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ASSESSING THE IMPACT OF THE EU ETS USING FIRM LEVEL DATA

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Highlights

- This paper investigates the impact of the European Union's Emission Trading System (EU ETS) at a firm level. Using panel data on the emissions and performance of more than 2000 European firms from 2005 to 2008, we are able to analyse the effectiveness of the scheme.
- The results suggest that the shift from the first phase (2005-2007) to the second phase (2008-2012) had an impact on the emission reductions carried out by firms. The initial allocation also had a significant impact on emission reduction. This challenges the relevance for the ETS of Coase's theorem (Coase, 1960), according to which the initial allocation of permits is irrelevant for the post-trading allocation of marketable pollution permits.
- Finally, we found that the EU ETS had a modest impact on the participating companies' performance. We conclude that a full auctioning system could help to reduce emissions but could also have a negative impact on the profits of participating companies.

Keywords: panel data, energy, climate change, evaluation econometrics, firm behaviour
JEL Classifications: D21, C23 and Q49

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1. Introduction

The European Union's Emission Trading System (EU ETS) is the biggest emissions trading scheme in the world. It is designed as a classical cap-and-trade system specifying a maximum amount of cumulated greenhouse gas emissions, and allocating tradable allowances to firms covered by the scheme. Allowing trade in these permits results in a market price for allowances. The price provides an economic signal of which mitigation measures are worthwhile[1].

A cap-and-trade system is by design effective in keeping the emissions of the participating installations below the cap. Thus, the relevant question is if this cap and thus emissions were below the emissions that one would expect in the absence of the system. There are two reasons why the cap might be too high and thus ineffective: first, setting the cap *ex ante* is difficult. Emissions depend on numerous hard-to-predict factors (most notably economic development). Therefore, setting a cap that is both ambitious and attainable is a difficult political exercise. Second, there are several flexibility mechanisms embedded in the design of the EU ETS. Most notably the transferability of Clean Development Mechanism (CDM) and Joint Implementation (JI) credits into EU emission allowances (EUA) as well as the bankability of allowances across phases[2]. Those instruments – that partly serve as security valves against too-high allowance prices – inflate the cap to an unpredictable degree. Consequently, it is *ex ante* unclear if companies will have to reduce their emissions due to the EU ETS.

In this paper we address the following questions: first, do the observed emissions reductions between 2005 and 2009 (see section 3) indicate that the EU ETS resulted in emissions reductions, or are those reductions explained by changes in the economic environment? Second, did the structural break between the first and second EU ETS phases led to a change in abatement behaviour? Third, what are the influences of the initial allocation on the reduction effort of regulated firms? Fourth, what is the treatment effect of the EU ETS on companies' performances?

The EU ETS is divided into phases: the trial phase 2005-2007; and the second phase 2008-2012 which coincides with the first commitment period of the Kyoto Protocol[3]. The rules of trading as well as the initial allocation of pollution permits have differed substantially between the two phases. The most notable changes are: first, the cap, ie the total amount of permits allocated, was much lower in the second phase. Second, the regulation of the transfer of pollution permits between phases changed. In the trial phase the transfer of permits to future phases (banking) and vice versa (borrowing) was precluded. Thus, the trial phase was completely isolated from subsequent phases. In contrast, banking from the second to future phases is allowed. Third, uncertainty about the future availability of pollution permits decreased in the second phase as the long-term reduction target for 2020 was revealed in 2008[4]. This motivates the question of how the structural break between phases affects the abatement decisions of firms. Studying the link between the carbon spot price and emissions is a way to answer this question. However, this carbon spot price was a short-term signal in the first phase because allowances were only to be used within the three years. By contrast the carbon spot price in the second phase should also encompass a long-term signal, as allowances are bankable at least until 2020 (bankability beyond is not ruled out by the current directives) and future rules of trading are subject to less uncertainty. Consequently, spot prices in the first and second phase are not comparable. Moreover, emission-reduction strategies are not entirely based on the marginal abatement cost of companies if the strategic motives of the regulated firms are taken into account. Given that initial allocation with valuable emission rights is based on a base year, firms try to manipulate emissions in that year in order to inflate their

[1] A comprehensive description of the rules and economics of the EU ETS can be found in Ellerman et al. (2010).
[2] Under the Kyoto Protocol, Joint Implementation (JI) and the Clean Development Mechanism (CDM) reward projects that reduce GHG emissions with credits that can be used toward meeting Kyoto reduction targets. The EU Linking Directive allows JI or CDM credits to be converted by member countries into allowances usable for EU ETS compliance.
[3] The EUETS is thus one of the European tools to fulfill the Kyoto commitments of the EU member states.
[4] Given the on-going discussion about a 30% reduction until 2020, there still is some uncertainty about the future supply of pollution permits.

initial allocation[5]. Consequently, we choose to study the changes of abatement behaviour between phases instead of using the carbon price to investigate the effectiveness of the scheme.

Another question arising in the context of the ETS is the impact of the rules of initial allocation on actual emissions. The invariant thesis of the Coase Theorem (Coase, 1960) suggests that the initial allocation of permits is irrelevant for the post-trading allocation of marketable pollution permits. Put differently, the initial allocation does not affect the reduction behaviour of regulated firms; but, it certainly matters under distributional aspects, ie who receives the income of carbon regulation. However, the Coase theorem was derived under idealised conditions (Coase, 1992). One line of theoretical reasoning against the neutrality of initial allocation originates in the theory of second best: if the trading system is imposed on an economy in which taxes exists, the initial allocation matters for the efficiency of the system (eg Goulder *et al*, 1999). Furthermore, initial allocation matters if regulated firms possess market power (eg Burtraw *et al*, 2001). If we find that the initial allocation matters for reduction behaviour, this would have significant implications for the design of emissions trading schemes, as compensation through initial allocation would no longer be emissions neutral.

Several authors have studied the effect of the EU ETS empirically. A concise overview is given in Anderson and Di Maria (2011). Our contribution is threefold. First, in contrast to other studies using country-specific firm level data (Anger and Oberndorfer, 2008) we cover the entire European Union. Second, we explicitly take into account the structural break between the EU ETS phases. This allows us *inter alia* to study the effect of changing allocation on emissions. Third, previous literature on the effect of initial allocations on reduction behaviour has been either of theoretical nature or based on numerical simulations. With our unique data we are able to estimate the effect of initial allocation empirically. This firm-level data offers several more advantages. It allows us to eliminate the impact of aggregation over firms or installations when performing estimations. Furthermore, it allows exploiting a wide heterogeneity of firms with respect to their host country, turnover, employment, profit margin, sector and initial allocation.

We find that the EU ETS induced emissions reductions in the second phase and that there were substantial differences in abatement behaviour across phases. Moreover, the initial allocation of permits and ex-post verified emissions are correlated. However, according to our findings, the EU ETS at most modestly affected profits, employment, and the added value of regulated firms.

This paper is structured as follows. In the next section we describe and qualitatively analyse the dataset. Sections 4 and 5 describe the methodological procedure and analyse the results of the estimation process. Section 6 concludes the paper.

2. Data

Our dataset consists of a panel of European firms under EU ETS. We match the emissions data obtained from the European Commission (Community Independent Transaction Log, CITL) to firm level performance data from the AMADEUS database. From the CITL emission data, we extract information on free allocation of emissions allowances and verified emissions (2005-2008) at the installation level. The availability of the data until 2008 is important since it allows us to include the second phase of the EU ETS. Some data issues with respect to the CITL data have been reported (Trotignon and Delbosc, 2008). In particular, during the first phase of the EU ETS, the use of New Entrants Reserves was not available in the CITL's public area, leading to some bias in the assessment of installation positions. We avoid these issues by selecting a balanced panel over the three years, ie we include installations that were present in the CITL's public area already in 2005. From AMADEUS, we extracted information on employment, turnover, profit margin, added value, labour and fixed capital costs (2003-2008). Both sets of data were matched via the addresses of the installations and we

[5] Another form of strategic behaviour is associated with market power in either the permit or the output market (or both) (eg Hahn, 1984; Matti and Montero, 2005).

end up with a set of 2101 firms (3608 installations), representing on average 59 percent of the total verified emissions[6]. We compute an allocation factor (AF) defined as the quotient of free allocation of emissions allocated to the verified emissions (Anger and Oberndorfer, 2008). An AF > 1 suggests that an installation has received allowances that exceed its emissions whereas the opposite suggests that this installation should either buy additional emission allowances or abate some of its emissions in order to comply with EU ETS. Table 1 in the Appendix 1 compares emissions and allowances in our sample of matched installations to the original CITL data.

Our matched sample is representative of the biggest installations of the original CITL data in terms of emissions and allowances. There is also more heterogeneity in our installations than in the original CITL data. We classify firms into five sectors based on the two digit NACE Rev.2 code. Groups of countries were created with the geographic proximity as the main criteria. Firms are therefore classified in 18 regions or countries. Table 2 and Table 3 show the sectoral and regional distribution of our regulated firms. We notice that other non-metallic mineral products as well as electricity and heat sectors represent more than two-third of our sample. The two most represented countries in the sample are Spain and Germany with an aggregate frequency of 35 percent. Whereby, we retrieved 1/3 of the installations for the biggest emitting country (Germany). Section 3 gives more information on the aggregate emissions by country.

Table 1: Sectoral distribution of the sample companies

Sectors	Number of firms	Frequency (%)
Other non-metallic mineral products	806	38.36
Electricity and heat	660	31.41
Paper and paper products	416	19.8
Basic metals	159	7.57
Coke and refined petroleum products	60	2.86

[6] The matching procedure contains three steps. First, an automatized pre-matching identifies potential matches based on the similarity of company name, addresses and zip-code. In a second step this generous matching is narrowed down by selecting the actual matches from the computer-generated proposed matches. Finally, matches for the biggest unmatched installations are searched "by hand". In the last two steps, in case of ambiguity additional sources of information are drawn upon.

Table 2: Regional distribution of sample companies and CITL installations

	Total CITL installations	Sample of matched firms		
Countries	# of installations	# of firms	# of installations	Country share in total sample firms (%)
Spain	1106	420	567	19.99
Germany	1971	314	644	14.95
Portugal	277	236	183	11.23
France	1118	199	291	9.47
Czech Rep.	421	120	219	5.71
Poland	930	114	205	5.43
Italy	1124	113	167	5.38
Finland	649	103	412	4.9
UK-Ireland	1247	85	163	4.05
Bulgaria- Romania	399	73	114	3.47
Sweden	798	71	116	3.47
Austria	222	68	118	3.24
Belgium-Lux	372	67	43	3.19
Slovakia	193	62	94	2.95
Netherlands	437	47	92	2.24
Denmark	403	39	62	1.86
SI-HU	365	33	42	1.57
EE-LV-LT	280	27	66	1.29
Greece	157	NA	NA	NA
Cyprus	13	NA	NA	NA
Malta	2	NA	NA	NA
LI	2	NA	NA	NA
Norway	115	NA	NA	NA

Descriptive statistics of the main variables of interest are presented in Table 4. The relatively large difference between the value of the mean and the value of the median for these variables could indicate the presence of outliers in our sample. In the analysis it should be kept in mind, that the identified companies/installations are significantly larger than the average AMADEUS company / average CITL installation. Larger firms are overrepresented because retrieving the matching AMADEUS entry is more likely for larger firms.

Table 3: Characteristics of the sample companies

	Added Value	Employees	Fixed Capital	Profit Margin	Allocation Factor
1%	-1048	2	0	-46.69	0.50
5%	470	10	309	-17.18	0.75
25%	2343	43	2968	0.05	1.00
Median	8673	150	12125	4.2	1.15
Mean	88541	663	159216	4.5	6.61
75%	35014	447	49279	10.62	1.43
95%	288316	2170	443055	25.37	3.31
Std	389039	2580	909914	14.32	178

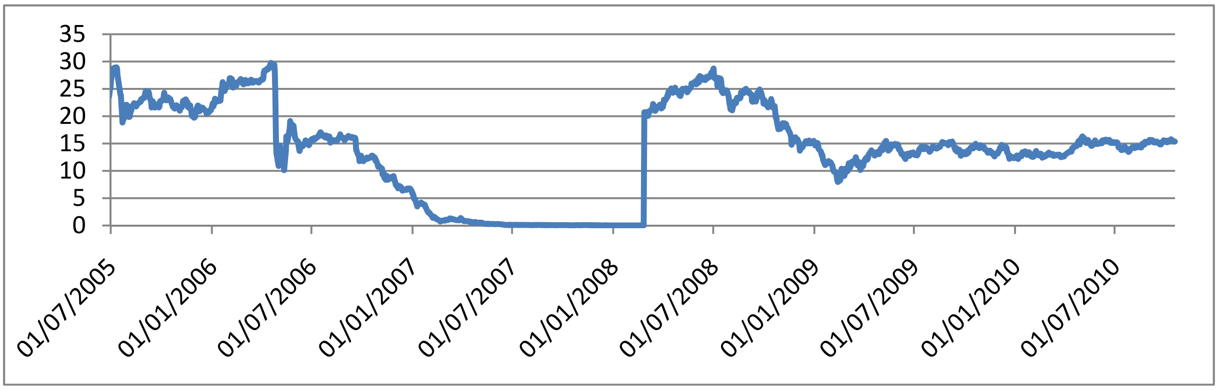
3. The general performance of the EU ETS

The EU ETS is divided into so-called phases. The first three years (2005-2007) were intended as a trial phase so that participants could become familiar with the new instrument. The current second phase (2008-2012) coincides with the first commitment period of the Kyoto Protocol. While the first phase was isolated from the second, ie the shifting of emissions from one to another phase – banking and borrowing of allowances – was not permitted; banking from the second to subsequent phases is allowed. In these first two phases the initial allocation of allowances was done by member states via National Allocation Plans, which had to be approved by the European Commission. There was great variation in the plans of different countries. For example, the basis phases for calculating historic emissions were very different between member states[7]. Most of the emission allowances were allocated for free to installations based on historical emissions (so called, 'grandfathering').

During the first phase of the EU ETS the total emissions of the participating installations grew by about two percent. This was possible due to a generous cap and/or unexpectedly low abatement cost. In fact, the average annual cap in the first phase of the EU ETS was about three percent higher than the emissions in 2005. Consequently, the total amount of allowances distributed exceeded the verified emissions by 2.3 percent during the first phase. When market actors became aware that more allowances than needed were available, the price for allowances in the first phase crashed to below €1 per EU Allowance Unit of one tonne of CO_2 (EUA – see Figure 1).

In the second phase, the amount of allowances distributed was reduced from 2007 to 2008 by about 11 percent. This was followed by a 2 percent decline in verified emissions. Consequently, in 2008 and 2009 companies were on average short of allowances. The verified emissions exceeded the allocated allowances by 2.9 percent. In 2008, the lack of allowances led to carbon prices of about €20 per EUA. In 2009, due to the crisis-induced demand reduction for allowances, the carbon price fell to about €15.

Figure 1: Daily Closing Price EUA spot



The trends in emissions and free allocation of allowances differ between sectors. The power sector dominates the EU ETS. It is the only sector that used more allowances than it obtained for free, in the first and the second phases. All other sectors were net sellers of allowances. Nevertheless, the power sector showed a below average decrease in emissions in the years 2005 to 2009 (-8.9 percent in the power sector vs. -11 percent in the EU ETS). Interestingly, the sectoral emission reductions for the first and the second phases are strongly negatively correlated. That is, sectors that increased carbon emissions in the good years between 2005 and 2007 reduced emissions between 2008 and 2009. When omitting the crisis year 2009, emission reductions were seen in the following sectors: mineral oil refineries, iron or steel, glass, ceramic products, pulp and paper and the remaining non-classified sectors, while coke ovens, metal ore and cement clinker increased emissions.

[7] For example Germany uses averages of the years 2000-2002 for the first phase while Slovakia uses sector specific basis periods (for steel the average of the ten years with the most emissions in 1990-2003).

Figure 2: ETS emissions by country

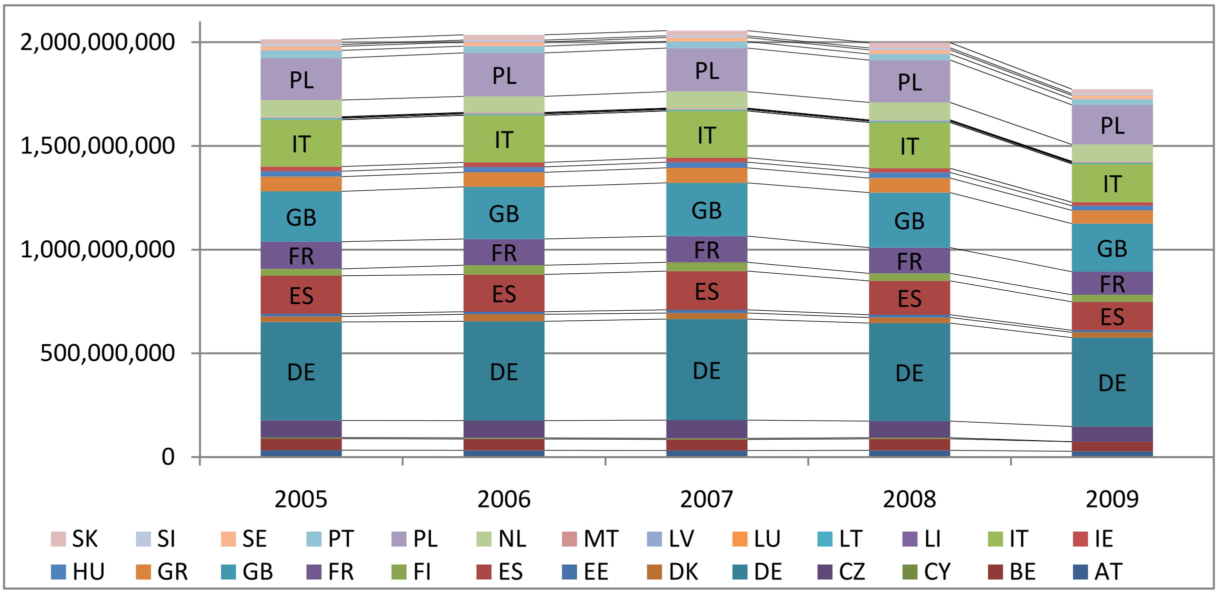


Figure 3: ETS emissions by sector

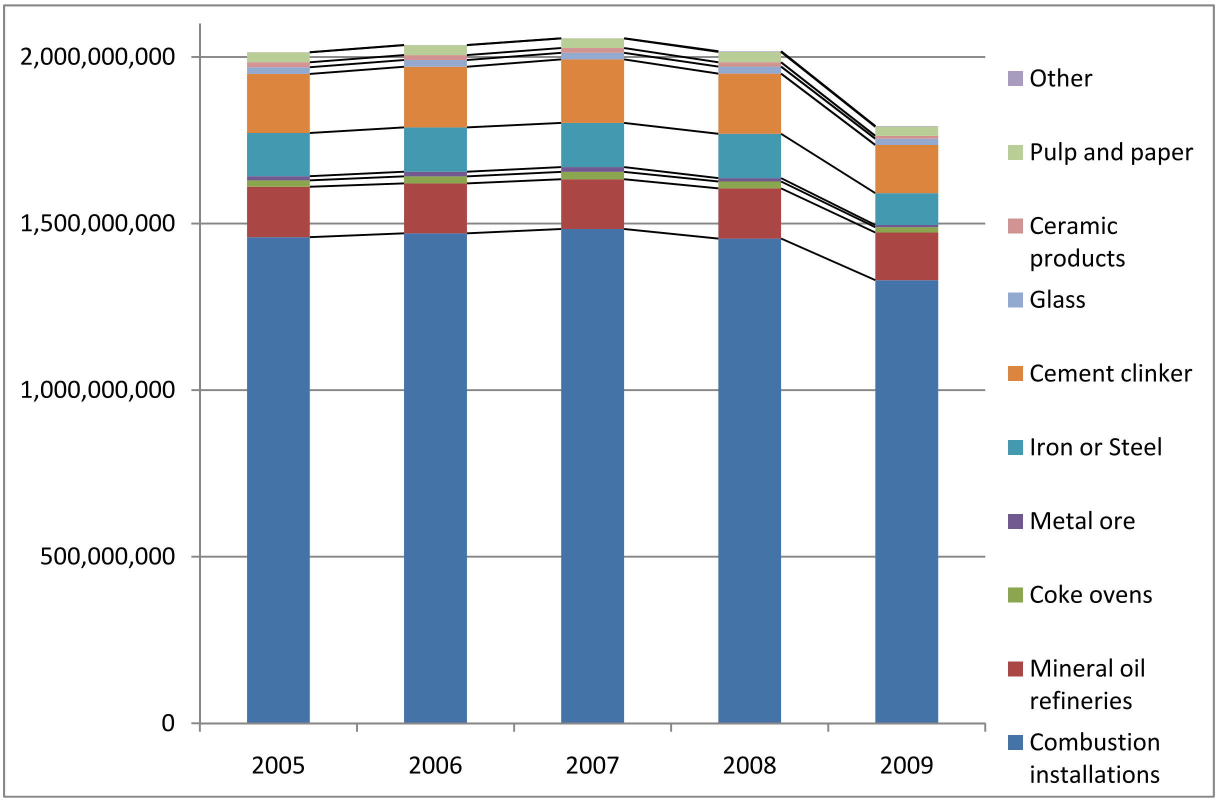


Figure 4: Excess allocation by country

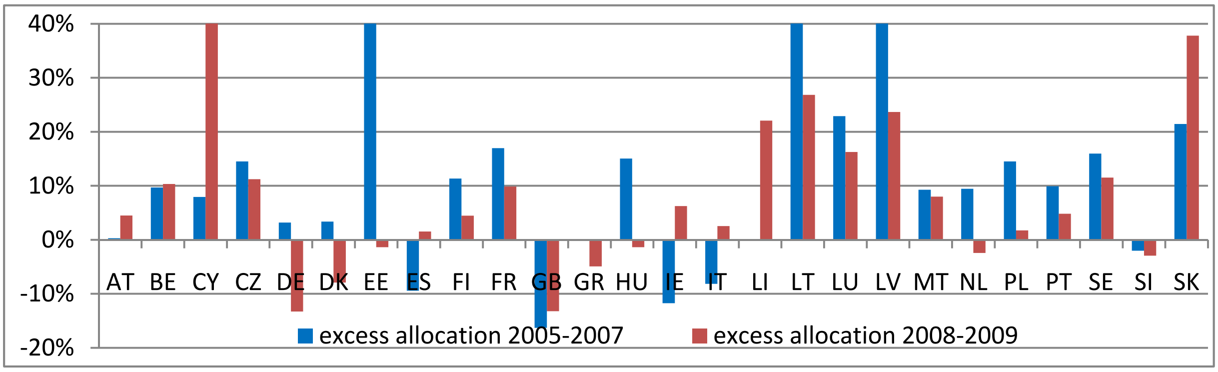
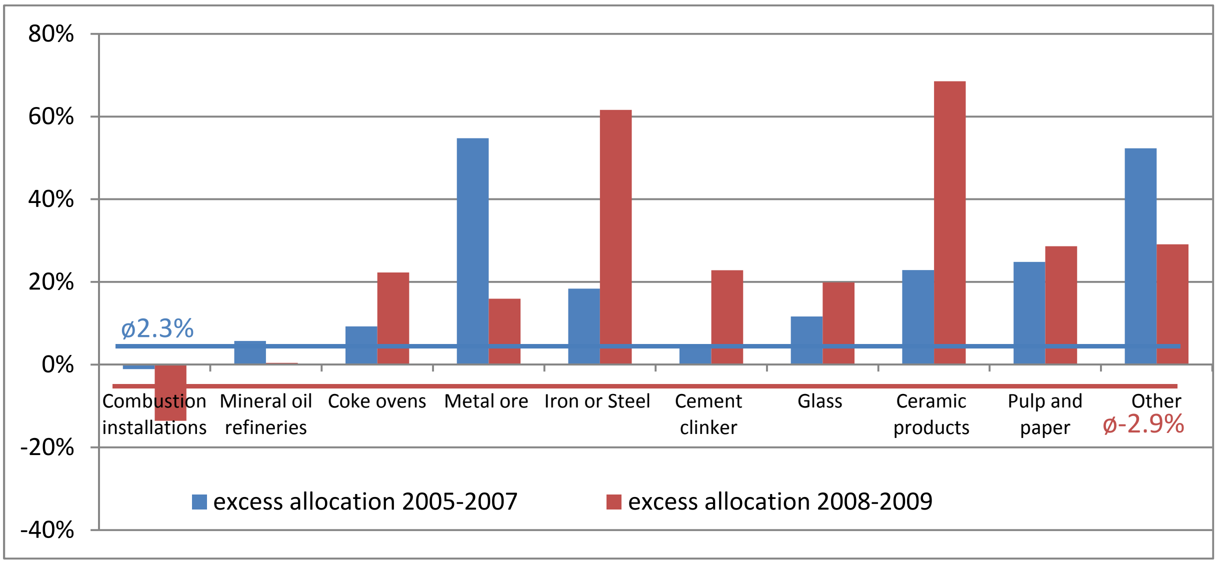


Figure 5: Excess allocation by sector



The CITL data suggests that emissions increased during all years of the first phase of the EU ETS while they decreased in the first two years of the second phase. This is also the case for our matched sample of AMADEUS firms. Based on this source of information it is, however, impossible to judge whether the EU ETS led to a reduction of emissions compared to a hypothetical baseline, or whether the observed emission pattern just represents business as usual. We can, however, assess the abatement strategies of companies within the EU ETS to analyse if changes in the system induced additional reduction efforts. A corresponding analysis based on firm level data is carried out in the following section.

4. Did the ETS led to emission reductions?

4.1. Methodology

The appeal of the EU ETS is that by design it provides certainty about the environmental outcome. Therefore, the key challenge when evaluating whether the ETS led to emission reductions is to estimate what emissions would have been in the absence of the ETS. This counterfactual is unobservable. Several techniques to proxy this counterfactual have been developed[8]. There is no consensus on the success on the ETS in abating CO_2 emissions in the first phase. Indeed, according to Anderson and Di Maria (2011) some companies did

[8] See Anderson and Di Maria (2011) for more details on the different methods.

abatement during the first phase, while others inflated their emissions. We contribute to this debate by estimating *ex post* the reduction in CO_2 emissions at firm level. More specifically, we study the behaviour of firms around the point of cross over from the first to the second phase of the ETS. That is, we evaluate the effectiveness of the ETS by comparing the development within the first phase to the shift from the first to the second phase. Our goal is thus to analyse if companies changed their emission reduction strategy from 2005-2006 to 2007-2008. This is instructive as the first part saw fairly constant carbon prices – the EUA price went from €23 in 2005 to €17 in 2006, while in the second phase emission prices rose from €1 in 2007 to €22 in 2008. Thus, our intuition is that companies increased their emission-reduction efforts in 2007-2008 due to the shift in phases and the increasing EUA price compared to 2005-2006.

We control for other plausible factors that may have induced a reduction in emissions, eg the economic environment could have led some companies to reduce their production and thus reduce their emissions. Our data provides information on European firms' emissions (2005-2008) and economic activity (2003-2008). Our dynamic panel approach allows us to overcome the absence of consistent data on the CO_2 emissions of the firms before the start of the EU ETS. Furthermore it avoids the endogeneity and inconsistency[9] that occur when regressing emission volumes on emission prices. Finally it allows the exploitation of a wide heterogeneity of firms with respect to their host country, turnover, employment, profit, margin, sector and initial allocation. Thus, some stylized facts on the influence of these characteristics on firm abatement decisions can be identified.

In order to test if there has been an acceleration in emission reductions in the second phase, we use the following equation:

$$y_{it} = \alpha_0 + \alpha_1 d_{it} + \alpha_2 cv_{it}^1 + \alpha_3 cv_{it}^2 + \varepsilon_{it} \text{ , t} = 2005{,}2006{,}2007{,}2008 \ (1)$$

Where:

- i and t are respectively company and year index
- y_{it} is the log value of verified emissions
- d_{it} is a time dummy
- cv_{it}^1 is a set of control variables: turnover and labour in log values
- cv_{it}^2 is a second set of control variables: sectoral and country dummies
- ε_{it} is the error term which can be decomposed into a time variant u_{it} and a firm specific effect η_i

Taking the third difference of this equation gives us the following equation to estimate:

$$\Delta^3 y_i = \alpha_1 + \alpha_2 \Delta^3 cv_i^1 + \alpha_3 \Delta^3 cv_i^2 + \Delta u_i \text{ , } (2)$$

In the equation, Δ is the difference operator. The interesting parameter is α_1 which captures the change of behaviour in emissions by the firm from the first to the second phase. The presence of outliers in the data set can strongly distort the classical least squares estimator and lead to unreliable results. Consequently, we perform a robust regression analysis. Details of the weighting algorithm are available in Appendix B.

[9] In the first phase the spot price was a pure short term signal while it is a long term signal in the second phase.

4.2. Results

First, we can report a strong positive relationship between changes in turnover and changes in emissions. That is, the emissions of the installations of a company are likely to decrease if its turnover declines. This predictable interaction between the turnover data from AMADEUS and the emission data from CITL indicates that our matching of CITL-installations to AMADEUS companies has been effective. The causality of this interaction can, however, not be addressed by our analysis, ie it is unclear to what degree the higher cost of emissions allowances induced reductions in production, and to what degree an exogenous reduction in production led to decreasing emissions.

- **Significant mitigation due to the second phase**

As indicated by the raw CITL data, companies increased their emissions between 2005 and 2006 by about one percent while they reduced emissions between 2007 and 2008 by about two percent. The total differential in emission growth rate thus was about -3.2 percentage points. For our subsample, emissions between 2005 and 2006 increased by 0.82 percent, and between 2007 and 2008 decreased by 5.51 percent. Thus, the differential between growth rates was 6.33 percentage points. When controlling for companies' turnover, number of employees, sector and home country, the differential in emission growth rates for our subsample is significantly lower (-3.6 percentage points) but still significant. That is, given its economic activity one would have expected that companies emit more than they actually did.

But because the reduction is still significant after controlling for economic activity, we can conclude that the emissions reductions were not only caused by the economic environment conditions. It is thus likely, that the reductions between 2007 and 2008 were also due to the shift from the first to the second phase of the EU ETS.

The fact that emissions reductions between 2007 and 2008 were significantly greater than between 2005 and 2006 – even when controlling for company output changes – also indicates that increased emissions reductions did not imply a proportionate loss in the output of the firms in the sample. This suggests that emissions reductions were not (only) achieved by reductions in the economic activity of the firms.

Table 4: Differential in emissions growth rate 2005/06 vs. 2007/08

Dependant variable	**Growth rate of emissions differentiated three times**				
	(1)	(2)	(3)	(4)	(5)
Sample	All companies	Initially under-allocated companies AF_i 2005 <1.15	Initially over-allocated companies AF_i 2005 >1.15	Firms with strongest decrease in allocation ΔAF_i 07-08 <-.08	Firms with least strong decrease in allocation ΔAF_i 07-08 >-.08
$\widehat{\alpha_1}$	-0.036**(.02)	-0.034*** (.01)	0.002 (.03)	-0.063**(.02)	-0.02 (.02)
changes in turnover	0.19***(.03)	0.19***(.04)	0.21***(.04)	0.14**(.04)	0.35***(.04)
changes in labour size	0.00 (.03)	-0.03 (.02)	0.07 (.05)	.07 (.06)	-0.03 (.02)
adj R-squared	0.17	0.21	0.23	0.20	0.40
Significance: * at 10%, ** at 5 % and *** at 1%. Standard errors are reported in brackets					

- **Initial allocation is important for mitigation effort**

Companies that obtained more allowances relative to their actual emissions show different mitigation behaviour than companies that received relatively less. We classify companies as "initially under-allocated" or "initially over-allocated" based on whether they had a higher individual allocation factor in 2005 than the medium company (1.15). According to column (2) of Table 4 under-allocated companies increased their reduction efforts between the first and the second phases. By contrast, according to column (3) of Table 4, companies that received an above-average initial allocation in the first phase did not increase their reduction effort between the phases. This indicates that firms that were short of allowances in the first phase reduced their emissions most between 2007 and 2008.

Furthermore, firms whose initial allocation was reduced by an above-average amount between 2007 and 2008 (column (4)) significantly reduced their emissions, even when controlling for changes in turnover and employment. On the other hand, firms whose allocation decreased less (column (5)) did not increase their reduction effort between the first and second phases. That is, tighter initial allocation correlates to emission reductions.

The causality of these results is difficult to establish. Four routes are plausible in general:

(i) Companies received initial allocations based on some sort of emission benchmark for their sector, eg, 1 EUA per ton of steel. Thus, companies with the lowest emission performance (2 tons of carbon per ton of steel) initially received the lowest allocation factor. Those companies were best able to reduce emissions and thus showed the highest emission reductions. This is unlikely to explain our findings, as the initial allowances in the first phase were almost entirely grandfathered (ie, based on historic emissions).

(ii) Those sectors that were able to reduce emissions the most obtained the tightest allocation. This effect is unlikely to explain our findings as we control for sectoral differences.

(iii) Those companies that announced reduced production between 2007 and 2008 received fewer allowances and emitted less in 2008. This is unlikely to explain our findings, as we (1) control for changes in economic activity of companies and (2) ignore installations that were absent in any year.

(iv) Due to various inefficiencies of the carbon market – eg market power, limited liquidity, conditionality of future allocation on past emissions, etc. – companies' mitigation strategies are contingent on their initial allocation[10].

Consequently, our findings challenge the view that initial allocation does not drive emission reduction.

- **Major sectoral differences**

The response to the shift from the first to the second phase differed between sectors. While some sectors, such as basic metals and non-metallic minerals, significantly increased their reduction efforts between 2005/06 and 2007/08, other sectors such as electricity and heat did not. The reason for these sectoral differences might be the different profiles of the sectoral abatement cost curves (the cost profile of emission reduction in the sector). That is, some industries already carried out most of the cheap emission reduction efforts as they were already economically viable at the low carbon prices of the first phase. In addition, the fact that allocation plays a role for emissions reduction might also explain these differences since allocation is decided at a sectoral level.

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[10] Hinterman (2010) shows that market power on both the product market and the permit market can create inefficiency in the carbon market. He found that German and UK power generators firms with market power could have found it profitable to manipulate the permit price upwards despite being net permit buyers.

Table 5: Differential in emission growth rate 2005/06 vs. 2007/08

	Paper and paper products	Non-metallic minerals	Basic metals	Electricity heat
$\widehat{\alpha_1}$	-0.029(0.027)	-0.087***(0.025)	-0.095*(0.049)	-0.001(0 .038)
Control variable1: changes in turnover	0.154**(0.077)	0.299***(0.058)	0.089(0.126)	0.136**(0.06)
Control variable2: changes in labor size	-0.062 (0.093)	-0.046(0.044)	0.099(0.208)	0.012(0.042)
Adj R-squared	0.13	0.27	0.71	0.21
Sample	**416 firms**	**806 firms**	**159 firms**	**660 firms**
Significance: * at 10%, ** at 5 % and *** at 1%. Standard errors are reported in brackets Countries dummies are not reported.				

5. Did the EU ETS affect company performance?

5.1. Methodology

There are already several studies on the direct impact of the EU ETS on the participating companies. An *ex ante* report by Carbon Trust (2004) listed three determinants of the impact of an ETS on competitiveness at the firm, sector, country level: energy intensity, ability to pass on higher costs via prices and ability to avoid CO_2 consumption during the process of production or to replace CO_2 intensive inputs. The overall conclusion of the report is that companies under regulation will be subject to greater burdens although the ETS does offer competitive advantages compared to alternative regulatory scenarios (the ETS with grandfathering has comparatively lower costs imposed by the system).

Ex post studies are rather scant. Demailly and Quirion (2008) study the impact of the ETS on production and profitability for the iron and steel sector. They find modest competitiveness losses partly explained by pass-through rates and the updating of allocation rule. On the employment effects of environmental policies, Golombek and Raknerud (1997) investigated the employment effects of imposing environmental standards on polluting firms. Using Norwegian data, they find that firms working under strict environmental regulations tend to increase employment in two out of three manufacturing sectors. Perhaps the closest study to ours is Anger and Oberndorfer (2008), who study the impact of the relative allocation of EU emissions allowances on competitiveness and employment in a sample of German firms for 2005-2006. They find evidence that the allocation mechanism within the ETS framework did not have a significant impact on revenues and employment of the firms under regulation using a simple OLS regression.

Our methodology is also based on an econometric analysis but uses a different model from Anger and Oberndorfer (2008). We study the effect of the ETS on the added value, the profit margin and employment of participating firms over a longer phase for a panel of European firms [11]. Indeed, to evaluate the impact of the

[11] There are macroeconomic simulations of the effects of the ETS on the entire economy: COWI (2004) use GTAP-ECAT (European Carbon Allowance Trading) to assess impacts of the EU ETS on competitiveness. With two different ETS scenarios (long-term and sluggish shorter-term adaptation) and BAU as a reference scenario, they suggest that competitiveness will be impacted in Europe due to the ETS introduction. The SIMET energy system model (Matthes et al., 2003) analyses the impact of emissions trading on Germany. With 25 different variations of emissions trading system, the main result is that an allocation on the basis of selected basis years has a huge impact on the level of additional costs and gains. The DART model (Klepper and Peterson, 2004) analyses competitiveness on the basis of a computable general equilibrium (CGE) model. Covering 16 regions, including nine EU countries or groups of countries in 2012, BAU as the reference scenario, it shows significant reductions in production and hence a loss of competitiveness if the EU ETS is

ETS on the firms' performance, we measure the difference between the state of the firms after being subject to the ETS and the hypothetical state (ie, the counterfactual) of their performance if they had not been under regulation. The counterfactual is not observable, but can be estimated (eg Heckman *et al*, 1999) by means of comparison to a control group (non-participating firms). Furthermore, to reduce the selection bias created by assigning a non participating firm to each participating firm, we use propensity score matching. This is a common way to 'correct' the estimation of participation effects while controlling for other factors that might have an influence. The basic idea is that this bias is reduced when participating and control subjects are as similar as possible. The matching procedure is explained in the next section.

In order to assess the impact of the ETS across the two phases, we estimate the following equation:

$$y_{it} = \alpha_0 + \alpha_1 d_{1,it} + \alpha_2 d_{2,it} + \alpha_3 x_{it} + \alpha_4 cv_{it} + \varepsilon_{it}, t = 2004,2005\ or\ 2008\ (3)$$

Where:

- y_{it} is the outcome variable in log value which can be added value, profit margin or employment
- $d_{1,it}$ is a dummy variable which equals 1 after the launching of the ETS (2005 or 2008) and 0 otherwise (2004)
- $d_{2,it}$ is a dummy variable which equals 1 if the firm i in phase t is under EU ETS (2005 or 2008)
- x_{it} is a set of dependent variables for each outcome variable: labour and fixed capital for added value, lagged value of employment value for employment and lagged value of turnover and employment for profit margin
- cv_{it} is a set of sectoral and country dummies
- ε_{it} is the error term decomposed into a firm specific effect η_i and a time variant effect u_{it}.

By taking the first differences of (3), we have:

$$\Delta y_i = \alpha_1 + \alpha_2 \Delta d_{2,i} + \alpha_3 \Delta x_i + \alpha_4 \Delta cv_i + \Delta u_i\ (4)$$

The relative allocation of emissions may have an impact on the firm's behavior, and results can be different from a sector to another as we have seen in section 4. Therefore we perform additional regressions on subsamples.

compared with the BAU. However, if one applies Kyoto measures, ETS is the most competitive scheme even in sectors which do not take part in emissions trading.

5.2. Matching procedure

Our one-to-one matching is performed based on a propensity score $p(X) = \Pr(D = 1|X)$ where X is the set of pre-treatment characteristics (working capital, number of employees, fixed capital, intermediate consumptions, remuneration of employees) and D is an indicator of the treatment actually received by firms. Using X is crucial to satisfy the conditional independence assumption (CIA) which states that different firms with identical realizations of X_i will be different in their outcome Y_i only through the effect of participating in the ETS. Since it is virtually impossible to find exact twins, functions such as the propensity score are used to find the closest match for participating firms. The control group was selected from the following sectors:

Table 6: Sector names for the control group

	Sector name
1	Other mining and quarrying
2	Mining support service activities
3	Food products
4	Beverages products
5	Tobacco products
6	Textiles
7	Wearing apparel
8	Wood and related products
9	Leather and related products

We find the sample of non-participating firms (control group) for each of the participating firms that is most similar in terms of the propensity score $p(X)$. Participating unit i is matched to non-participating unit j such that:

$$p_i - p_j = \min_{k \epsilon \{D=0\}} \{abs(p_i - p_k)\}$$

Once the matching partners are found, it is then possible to estimate the average effect of participation by assessing the impact of the ETS on the dependent variable:

$$\hat{\alpha}_2 = \Delta\bar{Y}_T - \Delta\bar{Y}_C \ (5)$$

where $\bar{Y}_T$ is the average for the participant group and $\bar{Y}_C$ i is the average for the control group. Alternative matching procedures have been proposed in the literature such as Nearest Neighbour Matching, Radius Matching, Kernel Matching and Stratification Matching. To assess the robustness of our estimates, we also perform these matching procedures. These commands are performed with Stata Psmatch2 command (E. Leuven and B. Sianesi, 2003). We assess the quality of the matches by comparing the situation before and after matching and check if there remain any differences after conditioning on the propensity score. A suitable indicator for this assessment of quality is the bias reduction, which is derived from before and after matching standardized bias. In most empirical studies a bias reduction of below 3 percent or 5 percent is seen as sufficient. In our case we have for each covariate X a bias reduction below 5 percent. Additionally, Sianesi (2004) suggested assessing the quality of the matching via the reestimation of the propensity score on the matched sample, that is only on participating firms and matched non-participating firms, and comparing the pseudo-$R2$ before and after matching. The pseudo-$R2$ is an indicator of how well the covariates X explain the 'treatment' probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore, the pseudo-$R2$ should be fairly low. In our case we find a pseudo-R2 of 0.012.

5.3. Results

According to Table 7, being subject to the ETS had no impact on a company's added value, employment and profit margin in 2005 or 2008. This is slightly counterintuitive, as obtaining the right to either use or sell free allowances should increase the degree of freedom of a company's profit maximization strategy and thus potentially increase profits. Furthermore, the pass-through of the opportunity cost of emission allowances should increase the prices of carbon-intensive products. Thus, participating companies could expect higher profits (so-called windfall profits, eg Sijm *et al*, 2006).

We also perform different analyses on the subsamples of under- and over-allocated firms, but there is still overall no significance for the parameter estimating the impact of the ETS (see Appendix 3 for the regressions within sectors which do not lead overall to significant results). At the 10 percent level, however, some interesting results can be reported. *First*, over-allocated firms obviously benefited from their participation in the ETS by increasing their profit margins in the first and the second phases. *Second*, the profit margins of under-allocated firms decreased between 2004 and 2008. And *third*, certain sectors (eg non-metallic minerals, see Appendix 3) are disproportionately affected. However, the overall conclusion is that participating companies did not experience any significant loss of competitiveness.

Some caveats apply to our results. First of all, the matching procedure should have been done within the sectors of interest for our study. This was not possible because we wanted to avoid including in our control group participating firms that we were not able to identify in the Amadeus data. Consequently, we compare companies from all non-regulated sectors to companies from regulated sectors. Thus, our results might just capture sectoral dynamics. Second, the five-year panel does not allow us to introduce as many control variables as we would have needed, especially for the employment equation. Finally, economic firm data was obtained from Amadeus which is known to have a different way of measuring firm characteristics (employee size, turnover) than national statistics.

Table 7: Effect of the ETS on companies' performance

Dependent variable	Added value		Employment		Profit margin	
Period	(1)= 2004-2005	(2)= 2004-2008	(1)= 2004-2005	(2)= 2004-2008	(1)= 2004-2005	(2)= 2004-2008
$\hat{\alpha}_2$	-0 .09 (0.08)	-0.11 (0.08)	- 0.002 (0.002)	-0 .009 **(0.004)	-0.53 (0.45)	-0.51 *(0.37)
Changes in fixed capital	0.08***(0.01)	0.06***(0.01)				
Changes in employment	0.11***(0.01)	0.10***(0.02)	0.50***(0.002)	0.52***(0.02)	-0.59*(0.32)	-0.52(0.32)
Changes in turnover			0.04***(0.02)	0.05***(0.02)	3.91***(0.21)	3.67***(0.21)
Adj R-squared	0.78	0.83	0.75	0.73	0.58	0.62
Sample	4202 firms	4202 firms	4202 firms	4202 firms	4202 firms	4202 firms
Underallocated firms (AF<1)						
Dependent variable	Added value		Employment		Profit margin	
	(1)	(2)	(1)	(2)	(1)	(2)
$\hat{\alpha}_2$	-0.04 (0.04)	-0.05 (0.06)	-0.003(0.003)	-0.013 (0.095)	-0.22 (0.31)	-1.95 *(1.11)
Changes in fixed capital	0.08***(0.01)	0.11***(0.01)				
Changes in employment	0.16***(0.02)	0.17***(0.02)	0.49***(0.002)	0.50***(0.002)	-0.42(0.43)	-0.34(0.43)
Changes in turnover			0.04***0.003)	0.03***(0.003)	2.61***(0.27)	2.54(0.27)
Adj R-squared	0.75	0.77	0.69	0.67	0.51	0.52
Sample	1436 firms	1538 firms	1538firms	1538 firms	1538 firms	1538 firms
Overallocated firms (AF>1)						
Dependent variable	Added value		Employment		Profit margin	
	(1)	(2)	(1)	(2)	(1)	(2)
$\hat{\alpha}_2$	-0.07 (0.07)	-0.12(0.10)	0.008 **(0.004)	-0.004(0.002)	2.14* (1.25)	2.32 *(1.29)
Changes in fixed capital	0.05**(0.02)	0.07***(0.02)				
Changes in employment	0.08***(0.02)	0.09***(0.02)	0.52***(0.002)	0.51***(0.003)	-0.95**(0.50)	-0.87*(0.49)
Changes in turnover			0.05***(0.004)	0.06 ***(0.005)	5.29***(0.35)	5.07***(0.34)
Adj R-squared	0.85	0.77	0.89	0.57	0.58	0.64
Sample	2766 firms	2664 firms	2766 firms	2664 firms	2766 firms	2664 firms
Significance: * at 10%, ** at 5 % and *** at 1%. Standard errors are reported in brackets. Sectoral and countries dummies parameters are not reported.						

6. Conclusion

The purpose of this study was to shed light on the effect of the EU ETS at firm level. We have used a sample of 2101 European firms covered by the ETS to study the effectiveness of the ETS during its first phase and the beginning of its second phase, and its impact on company performance. We find evidence that the ETS in the second phase led to a reduction in emissions. We also demonstrate that two sectors (non-metallic minerals and basic metals) contributed most to the reductions, while the electricity and heat sectors did not at all.

Furthermore, we find that initial allocation and *ex-post* emissions are correlated. The most plausible explanation is that carbon markets deviate from the idealised market conditions assumed in the Coase theorem. Limited market liquidity and the high concentration of initial allocation might be two of the deviations from Coase's assumptions responsible for the effect we found of allocation on emissions.

Analogous to previous studies on the competitiveness effects of the EU ETS (Demailly and Quirion, 2008; Anger and Oberndorfer, 2008), we found that being subject to the ETS did not significantly affect profits, employment or added value during the first phase and the beginning of the second phase. When we conducted analyses on different groups (under- versus over-allocated firms, sectoral analysis) we find that certain sectors (eg non-metallic minerals) are disproportionately affected. These results have to be interpreted with caution as our counterfactual (similar companies from non-regulated sectors) is far from perfect. Also, we have to note that this analysis only deals with the effect on companies under regulation and thus completely ignores the effects on indirectly affected industries (eg, electricity-intensive companies).

Various refinements and extensions are desirable. Including more years of the ETS could increase confidence in the results and help to capture longer-term effects (such as investments). Analysing the endogeneity of allocation in the second phase could help to disentangle the strategic mitigation behaviour of firms in the first phase.

7. References

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APPENDIX 1

Table 1: Distribution of emissions and allowances in thousand EUAs: Matched sample and raw CITL data

	Verified emissions 2005 (Sample)	Verified emissions 2005 (CITL)	Allocated Allowances 2005 (Sample)	Allocated Allowances 2005 (CITL)	Verified Emissions 2008 (Sample)	Verified Emissions 2008 (CITL)	Allocated allowances 2008 (Sample)	Allocated allowances 2008 (CITL)
Total								
Mean	336	160	337	166	468	168	407	155
Median	16	10	20	12	20	11	24	14
Max	32000	32000	30800	30800	72800	30900	46900	26900
Q3	84	39	103	48	114	43	120	51
Q1	2	0	4	0	4	1	6	2
Q3-Q1	81	38	99	47	110	42	114	49
Std	1479	881	1421	862	2389	865	1873	718
Germany								
Mean	471	241	484	250	618	240	491	197
Median	22	15	27	19	28	13	31	17
Max	29700	29700	28700	28700	72800	24900	46900	19600
Q3	121	56	164	68	170	55	188	62
Q1	5	5	6	6	5	2	7	3
Q3-Q1	116	51	158	62	165	53	180	59
Std	2227	1359	2220	1353	3460	1311	2283	937
Poland								
Mean	572	218	613	255	716	219	685	216
Median	26	21	32	27	25	19	28	21
Max	32000	32000	30800	30800	30900	30900	26900	26900
Q3	101	50	157	65	110	48	112	57
Q1	12	8	14	11	9	6	11	8
Q3-Q1	89	43	143	54	100	42	101	49
Std	2638	1332	2592	1375	2902	1311	2637	1177
France								
mean	235	117	261	135	342	111	354	116
Median	38	19	55	26	42	16	55	20
Max	11500	11500	12200	12200	15500	15500	15800	15800
Q3	118	51	147	66	141	45	162	52
Q1	14	8	19	12	14	5	16	8
Q3-Q1	104	43	128	54	128	39	146	44
Std	921	547	984	601	1380	513	1386	522

Table 2: Descriptive statistics by sector

Paper	Added value	Employees	Fixed Capital	Profit Margin
Median	9418	208	14958	1.7
Mean	52720	578	105853	1.2
Std	297281	2815	614557	12.4
Coke and refined				
Median	62409	435	103922	2.7
Mean	468360	1478	526076	3.7
Std	1077743	2348	1020245	8.3
Other non-metallic				
Median	5179	98	5749	5.8
Mean	44797	466	53982	6.0
Std	256510	2550	430804	16.2
Basic metals				
Median	47839	730	53175	3.8
Mean	152100	1700	152627	4.5
Std	295276	2757	281187	10.0
Electricity and heat				
Median	7349	90	16480	4.8
Mean	117623	627	286498	5.1
Std	456086	2285	1413993	14.2

Table 3: Descriptive statistics by region

Spain	Added value	Employees	Fixed Capital	Profit Margin
Median	3016	45	4582	4.5
Mean	57465	366	132424	4.6
Std	273521	1956	775999	16.4
Bel-Lux				
Median	33747	272	19397	3.6
Mean	222391	982	193984	5.4
Std	747286	2608	665943	13.9
France				
Median	17071	280	14118	3.6
Mean	70777	704	67721	4.0
Std	197116	1410	218339	10.0
Austria				
Median	53899	250	27609	3.4
Mean	100040	544	92519	1.8
Std	120406	931	213101	13.5
Germany				
Median	21794	257	39866	6.2
Mean	93836	932	171835	6.7
Std	356256	3860	641047	9.6
Netherlands				
Median	52810	351	19368	4.8
Mean	714841	1511	515075	4.6
Std	1289691	3048	1459945	10.5

Table 4: Descriptive statistics by region (concluded)

Italy	Added value	Employees	Fixed Capital	Profit Margin
Median	5093	64	7676	2.3
Mean	83174	342	224217	2.8
Std	454308	1445	1370647	10.6
Sweden				
Median	9383	175	20892	7.6
Mean	133803	928	414016	8.6
Std	710499	4091	2628443	16.0
Finland				
Median	8385	83	26024	4.2
Mean	169592	1607	365394	5.0
Std	609475	6361	1383563	10.3
UK-Ireland				
Median	14324	158	24019	3.4
Mean	201657	889	307235	4.1
Std	541003	2624	1098426	20.1
Poland				
Median	3909	195	12468	5.5
Mean	18162	383	174061	5.9
Std	68145	696	724944	12.0

Table 5: Allocation factor: Matched CITL-Amadeus sample compared to the raw CITL data

Germany	**2005**		**2006**		**2007**		**2008**	
	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL
25%	**0.94**	**0.94**	**0.94**	**0.94**	**0.94**	**0.94**	0.9	0.93
Median	**1.10**	**1.10**	**1.11**	**1.11**	1.12	1.15	1.06	1.1
75%	1.34	1.39	1.36	1.41	1.49	1.53	1.29	1.38
Spain	**2005**		**2006**		**2007**		**2008**	
	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL
25%	**0.97**	**0.97**	0.94	0.97	0.91	0.92	0.99	1
Median	**1.07**	**1.07**	1.07	1.11	1.06	1.1	1.21	1.23
75%	1.22	1.25	1.29	1.41	1.28	1.39	1.61	1.66
France	**2005**		**2006**		**2007**		**2008**	
	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL
25%	1.05	1.06	1.01	1.06	1	1.08	0.98	0.93
Median	1.22	1.26	1.22	1.29	1.21	1.35	1.1	1.09
75%	1.41	1.47	1.47	1.55	1.51	1.64	1.33	1.36
UK	**2005**		**2006**		**2007**		**2008**	
	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL
25%	0.77	0.83	0.64	0.83	0.67	0.81	0.59	0.92
Median	0.99	1	1	1.02	0.96	1.06	1.1	1.15
75%	1.36	1.32	1.32	1.34	1.31	1.41	1.4	1.58
Poland	**2005**		**2006**		**2007**		**2008**	
	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL	Amadeus	CITL
25%	1.07	1.08	**1.08**	**1.08**	1.08	1.07	0.98	0.97
Median	1.20	1.21	1.24	1.22	1.25	1.24	**1.08**	**1.08**
75%	1.43	1.47	1.45	1.5	**1.56**	1.51	**1.25**	**1.25**

APPENDIX 2: Robust regression

From: Huber, P., 1964, “Robust Estimation of a Location Parameter”, *Annals of Mathematical Statistics 35(1)*, pp. 73-101. and Verardi, V. and C. Croux, 2009 , “Robust Regression in Stata”, *Stata Journal, 9(3)*, pp. 439-453 .

Let us consider the following regression in matrix notation:

$$Y = X\theta + \varepsilon$$

where Y is the (nx1) vector, X is a (nxp) matrix of independent variables, θ is the (px1) vector of parameter estimates and ε is the (nx1) vector of error terms.

On the basis of estimation of θ, we can obtain the vector of residuals $r = Y - \hat{Y}$. The typical least squares estimate is obtained through the following minimization:

$$\hat{\theta}_{LS} = arg\,\min_{\theta} \sum_{i=1}^{n} r_i^2(\theta)$$

The clear drawback of such estimation is that it gives too much importance to observations with very large residuals, namely outliers. Huber (1964) proposed a class of estimators known as M-estimators in order to keep robustness with respect to vertical outliers (outlying values for the corresponding error term but not outlying in the space of explanatory variables) and increase Gaussian efficiency. An M-estimator is expressed in the following way:

$$\hat{\theta}_M = arg\min_{\theta} \sum_{i=1}^{n} \rho(\frac{r_i(\theta)}{\sigma})$$

where $\rho()$ is the convex loss function and σ is the measure of dispersion. To implement this estimation, we use an iterative reweighted least square algorithm with weights $w_i = \rho(\frac{r_i/\theta}{r_i^2})$

(observations with a cook distance larger than one are assigned a weight zero) such that we now have:

$$\hat{\theta}_M = arg\min_{\theta} \sum_{i=1}^{n} w_i r_i^2 (\theta)$$

With this weighted least-squares estimator, the weights w_i are unknown because they are a function of θ. The starting weights are obtained using the initial estimate $\tilde{\theta}$ for θ. The loss function $\rho()$ is a Tukey biweight function:

$$\rho(u) = \begin{Bmatrix} 1 - \left[1 - \left(\frac{u}{k}\right)^2\right]^3 if\ /u/ \leq k_1 \\ 1\ if\ /u/ > k \end{Bmatrix}$$

where k is commonly set at 1.547 for the starting value of the algorithm and then k is commonly set at 4.685 for the other steps. To increase both the robustness and the efficiency of the estimation, it is better to have a measure of dispersion of the residuals that is less sensitive to extreme values than σ. Such a robust dispersion σ_s is chosen such that:

$\frac{1}{\mathrm{n}} \sum_{i=1}^{n} \rho(\frac{r_i(\theta)}{\sigma_s}) = \mathrm{b}$ where $b = E[\rho(Z)]$ and $Z \sim N(0,1)$ and

$$\hat{\theta}_s = arg\min_{\theta} \hat{\sigma}_s (r_1(\theta), \dots, r_n(\theta))$$

This robust dispersion estimator is then used to obtain the final $\hat{\theta}_{MM}$ estimator:

$$\hat{\theta}_{MM} = arg\min_{\theta} \sum_{i=1}^{n} \rho(\frac{r_i(\theta)}{\hat{\sigma}_s})$$

APPENDIX 3: Additional regressions

Table 1: Efficiency of EU ETS: intra sectoral analysis

Dependant variable	Added value							
	Paper and paper products		Non-metallic minerals		Basic metals		Electricity and heat	
Period	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008
Impact of EU ETS	-0.03 (0.03)	-0.09** (0.04)	-0.05**(0.02)	-0.2 ***(0.02)	-0.17 (0.16)	-0.14(0.19)	-0.003 (0.02)	-0.016 (0.016)
Changes in fixed capital	0.03(0.02)	0.06(0.02)**	0.06**(0.02)	0.06**(0.02)	0.05(0.05)	0.08(0.05)	0.16***(0.02)	0.18***(0.01)
Changes in employment	0.02(0.03)	0.019(0.04)	0.26***(0.02)	0.28(0.03)	0.19**(0.06)	0.19***(0.05)	0.01(0.02)	0.022(0.025)
Adj R-squared	0.45	0.41	0.65	0.79	0.43	0.45	0.52	0.55
Dependant variable	**Profit margin**							
	Paper and paper products		Non-metallic minerals		Basic metals		Electricity and heat	
Period	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008
Impact of EU ETS	1.13 (1.94)	-0.32 (0.51)	-3.05 *** (0.84)	-5.04***(0.51)	-4.3(3.28)	-4.88(5.47)	0.04 (0.42)	1.07** (0.45)
Changes in turnover	7.94***(0 .42)	7.55***(0.53)	5.51***(0.51)	5.53***(0.51)	2.09***(0.43)	1.93***(0.42)	1.31***(0.45)	1.77***(0.46)
Changes in employment	-0.48(0.75)	-0.40(0.75)	-0.32(0.69)	-0.47(0.69)	-1.18(1.001)	-1.03(0.95)	-0.7(0.49)	-0.66(0.49)
Adj R-squared	0.36	0.38	0.42	0.41	0.33	0.29	0.62	0.7
Dependant variable	**Employment**							
	Paper and paper products		Non-metallic minerals		Basic metals		Electricity and heat	
Period	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008	(1)=2004-2005	(2)=2004-2008
Impact of EU ETS	-0.0002 (0.003)	0.006*(0.004)	-0.01** (0.005)	0.005 (0.003)	.00005 (0.007)	0.01** (0.008)	-0.01** (0.004)	-0.002 (0.003)
Changes in employment	0.50***(0.003)	0.49***(0.004)	0.5***(0.003)	0.51***(0.003)	0.16***(0.005)	0.18***(0.007)	0.5***(0.003)	0.51***(0.004)
Changes in turnover	0.05***(0.004)	0.06***(0.006)	0.07***(0.004)	0.06***(0.004)	0.008(0.006)	0.003(0.007)	0.03***(0.005)	0.02**(0.005)
Adj R-squared	0.73	0.82	0.52	0.54	0.32	0.29	0.37	0.32

Significance: * at 10%, ** at 5 % and *** at 1%.
Standard errors are reported in brackets. Countries dummies parameters are not reported.