carbon energy sources.

In 2009 GDP declined by approximately 5% in the EU, primary energy use by 5-7% and CO_2 emissions by 7-8% compared to 2008. Thus, the reaction in energy use and emissions to the crisis was larger than in aggregate economic activity. In the EU-15 countries energy intensity improved less than emission intensity while in the New Member States emission intensity remained stable in 2009.

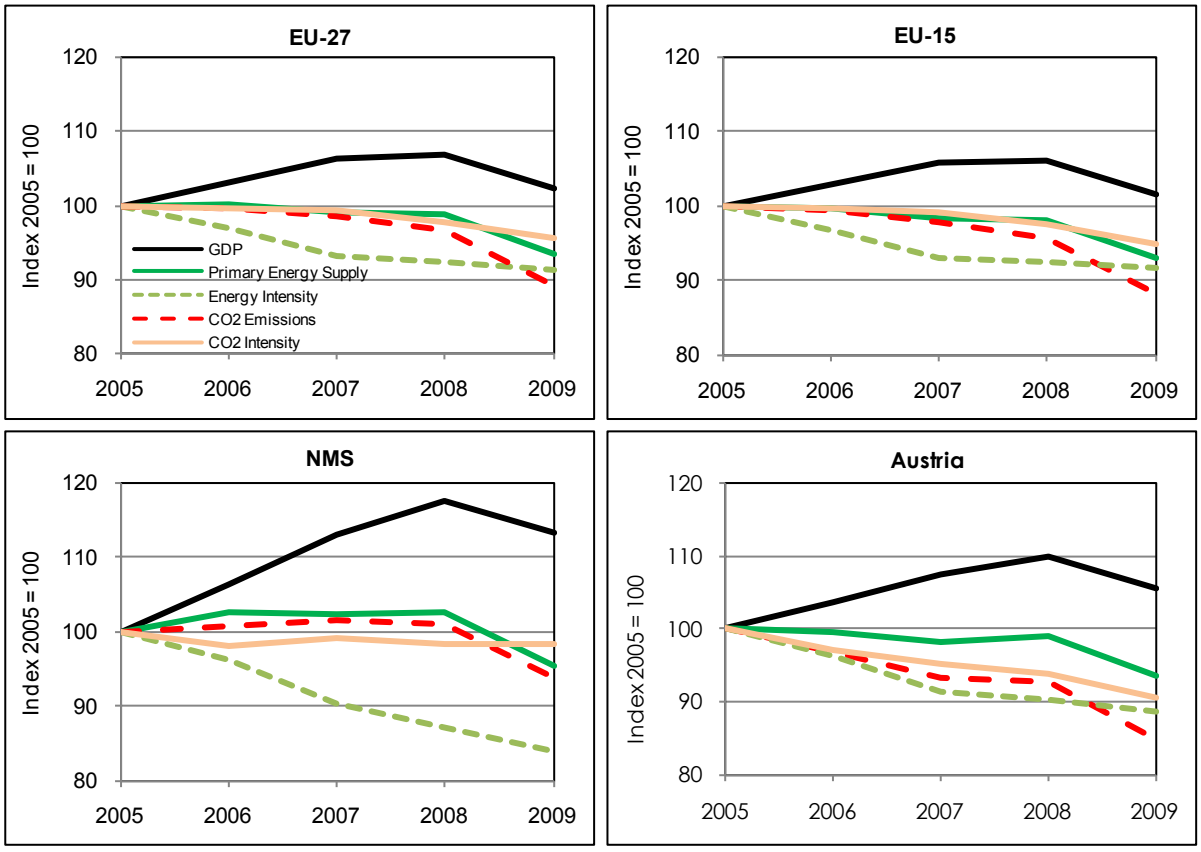
What becomes apparent when looking at the whole period are different developments by regions. The New Member States in general show stronger economic growth, but comparatively lower reductions in energy use and emissions. Their above-average improvements in energy could indicate ongoing structural change in this group of countries, especially the replacement of outdated technology. Furthermore, fuel switching seems to occur only to a very small extent as emission intensity remains largely stable. Economic growth in Austria by comparison lay above the EU-15 and below the New Member States. CO_2 emissions declined at an above average annual rate between 2005 and 2009 while primary energy use decreased at the same rate as in the other EU-15 countries on average. Thus, emission intensity – due to fuel switching – improved strongly by 3% p.a., while energy intensity improvements track average EU developments.

Comparing the developments in the EU-27 in the period 2005 to 2009 to the previous five year period (2000 – 2004) shows that GDP grew continuously but average annual growth rates

were lower after 2005. Primary energy and CO_2 emissions in contrast increased before 2005 and declined afterwards. Thus, in the EU-27 the average annual improvement of energy intensity increased from 0.5% to 2.2% and the annual improvement in emission intensity from 0.6% to 1.1%.

So during the period under consideration the EU on aggregate and especially the EU-15 countries exhibit an increasing decoupling of economic growth, energy use and emissions. Compared to previous years the improvements have become larger. To which extent these developments can be attributed to the introduction of the EU ETS or were supported by other developments cannot be clarified from this macro-level perspective as underlying sectoral trends are not identified.

Figure 8. Development of GDP, primary energy supply, CO_2 emissions, CO_2 and energy intensity – macroeconomic level



Source: UNFCCC (2011), Eurostat; authors' own calculations.

Developments in manufacturing

As indicated in Figure 9 value added has been increasing in the European manufacturing sectors by 7% in the period 2005 to 2008 with the New Member States showing an increase of more than 20%. In the EU-15 value added rose by 7% between 2005 and 2008; the Austrian

manufacturing sector exhibited an above-average increase in value added of 11%. In 2009 value added in manufacturing, in contrast, declined in the course of the economic crisis by approximately 5% in the EU total (with respect to 2008).

Final energy consumption in manufacturing decreased by 5% between 2005 and 2008 and between 2008 and 2009 again by 14% in the EU. Both the EU-15 and the New Member States show similar developments, only for Austria final energy consumption in manufacturing increased until 2008 and subsequently decreased by only 9% in 2009. The development of value added and final energy consumption show a pronounced decoupling over the whole period 2005 to 2009. Energy intensity of value added improved on average by 20% between 2005 and 2009 in the EU with the New Member States showing a decrease of 30% and the EU-15 accounting for a decrease of 20%. This points at considerable energy-saving technological change. The Austrian manufacturing sector, in contrast, exhibits a below-average decoupling of final energy consumption and value added with an energy intensity improvement of only 10% between 2005 and 2009. In the period 2000 to 2004 the improvement in energy intensity in contrast was only 1% p.a. in the EU-15 and 4% p.a. in the New Member States. To which extent the stronger decoupling between value added and final energy consumption can be attributed to the introduction of the EU ETS cannot, however, be answered by an analysis on this aggregate level[11].

The CO_2 intensity – CO_2 per unit of final energy – remained rather unchanged in the EU manufacturing sectors between 2005 and 2009, both for the New Member States and for the EU-15. This points at limited technological changes (fuel switch) as well as at limited structural change within the manufacturing sector in the period 2005 to 2009. Only in Austria a constant CO_2 intensity of manufacturing and a decline of more than 6% in 2009 can be observed. This might be the result of a stronger production decline in the steel industry compared to other manufacturing sectors, as the steel industry uses coal as the dominant fuel in Austria. In the period 2000 to 2004 a more pronounced decline in the CO_2 intensity of the manufacturing sector is found for the EU-15 on aggregate as well as for Austria. This might indicate that fuel switch options in manufacturing have already been exploited in these countries or the pace of structural change declined. In the New Member States the improvements in CO_2 intensity in contrast were still low between 2005 and 2009 but higher than in the period 2000 to 2004.

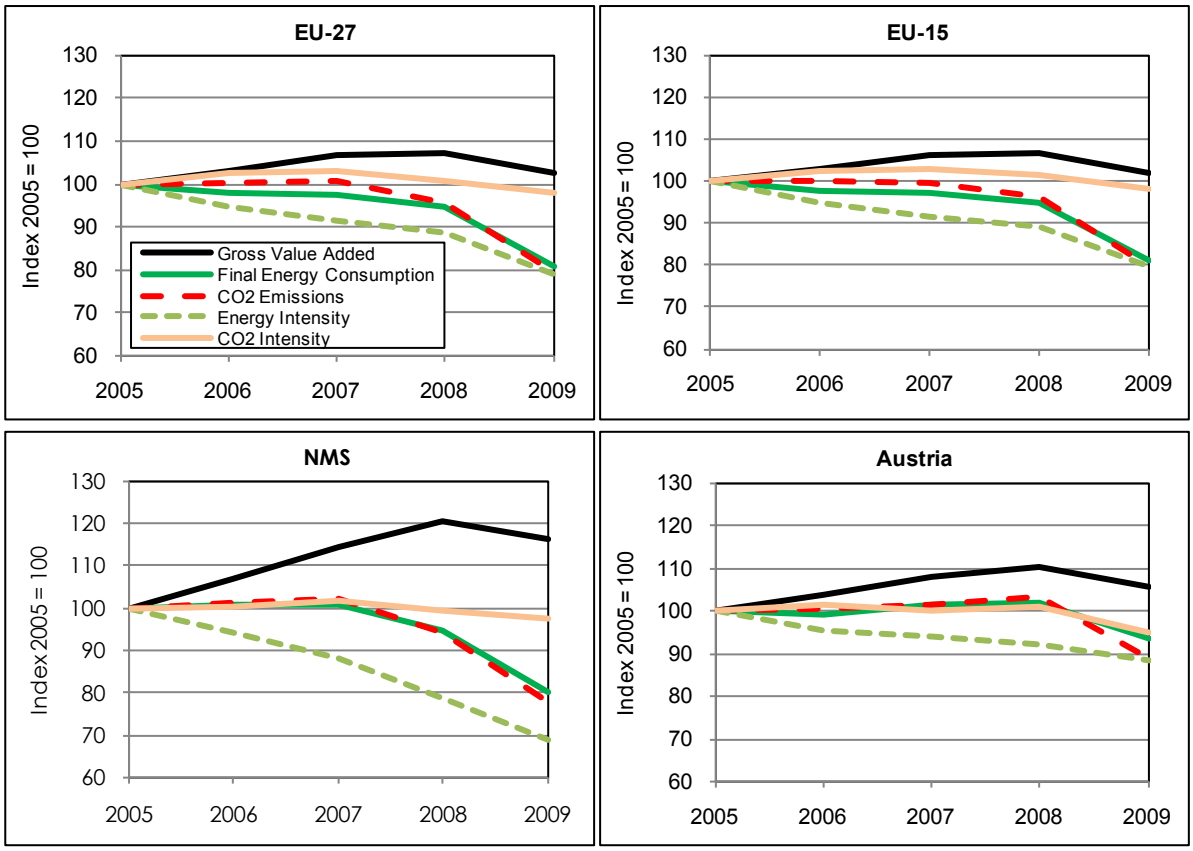
Since 2005 CO_2 emissions from manufacturing more or less continuously declined in the EU[12]. The EU-15 and the New Member States exhibit similar reductions in CO_2 emissions (of 20%) between 2005 and 2009. In the New Member States, however, a higher increase in the production volume and stronger improvement in energy intensity is observed compared to

[11] For a discussion of difficulties in analysing the potential effects on abatement caused by the EU ETS see Egenhofer et al. (2011).

[12] This is, however, not true for the EU ETS sectors where emissions increased between 2005 and 2007 and did not decline until 2008 when a stricter cap was imposed. ETS emissions further declined in 2009 in the course of the economic crisis but increased again in 2010 (see above).

the EU-15. In Austria, in contrast, a reduction in CO_2 emissions from manufacturing can be observed only in the year 2009. Over the whole period a 5% improvement of CO_2 intensity and a 10% improvement in energy intensity balance a 6% increase in value added (2009 compared to 2005) yielding a total reduction in CO_2 emissions of 6%.

Figure 9. Development of gross value added, final energy consumption, CO_2 emissions, energy and CO_2 intensity - manufacturing



Source: UNFCCC (2011), Eurostat; authors' own calculations.

The following paragraphs describe the detailed analysis of production, energy use and emissions in the sectors power and heat, cement and lime and pulp and paper.

Power and heat

The sector 'power and heat' accounts for more than 26% of total European greenhouse gas emissions and for almost 50% of the emissions covered by the EU ETS. Changes in emissions from electricity and heat generation are on the one hand caused by changes in final energy demand as triggered by the economic crisis or changing weather conditions (e.g. changes in heating degree days or rainfall) and on the other hand by changes in the fuel mix. Fuel

switching to less carbon intensive energy sources or the choice of the dispatch order[13] is regarded as the most important short-term options for reducing emissions in the power sector (Rickels et al., 2010).

We assess the drivers of the CO_2 reductions in the energy sector in the course of the economic crisis using energy and emissions data from the UNFCCC National Inventory Reports 2011. These data are complemented by information on heating degree days from Eurostat. The data cover the EU-27 Member States in the period 2005 to 2009 except Cyprus because of data availability reasons. We focus exclusively on fossil transformation input as the source of CO_2 emissions in electricity and heat generation. Again, we perform the analysis on four levels – the EU total, Austria, the EU-15 and the New Member States – using three indicators – transformation input, CO_2 emissions and CO_2 intensity complemented by information on heating degree days.

For the EU total and the EU-15 these indicators follow similar development paths (see Figure 10): The heating degree days have shown only small fluctuations in the period 2005 to 2009. Between 2005 and 2007 no changes in fossil transformation input in electricity and heat generation were observed. For 2008 and 2009 a decline in transformation input by nearly 10% is found (contrary to the trend in heating degree days). Emission intensities – CO_2 emissions per transformation input – remained almost unchanged between 2005 and 2009 which points at a constant fuel mix. The CO_2 reductions of 11% in the EU-27 and 13% in the EU-15 hence mainly reflects changes in transformation input due to reduced demand from commerce and industry and only to small extent changes in the fuel mix.

For the New Member States we find a small increase in fossil transformation input between 2005 and 2007; afterwards transformation input declined in line with the economic crisis. The CO_2 intensity stayed constant for all years, i.e. no fuel shift is observed in fossil transformation. Hence changes in CO_2 emissions exclusively reflect changes in transformation input.

Data for Austria show quite a different picture. In Austria a decline in fossil transformation input in line with heating degree days was observed until 2007; in 2008 and 2009 fossil transformation input further declined (by nearly 10%) despite a rise in heating degree days[14]. CO_2 intensity declined by 13% between 2005 and 2009 which reflects a fuel shift towards low carbon fuels in fossil fuel based electricity and heat generation plants. Altogether, an emission reduction of 27% is observed for Austrian electricity and heat generation in the period 2005 to 2009.

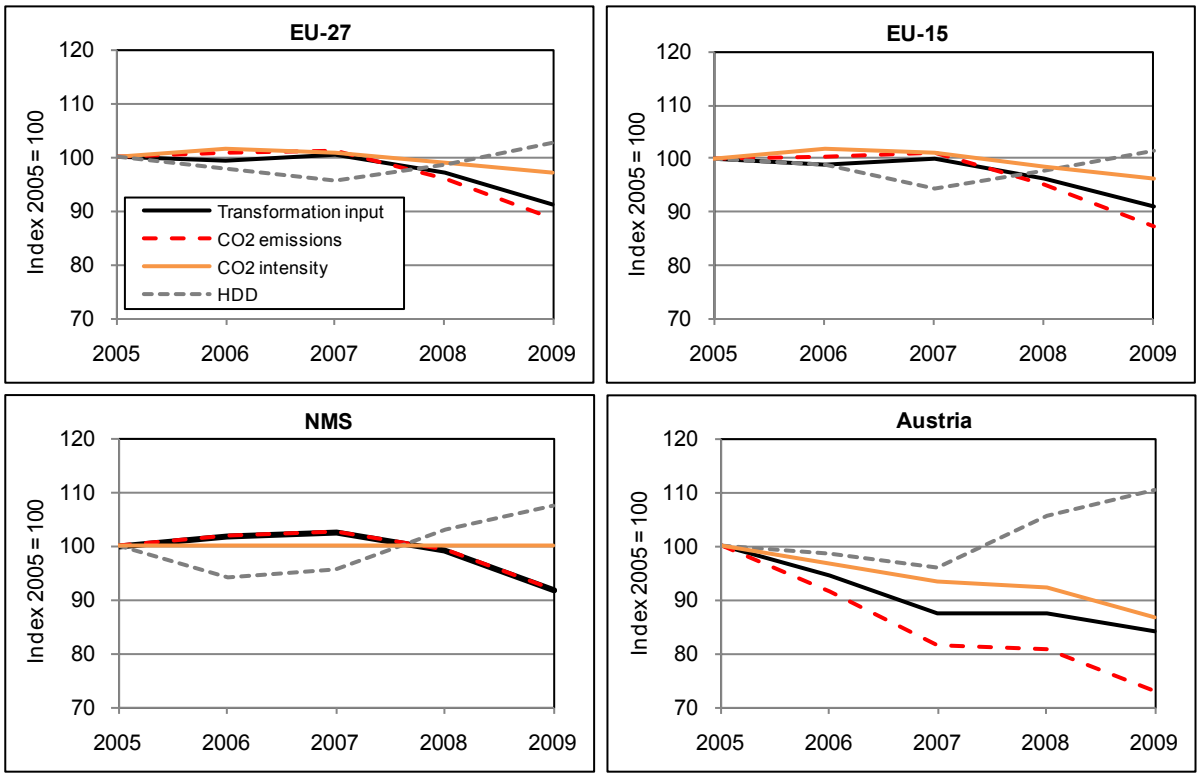
---

[13] The dispatch order defines the sequence at which different power plants are put in operation which – from the economic perspective - is strongly affected by the respective generation costs. This is especially relevant for the choice between coal and natural gas.

[14] Total transformation input for electricity and heat generation remained however constant in Austria between 2005 and 2009 (Statistics Austria, 2010). This implies an additional shift from fossil fuels to renewable energy sources in electricity and heat generation.

The data show that the power and heat sector on aggregate succeeded in stabilising CO_2 emissions despite growing energy demand in recent years. The disaggregation by regions shows some diverging trends, especially with regard to Austria which seems to have achieved a stronger improvement in the carbon intensity of power and heat generation by reducing fossil fuel input and shifting to low carbons fuels.

Figure 10. Power and heat – Development of transformation input, CO_2 emissions and CO_2 intensity



Source: UNFCCC (2011), Eurostat; authors' own calculations.

Cement and lime

The financial and economic crisis considerably affected the European construction industry.[15] A reduction in economic activity could hence also be expected for the supplying sectors for the construction industry such as cement and lime production. For the analysis of the sector we use data on cement and lime production in physical units as well as emission data from the UNFCCC National Inventory Reports 2011. Again, we perform the analysis on four levels –

[15] In the EU-27 gross value added of the construction sector declined by 5% between 2008 and 2009 (Eurostat, National Accounts database).

the EU total[16], Austria, the EU-15 and the New Member States – using three indicators – cement and lime production, CO_2 emissions and CO_2 intensity.

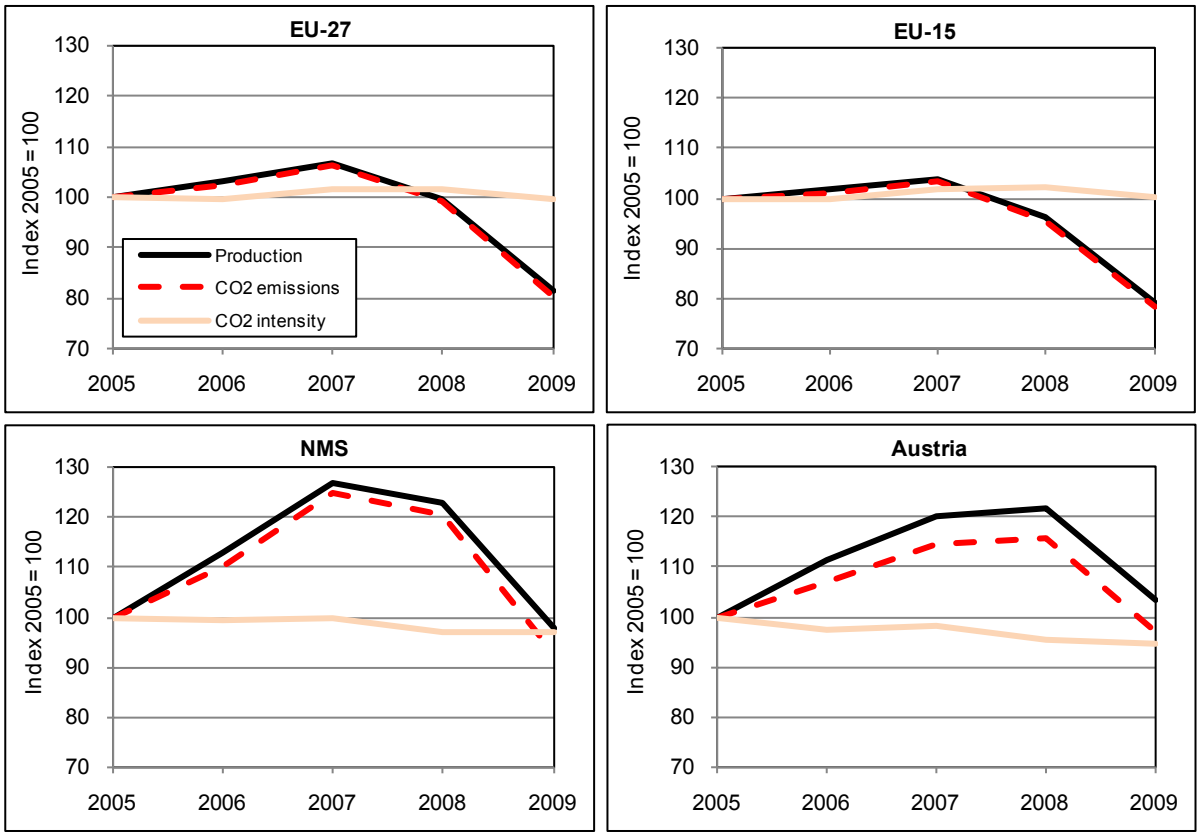
For the EU-27 and the EU-15 the CO_2 intensity remains roughly at 2005 levels, while small improvements in emissions intensity were found for Austria and the New Member States (see Figure 11). Cement and lime production in the EU-27 and in the EU-15 increased modestly (about 5%) between 2005 and 2007 and declined by about 25% in the subsequent years. These changes in production levels are reflected in the development of the sector's CO_2 emissions. In Austria cement and lime production in contrast increased strongly until 2008 (+20%) and fell by 15% between 2008 and 2009. Due to a modest improvement in CO_2 intensity, emissions grew somewhat slower than production and fell below the 2005 levels in 2009. In the New Member States production peaked in 2007 (with an increase of 25% relative to 2005); in 2008 and 2009 production, however, declined significantly. Due to slight improvements in emission intensity, CO_2 emissions grew more slowly than production and were 3% below the 2005 levels in 2009.

In general, the tight link between production volumes and emissions as well as the more or less constant emission intensity is not surprising for cement and lime production[17]. The major part of emissions occurs due to the production process and is not related to the combustion of fossil fuels. Thus, a switch towards lower carbon energy sources would not yield large effects. Improvements in the emission intensity would have to be achieved by changes in the production process, i.e. technological modifications or changes in e.g. the clinker content of cement. This is unlikely to occur in the short period under investigation (4 pre-crisis years), all the more as on aggregate there was no strong signal from the EU ETS to incentivise emission abatement investments.

[16] Bulgaria, Cyprus, Malta and Romania could not be included in the analysis due to data restrictions.

[17] In cement and lime production CO_2 is emitted as a by-product of a chemical conversion process when limestone is converted to lime.

Figure 11. Cement and lime – Development of production, CO_2 emissions and CO_2 intensity



Source: UNFCCC (2011); authors' own calculations.

Pulp and paper

Finally, we assess the development of CO_2 from the pulp and paper sector in the course of the economic crisis. We use data from the UNFCCC National Inventory Reports on energy and emissions and production data from the FAO. Cyprus, Luxembourg, Malta, Romania and the UK are not included in the analysis because of data restrictions. We perform the analysis for the EU total, the EU-15, the New Member States and Austria using five indicators: production, final energy consumption, energy intensity, CO_2 emissions and CO_2 intensity.

As indicated in Figure 12, pulp and paper production increased until 2007 and declined by 10% – 15% in 2008 and 2009 in the course of the economic crisis; energy intensity – i.e. final energy consumption per produced output – however remained largely constant between 2005 and 2009. Hence the development of final energy consumption tracked the development of production. For the EU-15 and the EU-27 we find a decline in emission intensity – i.e. in CO_2 emissions per final energy consumption – of 10% between 2005 and 2008 which points at an increased use of renewable and low carbon fuels in the sector. Between 2008 and 2009 no changes in CO_2 intensity can be observed. The reduction in CO_2 emissions

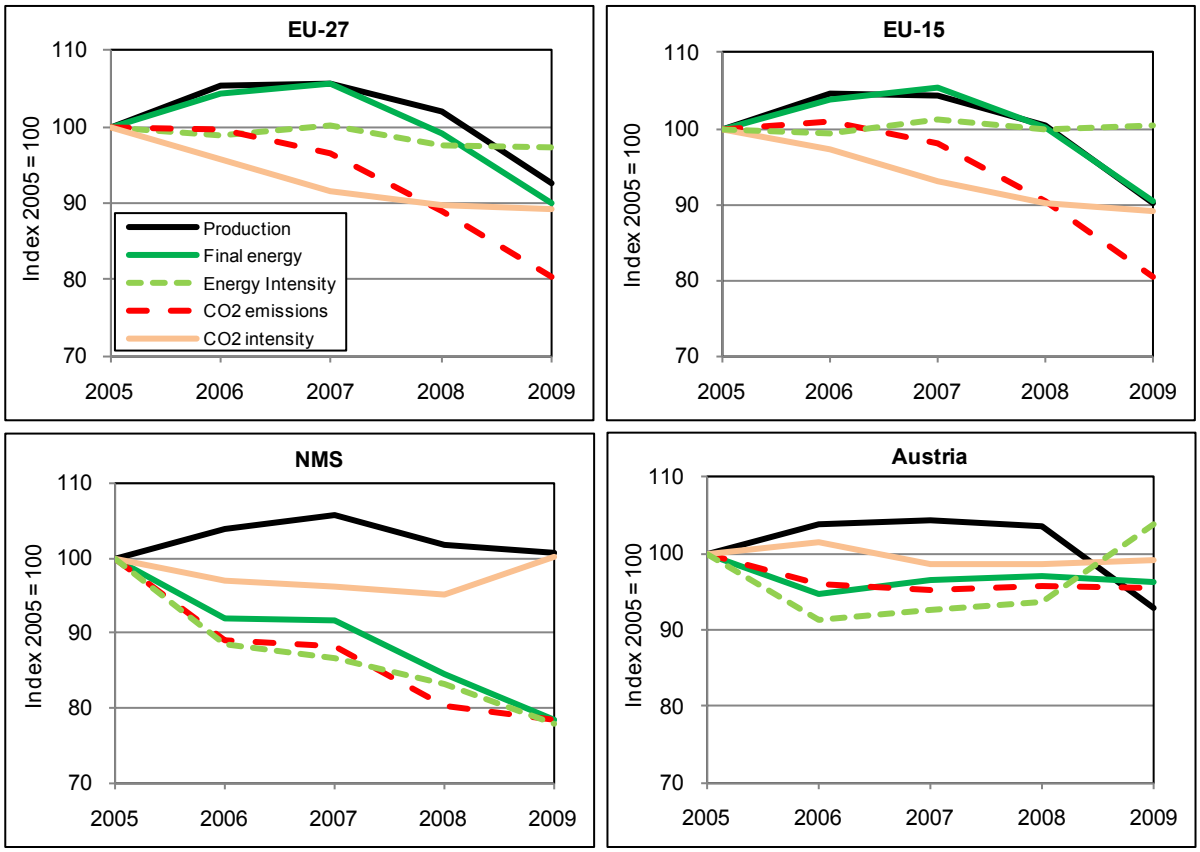
in 2009 reflects mainly the drop in production volumes and only to a small extent a further improvement in CO_2 intensity.

In the New Member States pulp and paper production increased by 5% between 2005 and 2007 and declined by the same extent in the following years. Energy intensity declined over the whole period 2005 to 2009 (total improvement of 20%). Final energy consumption hence declined by 22% between 2005 and 2009. CO_2 intensity decreased between 2005 and 2008, but rose in 2009 to 2005 levels again, which points to a shift towards more carbon intensive fuels in the year of the crisis. As a result of these changes in final energy intensity and CO_2 intensity, until 2009 emissions from pulp and paper production decreased by 21% in the New Member States compared to 2005, with a stronger decoupling from production from 2005 to 2007 and a more parallel development afterwards.

In Austria pulp and paper production increased by 3% between 2005 and 2008 while an improvement in energy intensity of 6% occurred. Hence, final energy consumption in 2008 was reduced by 3% compared to 2005. As the CO_2 intensity of Austrian pulp and paper production remained roughly constant until 2008, changes in CO_2 emissions resemble changes in final energy demand. For 2009, we find a 10% decline in production, while energy intensity increased at the same time. As these effects level out, CO_2 emissions from pulp and paper production remain unchanged in Austria between 2008 and 2009. This increase in energy intensity in 2009 related to lower capacity utilizations and downtimes in production due to the demand reduction in the course of the financial and economic crisis (Austropapier, 2009). Unchanged CO_2 intensities suggest that in Austrian pulp and paper production only a limited fuel switch and hence no technological change occurred.

Except for Austria, fuel switching seems to be an important measure for short-term emission reductions in pulp and paper production. Rather constant energy intensities in the EU-27, the EU-15 and Austria suggest that no energy-saving technological change has occurred since 2005. In contrast in the New Member States energy intensity declined by 22% between 2005 and 2009 which points at considerable technological improvements in the sector. Overall, for pulp and paper production and CO_2 emissions parallel development paths can be observed with an increasing decoupling over time.

Figure 12. Pulp and Paper – Development of production, CO_2 emissions and CO_2 intensity



Source: UNFCCC (2011), FAO; authors' own calculations.

Conclusions

Compared to the ETS pilot phase the European Commission played a stronger role in the preparations of the second trading period to ensure the environmental effectiveness of the EU ETS. The stronger role of the Commission is reflected in the higher overall stringency of the 2008 allocation caps. For 2009 we find, however, a non-binding cap as (ETS) emissions declined reflecting a fall in economic activity in the course of the financial and economic crises. For 2010, our analysis shows a modest rise in emissions compared to 2009 but still a lose cap.

Our analysis furthermore discloses pronounced differences in sectoral allocation patterns: We find that the power and heat sector is the only sector in a net short position and rather pronounced net long positions in the remaining sectors. Furthermore, the spread of allocation discrepancies is higher for the energy sector with installations in 16 EU Member States facing a stringent sectoral cap in the second trading period. In the sectors 'cement and lime' and 'pulp and paper' in contrast all national caps were not binding in the second trading phase.

The main objective of the EU ETS is to incentivise emission abatement in the regulated sectors. The extent to which this has been achieved so far is subject of scientific discussion. Especially the tighter cap in the second trading phase should have established a price signal for investments in low carbon technologies. However, the effects of the economic crisis, i.e. the drop in production and associated emissions, have offset the stricter cap. In our analysis, we investigate whether since the start of the EU ETS in 2005 significant changes in energy and/or emission intensities occurred. It shows that an analysis on the aggregate level, the macro-economy or total manufacturing, does not lead to clear-cut conclusions. The disaggregated analysis of individual ETS sectors reveals pronounced differences in their development regarding energy use and emissions, which also points to differences in the respective options for emission abatement. While the data for cement and lime production do not indicate technological changes between 2005 and 2009, improvements in energy and emission intensities can be observed for paper and pulp production and to a lesser extent for power and heat generation. However, the significant fall in emissions in 2009 is almost exclusively related to the shrinking production. The main effect of the economic crisis regarding the EU ETS may thus be a postponement of emission reducing investments and technological change in manufacturing.

Acknowledgements

A working paper for the project ETCLIP "The Challenge of the European carbon market – emission trading, carbon leakage and instruments to stabilize the CO2 price". The project ETCLIP is funded by the Austrian "Klima- und Energiefonds" and is carried out within the research programme "NEUE ENERGIEN 2020".

References

Anderson, B. and C. di Maria (2011) Abatement and Allocation in the Pilot Phase of the EU ETS. Environmental and Resource Economics 48(1): 83-103.

Austropapier (2009) Die österreichische Papierindustrie 2009. Vienna: Austropapier.

Capoor, K. and P. Abrosi (2008) State and Trends of the Carbon Market 2008. The World Bank Working Paper, May 2008.

Commission Decision 2010/2/EU determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, a list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage.

Community Independent Transaction Log (2011) http://ec.europa.eu/environment/ets/.

Council Directive 2003/87/EC on Greenhouse Gas Emission Allowance Trading (2003).

Council Directive 2009/29/EC to improve and extend the greenhouse gas emission allowance trading scheme (2009).

Egenhofer, C., M. Alessi, A. Georgiev and N. Fujiwara (2011) The EU Emissions Trading System and Climate Policy towards 2050. Real incentives to reduce emissions and drive innovation? Brussels: CEPS Special Report.

Ellerman, A.D. and B. Buchner (2008) Over-Allocation or Abatement? A Preliminary Analysis of the EU ETS Based on the 2005–06 Emissions Data. Environmental and Resource Economics 41(2): 267-287.

Ellerman, A.D., B. Buchner and C. Carraro (eds.) (2007) Allocation in the European Emissions Trading Scheme: Rights, Rents and Fairness. Cambridge: Cambridge University Press.

Ellerman, A.D., F.J. Convery, C. de Perthuis et al. (2010) Pricing Carbon. The European Union Emissions Trading Scheme. Cambridge: Cambridge University Press.

Eurostat (2010), Heating Degree Days, Brussels. http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database?_piref458_1209540_458_211810_211810.node_code=nrg_esdgr_a

Eurostat (2010), National Accounts, Brussels.

FAO, (2011), Forestry data set, http://faostat.fao.org/site/626/default.aspx#ancor

Kettner, C., A. Köppl and S. Schleicher (2010) The EU Emission Trading Scheme: Insights from the first trading years with a focus on price volatility. In Dias Soares et al. (eds.) Critical Issues in Environmental Taxation VIII. Oxford: Oxford University Press. 187-225.

Kettner, C., A. Köppl, S. Schleicher and G. Thenius (2008) Stringency and distribution in the EU Emissions Trading Scheme: First Evidence. Climate Policy 8 (1): 41-61.

Kolshus, H.H. and A. Torvanger (2005) 'Analysis of EU Member States' National Allocation Plans', CICERO Working Paper 2.

Rickels, W., D. Görlich and G. Oberst (2010) Explaining European Emission Allowance Price Dynamics: Evidence from Phase II. Kiel Working Paper No. 1650, October 2010.

Statistics Austria (2010), Energy balances 1970-2009, Vienna.

Swedish Ministry of Sustainable Development (2006) Sweden's national allocation plan for emission allowances 2008-2012.

Trotignon, R. and A. Delbosc (2008) Allowance trading patterns during the EU ETS trial period: What does the CITL reveal? Caisse des Dépôts, Climate Report No. 13, June 2008.

UNFCCC (2011) National Inventory Submissions 2011. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php