7 The European Union Emissions Trading System and its economic and environmental impacts

The European Union Emissions Trading System (EU ETS) is currently the largest emissions trading system globally in terms of greenhouse gases covered. With an increasing number of emissions trading systems being implemented around the world, it is important to understand the environmental and economic impacts such a system might have. This chapter[1] provides a causal analysis of the impact of the introduction of the EU ETS on regulated companies. To evaluate the impact on carbon emissions, installation-level data on CO_2 emissions is used for four European countries, while the analysis focuses on the economic impacts on firms' revenues, assets, profits and employment, it uses firm-level data for 31 European countries. The empirical analysis uses a matching methodology combined with a difference-in-differences estimation to provide a causal estimate of the policy's impact. The analysis finds that the introduction of the EU ETS led to a reduction of carbon emissions by 10% between 2005 and 2012. The impact on economic outcomes is either insignificant or positive, suggesting that the potential fears in terms of competitiveness loss of the European industry have been exaggerated.

Background

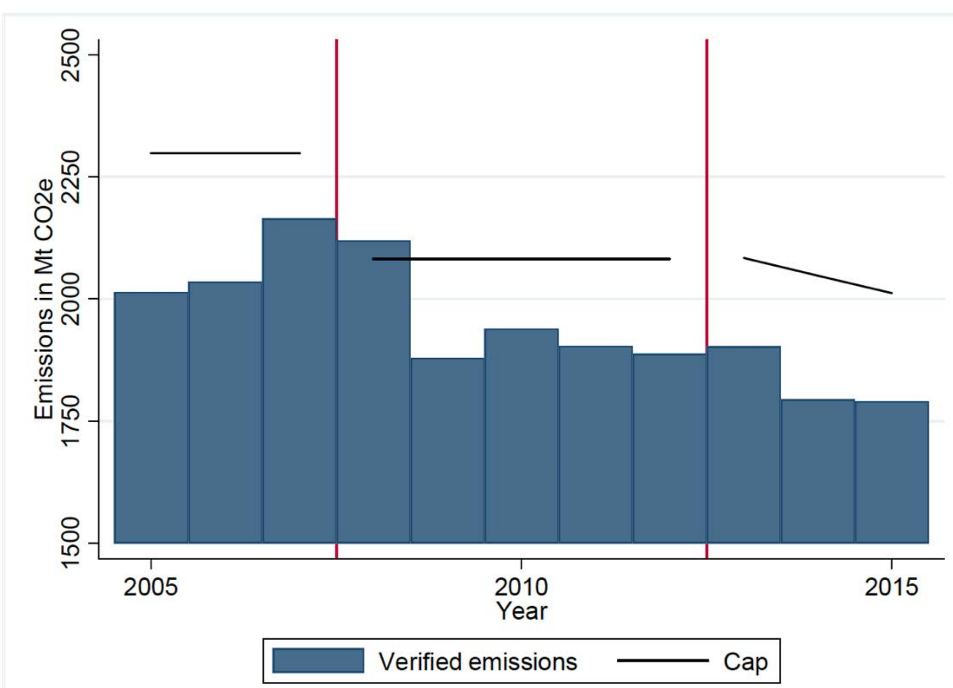
The largest emissions trading system in the world

The European Union Emissions Trading System (EU ETS) was introduced in 2005 and is the largest emissions trading system in the world in terms of greenhouse gases covered. The cap-and-trade mechanism covers around 12 000 energy-intensive installations in 31 countries, accounting for 40% of the European Union's total greenhouse gas emissions. Around 8 000 companies owning these installations are thus incentivised to reduce their carbon emissions. The trading of emission allowance certificates ensures that emission reductions are achieved in a cost-effective manner. Nonetheless, concerns that carbon pricing might hamper the competitiveness of the European industry have been present since the introduction of the scheme.

Emissions cap and verified emissions decreased over time

The EU ETS was set up with a steadily declining overall emissions cap. Being one of the first carbon emissions trading schemes, the EU ETS has been divided into different trading phases in order to be able to implement adjustments if necessary. The first trading phase, from 2005 to 2007 was a pilot which prohibited banking and borrowing of allowances across trading phases. The second (2008-12) and third (2013-20) trading phases allowed firms to bank unused allowances for later use. Figure 7.1. shows the emission cap as well as the verified emissions for the three trading phases. While it can be seen from the figure that overall verified emissions declined over time, it is a priori not clear whether this is a causal effect of the EU ETS or whether this development is due to other factors like technological progress or macroeconomic developments such as business cycle fluctuations or structural changes of the European economy.

Figure 7.1. Overall cap and verified emissions from EU ETS installations (2005 – 2015)



Note: Calculations by Dechezleprêtre, Nachtigall and Venmans (2018[1]), based on data from the European Transaction Log (EUTL).

Pollution Haven and Porter Hypothesis – the theory is ambiguous

As discussed in previous chapters, environmental policy tools, especially market-based ones, impose additional costs on companies which might divert resources away from productive activities. Two well-known hypotheses describe the potential effect of environmental regulation on productivity and hence competitiveness. First, the Pollution Haven Hypothesis predicts that parts of the regulated industry will either move abroad or close down because of foreign competition (Levinson and Taylor, 2008[2]), creating carbon leakage, especially when environmental policy stringency is weaker outside the ETS. Second, the Porter Hypothesis suggests that productivity and thus competitiveness of the regulated industry might increase in response to tighter environmental policy, as the latter induces innovation that would not have happened in the absence of the policy (Porter, 1991[3]; Porter and van der Linde, 1995[4]).

Empirical studies on the EU ETS focused on either economic or environmental outcomes so far

There is only a nascent field of literature investigating the environmental and economic outcomes of environmental policies at the same time. While there is a number of studies investigating either the environmental or the economic effects of the EU ETS, combined analyses of economic and environmental outcomes are scarce. Studies only looking at the environmental outcomes of the EU ETS find reductions of CO_2 emissions attributable to the EU ETS, with abatement rates ranging between 2.4% and 4.7% (see Martin, Muûls and Wagner (2016[5]) for a literature overview). Abatement rates are, however, found to vary significantly across sectors. Studies focusing only on the economic effects of the EU ETS (see Martin, Muûls and Wagner (2016[5]) for a review) found positive effects on value added, turnover and investment (Marin, Marino and Pellegrin, 2018[6]), no or slightly positive effects on employment (Anger and Oberndorfer, 2008[91]; Marin, Marino and Pellegrin, 2018[142]; Commins et al., 2011[92]; with the exception of Abrell, Ndoye Faye and Zachmann (2011[7]) who find a slight decrease in employment), and either positive (Commins et al., 2011[8]; Löschel, Lutz and Managi, 2016[9]; Calligaris, D'Arcangelo and Pavan, 2018[10]) or negative (Marin, Marino and Pellegrin, 2018[6]) effects on total factor productivity growth. One of the most comprehensive studies in terms of the countries covered provides evidence that the EU ETS has increased innovation activity in low-carbon technologies among regulated companies by 30% compared to a scenario where the EU ETS would not have been in place (Calel and Dechezleprêtre, 2016[11]). Regarding the evaluation of the joint EU ETS effects on carbon emissions and firm performance, four studies – each looking at one particular country – have been carried out so far. One study looking at France shows that the EU ETS reduced carbon emissions of regulated plants by 13%, but finds no statistically significant changes to employment, value added or the capital stock, suggesting that the effects of the ETS on the competitiveness of regulated firms has been limited (Wagner et al., 2018[12]). Another study focusing on Germany finds that the EU ETS reduced carbon emissions of regulated firms by 25%, while no significant impact on employment was found (Petrick and Wagner, 2014[13]). A study on Norway finds that emissions were reduced by 30% in the second trading phase of the EU ETS and that value-added and labour productivity of firms increased significantly (Klemetsen, Rosendahl and Jakobsen, 2020[14]), potentially because of the free allocation of allowance certificates. Looking at the initial phase of the EU ETS, a study on Lithuania finds no significant impact on carbon emissions or on firms' profitability (Jaraite and Di Maria, 2016[15]).

Contribution of this study – first comprehensive study of environmental and economic effects of the EU ETS

This study provides the first comprehensive study of the joint environmental and economic effects of the EU ETS. The study evaluates the first ten years of the EU ETS, from 2005 to 2015 (2005-12 for carbon emissions) and provides the first European-wide analysis of the effects on carbon emissions as well as on firm performance, as measured by revenues, assets, profits and employment. Using matching techniques and a difference-in-difference estimation allows for the causal estimation of the EU ETS effects.

Empirical set-up

Causal analysis using a difference-in-difference approach

The empirical analysis relies on a quasi-experimental setting where the identification of the causal effect exploits sector-specific capacity thresholds that determine inclusion in the EU ETS. The EU ETS only covers installations above a certain threshold of production capacity while installations below this threshold are not regulated. In order to evaluate the impact of being regulated under the EU ETS, the analysis can thus compare installations above the threshold with similar installations just below the threshold. Similarly, firms owning at least one installation above the threshold might be very close (in terms of turnover, number of employees, and so on) to unregulated firms owning only installations below the threshold. It is thus possible to compare regulated firms with unregulated firms, located in the same country, operating in the same sector and having similar characteristics, and use this set of firms as a control group. The regulated and unregulated entities are matched based on characteristics in the years before the introduction of the EU ETS. The matching is then combined with a difference-in-difference estimation, which compares regulated and unregulated entities before and after the introduction of the EU ETS. This approach allows to control for confounding factors which affect both regulated and unregulated installations as well as for unobserved heterogeneity.

Empirical model

The difference-in-difference model is estimated at the installation or firm level, depending on the outcome investigated, and is based on the following equation:

$$Y_{it} = \alpha ETS_i + \beta post + \gamma ETS_i post + \delta_i + \theta_t + \varepsilon_{it}$$

where Y_{it} is either carbon emissions of installation *i*, or turnover, assets, number of employees, profit or return on assets of firm *i* at time *t*. ETS_i is a dummy variable indicating whether the installation/firm was regulated by the EU ETS or not, $post$ is a dummy variable indicating the post-treatment period (after 2005), and $ETS_i post$ is the interaction term between the two variables. δ_i are installation/firm fixed effects, θ_t are year fixed effects. ε_{it} reflects the remaining error term. Depending on the specification and the nature of the dependent variable, an OLS or a Poisson estimator is used.

Data

The data on carbon emissions are taken from the national Pollution Release and Transfer Registers (PRTRs) and cover France, the Netherlands, Norway and the United Kingdom as the threshold for reporting emissions in the pollution release registries of these countries is comparably low (below 10 kt per year) and therefore provides emission information on many installations which are not covered by the EU ETS. The European Union Transaction Log (EUTL) is used to identify installations covered by the EU ETS. Matching the regulated installations to unregulated ones yields a final sample of 408 installations for the analysis of the environmental outcome. Regarding the analysis of economic outcomes, the dataset covers 31 European countries over the time period 2003 to 2015. The EUTL is used to identify firms owning at least one installation covered by the EU ETS. These firms are considered as regulated by the EU ETS. Data on economic outcomes come from the firm-level database ORBIS. The matched sample size for the analysis of the economic effects covers 3 067 firms.

Results

The EU ETS led to emission reductions, while firm performance was largely unaffected

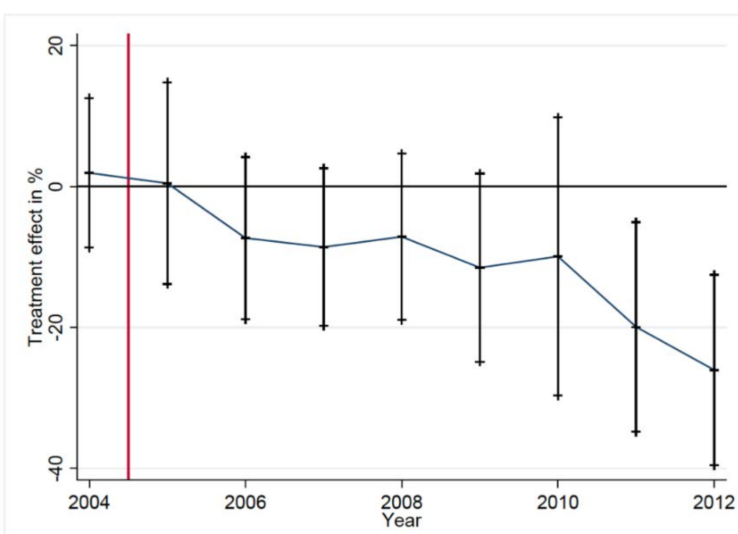
The empirical results show an average reduction of carbon emissions by 10% in the first two trading phases from 2005 until 2012 (Table 7.1. , column 1). During the first trading phase, carbon emissions were reduced by 6% while in the second trading phase, emissions were reduced by 15%. Figure 7.2. shows the estimated yearly treatment effects of the EU ETS on firms' emissions, indicating that most of the emission reductions took place towards the end of the second trading phase. Regarding firm performance, the analysis shows that the EU ETS led to an increase in revenues by 7% to 18% (depending on the specification and matching algorithm used) and to an increase in fixed assets by (6% to 10%) for regulated firms (Table 7.1. , columns 3 and 4). No statistically significant impact on the number of employees or on profits is found.

Table 7.1. Effects of the EU ETS - main estimation results

Dependent variable:	Carbon emissions	Revenue (log)	Assets (log)	Employees	Profit	ROA
Estimator	OLS	OLS	OLS	Poisson	OLS	OLS
Treatment effect	-0.10*	0.1671***	0.0811***	0.0234	283.6478	0.0002
	(0.06)	(0.0256)	(0.0225)	(0.0214)	(211.2466)	(0.0049)
Installation fixed effect	Yes	No	No	No	No	No
Firm fixed effect	No	Yes	Yes	Yes	Yes	Yes
Sector fixed effect	No	Yes	Yes	Yes	Yes	Yes
Country fixed effect	No	No	No	No	No	No
Year fixed effect	No	No	No	No	No	No
Observations	3 153	42 742	42 640	40 117	42 834	41 666

Notes: Robust standard errors for estimation 1 in parentheses. Clustered standard errors for estimation 2 to 6. ***, ** and * represent p<0.01, p<0.05, p<0.1 respectively.

Figure 7.2. Treatment effect in terms of carbon emissions by year



Notes: Point estimates are shown with confidence interval.
Source: Dechezleprêtre, Nachtigall and Venmans (2018[1]).

The effects of the EU ETS are heterogeneous across sectors and vary with the number of free allowances granted

The impact of the EU ETS on emission reductions vary across installation size, sector and the level of free allowance allocation (see Dechezleprêtre, Nachtigall and Venmans (2018[1]) for detailed estimation results). Emission reductions were strongest for larger installations. Large firms may be more responsive to carbon pricing because pollution control technologies are typically capital intensive and involve a high fixed cost. Larger firms may be able to spread fixed costs over higher output, lowering the cost per unit of production. The effect is found to differ across sector, with the chemicals, non-metallic mineral products and electricity sectors showing the largest reductions in carbon emissions. The results also show that reductions in emissions are lower for installations, which were granted more free allowances. Installations with an over-allocation of free allowances[2] did not reduce their emissions significantly.

Turning to the economic impacts, the positive and statistically significant effect on revenue and assets is present in all three phases of the EU ETS, even though the impact is larger in phase 2 and 3. The effect is slightly larger for smaller firms. Looking at individual sectors, the paper shows that no single sector was negatively hit by the EU ETS in terms of firm performance. The positive effect seems, however, to be driven by the minerals, metals, electricity and heat sectors. The electricity and heat sector did not only increase revenue and assets but also employment and return on assets – probably a consequence of effective cost pass-through combined with free allowance allocation.

Robustness checks

The results are robust to several robustness checks, such as excluding the largest installations, excluding outliers and using a balanced sample. In order to address the concern that the matched sample of installations is rather small and thus an extrapolation of the results to other EU-countries might be questionable, the matching procedure is relaxed, which results in almost doubling the sample size. The point estimate of the treatment effect is reduced in the larger sample but remains statistically significant. Overall, the different specifications yield a range of estimated effects of the EU ETS on carbon emissions in the range of a reduction of 6% to 12%.

Conclusion

The EU ETS led to emission reductions of regulated firms, but did not negatively affect their economic performance

The analysis of this study shows that the introduction of the EU ETS led to a reduction in carbon emissions of around 10% between 2005 and 2012. Most of this reduction took place in the second trading period, where carbon emissions were reduced by 15%. The effect is found to be strongest for larger installations, and is more prevalent in the chemicals, non-metallic mineral products and electricity sectors. Free allocation of allowances is associated with a smaller emission reduction, with over-allocated installations not reducing their emissions at all. Regarding economic outcomes, the study did not find statistically significant effects on employment or profits, but a positive effect on revenues and fixed assets of regulated firms. One explanation could be that the EU ETS induced investment in low-carbon technologies, which increased output per worker, but more research is needed to understand the drivers of these effects.

A larger database would strengthen the external validity of the results

While the analysis of the impact on economic outcomes covers all countries included in the EU ETS, this is not the case for the analysis of carbon emissions. This part of the analysis is based on a small sample of installations, which makes an extrapolation of these results to all EU ETS-regulated firms not suitable.

Increasing the size of the underlying database would certainly strengthen the external validity of the study. However, the study does provide a first step towards a geographically comprehensive analysis of the EU ETS.

Higher carbon prices would likely reduce emissions further, but might lead to different economic impacts on firms

While the EU ETS led to emission reductions, this was not accompanied by negative economic impacts on regulated firms. This could justify tighter environmental policies, which means in this case, higher carbon prices in the EU ETS. Increasing the price of allowances, for example, by further restricting the number of free allowances distributed, would therefore likely increase emissions reductions. Indeed, the study suggests that, had the regulated installations only received half of their free allowances, the reduction in carbon emissions induced by the EU ETS would have been around 25% instead of the estimated 10% (see Dechezleprêtre, Nachtigall and Venmans (2018[1]) for a detailed calculation). However, it is important to keep in mind that the results on economic impacts are valid for a period where carbon prices were relatively low, at around EUR 10/tonne of CO_2. The impact on firm performance might well differ in a context of much higher carbon prices.

Notes

[1] This chapter is a summary of the paper "The joint impact of the European Union emissions trading system on carbon emissions and economic performance" by A. Dechezleprêtre, D. Nachtigall and F. Venmans (2018[1]), published as OECD Economics Department Working Paper No. 1515.

[2] The over-allocation of free allowances means that installations received more free allowances than they required to cover their emissions.

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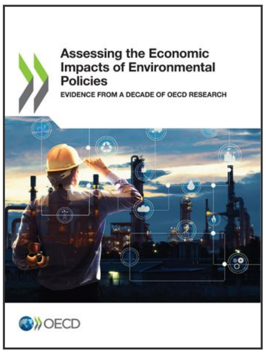

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