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EU Emissions Trading: Distinctive Behavior of Small Companies

By Helene Naegele and Aleksandar Zaklan

The EU Emissions Trading System (EU ETS) is the cornerstone of the European Union's climate policy and covers just under half of the EU's greenhouse gas emissions. More than ten years since the EU ETS was first introduced, there continues to be substantial research interest regarding its functioning and the behavior of participating companies. DIW Berlin conducted three econometric studies based on microdata at company and/or installation level. The findings suggest that, overall, there are only minor distortions in the behavior of companies regulated by the EU ETS. However, the studies also show that small companies exhibit distinctive behavior which could result in inefficiencies. For instance, during Trading Phase I, small companies participated less actively in trading allowances than companies with a higher turnover. Moreover, the emissions produced by small power plants depend, to a certain extent, on the allocation rules. Small companies also often fail to take full advantage of the cost reduction potential of international offset credits: for a total of 22 percent of all companies (predominantly small emitters), an average of 31,000 euros in cost reduction potential remained unused. The barriers causing this loss may be interpreted as fixed transaction costs. For further ex-post analyses, the timely provision of user-friendly emissions trading data at the installation level would be very beneficial.

The European Emissions Trading System (EU ETS) has been the cornerstone of European climate policy since trading first began in 2005. The system works on the "cap and trade" principle, i. e., a cap is set on the total amount of greenhouse gas emissions and, within the cap, companies receive or buy emissions allowances which they can trade. The system now covers greenhouse gas emissions from over 13,500 stationary installations in the power sector and the manufacturing industry as well as some aviation operators and encompasses almost half of all European greenhouse gas emissions.[1]

There is considerable research and political interest in the functioning of the emissions trade and in the behavior of EU ETS-regulated companies. Many research questions can only be addressed using data on the individual participating companies and installations. Company-level analyses require the provision of relevant research data. DIW Berlin is involved in this activity as part of a network of European research institutions.[2] The current issue of *DIW Economic Bulletin* first provides a short overview of the development of European emissions trading and then presents three studies which, based on the aforementioned data, examine company behavior for possible distortions.

Continuous development of the EU ETS

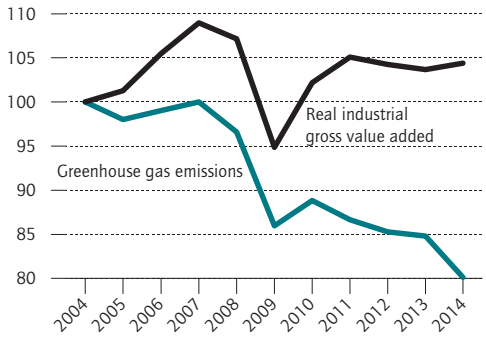
The EU Emissions Trading System is divided into Trading Phases, each lasting for several years and with fixed rules within each Phase. The rules are continually revised between the Trading Phases. Phase I was a three-year pilot period which ran from 2005 to 2007. Phase II covered the period from 2008 to 2012. The EU ETS is now in Phase III, which runs from 2013 to 2020. In the

1 A. D. Ellerman, C. Marcantonini, and A. Zaklan, "The European Emissions Trading System: Ten Years and Counting," Review of Environmental Economics and Policy 10 (1) (2016): 89–107.

2 J. Jaraite, T. Jong, A. Kažukauskas, A. Zaklan, and A. Zeitlberger, Ownership Links and Enhanced EUTL Dataset (Florence, European University Institute: 2013), http://fsr.eui.eu/EnergyandClimate/Climate/EUTLTransactionData.aspx.

Figure 1

Greenhouse gas emissions[1] and real industrial gross value added
Index 2004 = 100



1 Emissions regulated under the EU ETS in the 25 EU member states that have participated in the EU ETS since 2005. Industrial gross value added measures the portion of gross domestic product represented by industry and includes electricity generation.

Source: Ellerman et al. (2016).

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In recent years there has been a decoupling of emissions and industrial gross value added.

Box 1

International offset credits

The EU Emissions Trading System (EU ETS) is part of the implementation of intergovernmental commitments under the Kyoto Protocol[1] which allowed for the use of what are known as flexible mechanisms. An EU Directive[2] allows limited use of project-based international offset credits from these flexible mechanisms in European emissions trading. Fixed upper limits, *entitlements*, were distributed proportionally to the quantities of allocated allowances for each installation regulated by the emissions trading system.

There are two types of credits: CERs (Certified Emission Reduction) and ERUs (Emission Reduction Units). CERs are created by the *Clean Development Mechanism* (CDM). They were first introduced in 2005. In order to create CERs, emissions reductions in countries that signed the Kyoto Protocol but have no obligations under national reduction

1 The Kyoto Protocol on the United Nations Framework Convention on Climate Change (UNFCCC) dated December 11, 1997. http://unfccc.int/resource/docs/convkp/kpger.pdf.

2 Directive 2004/101/EC of October 27, 2004 ("Linking Directive").

course of the first three Phases, European emissions trading has undergone a process of reform. Originally, the system was embedded in the Kyoto Protocol, with the individual EU member states playing a key role in managing the system and allocating emissions allowances. Since then, however, European emissions trading has developed into a system which is centralized at the EU level and largely closed to the outside.

Initially, the allocation of emissions allowances to participating companies was set at a high level. Over time, however, the cap on allowances has been tightened and, since the start of Phase III, the cap is decreasing by 1.74 percent each year. Moreover, there has been a shift away from the fundamental principle of free allocation of emissions allowances toward auctioning.[3] This has only been directly implemented in the power sector, however, while most of the manufacturing industry continues to enjoy free allocation. The reasoning behind this discrepancy is to reduce the risk of carbon leakage, i.e. of transferring production and therefore emissions to other countries.[4]

In recent years, there has been a decline in greenhouse gas emissions from EU ETS-regulated installations in the 25 EU member states participating in the trading system since 2005 (see Figure 1). While there was a decline in both emissions and the real industrial gross value added during the financial and economic crisis of 2008 and 2009, these two indicators are now diverging: economic recovery has been accompanied by continuously falling emissions. An important cause of this decoupling is the promotion of electricity produced from renewable energy sources. Additionally, the empirical literature on the effects of the EU ETS shows that the emissions trading system has also contributed to the decline in emissions.[5]

Currently the focus is on revising the EU ETS for Trading Phase IV (2021 to 2030). In the current debate, some of the most important amendments that have been pro-

3 Article 10 of Directive 2009/29/EC of the European Parliament and of the Council of 29 April 2009.

4 Carbon leakage is the term used for the relocation of carbon-intensive economic activity to countries that are not participants in the EU ETS, whether through outsourcing, relocation of companies, or changes in competitiveness. See K. Neuhoff et al., "Leakage Protection for Carbon-Intensive Materials Post-2020," *DIW Economic Bulletin*, no. 29/30 (2015); See also A. Zaklan and B. Bauer, "Europe's Mechanism for Countering the Risk of Carbon Leakage," *DIW Roundup* 72 (2015).

5 S. Petrick and U. J. Wagner, "The Impact of Carbon Trading on Industry: Evidence from German Manufacturing Firms," *Kiel Working Paper* 1912 (2014). See also J. Jaraite-Kažukauske and C. Di Maria, "Did the EU ETS Make a Difference? An Empirical Assessment Using Lithuanian Firm-Level Data," *The Energy Journal* 37 (1) (2016): 1–23.

targets (non-Annex I countries) are certified by the United Nations Environment Programme (UNEP). This refers largely to developing and emerging countries. In contrast, ERUs are based on *Joint Implementation* (JI) through which countries with binding reduction targets (Annex I countries) can exchange emission reduction credits among themselves. ERUs could only be used from 2008 onward. JI projects are taking place predominantly in countries of the former Soviet Union. By the end of Trading Phase II, around 75 percent of the available CERs came from China and India, while more than 90 percent of available ERUs originated from Russia and Ukraine.[3]

Offset credits can be created by different types of projects, in particular also by reducing greenhouse gases other than carbon dioxide. These are converted in carbon dioxide equivalents according to their global warming potential. The highest share (around 42 percent) of offset credits used in Trading Phase II (2008 to 2012) was generated from *industrial gas projects*. Due to doubts as to the actual emission reduction effects of industrial gas projects, it was no longer permitted to use offsets from these projects in the EU ETS after the reporting year 2012.

Offset credits were originally intended to primarily cover intergovernmental commitments under the Kyoto Protocol. Most of the demand for offsets, however, came from companies that were subject to the EU Emissions Trading System: in total, credits for around one billion tonnes of greenhouse gases were used in the EU ETS, representing half of all credits available globally up until 2012. The weight of European demand was particularly evident after the end of the Trading Phase II. From 2008 to 2012, the price fluctuated between 0.33 and around 14 euros, while offsets were always cheaper than EU allowances. After some limitations were announced in the use of offset credits in the EU ETS[4] and it became clear that the majority of firms had exhausted their installation-specific offset entitlements, this led to considerable surplus supply and the price of offsets dropped to just a few euro cents.

3 Ellerman et al., "European Emissions Trading System."

4 Commission Regulation (EU), No. 550/2011 of 7 June 2011.

posed include a greater annual reduction of the cap on maximum permitted emissions of 2.2 percent and a revision of the rules on free allocation of allowances so as to take better account of current production. To achieve this the relevant data sources are to be updated and the criteria determining which sectors receive a free allocation of allowances are to be reformed.[6]

Increasing trade volumes, low price levels

Partly as a result of the economic crisis and heavy use of international offset credits generated within the framework of the Kyoto Protocol (see Box 1), the price of European emissions allowances has remained at under ten euros per credit for some years now (see Figure 2).[7]

A sustainable increase in price levels, required to provide an effective incentive for low-carbon investments, is prevented by an accumulated allowance surplus which has resulted from a combination of unexpectedly low demand and comparatively high supply of allowances.[8] A market stability reserve will be established to address this surplus.[9] It will aim to keep the number of allowances in circulation within a certain predefined range and stabilize the allowance price in the medium term.

The allowance trading volume has grown steadily, and, over time, trading on stock exchanges has also gained ground (see Figure 3). Whereas during Phase I (2005 to 2007) and the beginning of Phase II (2008 to 2012), over-the-counter trade (bilateral exchanges between companies) accounted for the majority of transactions, for some years now, trading on organized exchanges has predominated. The increase in this type of trade has led to more liquid markets for allowances and more transparent trade for all market players.

6 Proposal for a Directive of the European Parliament and the Council amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments. COM(2015)337 final, July 15, 2015.

7 One allowance covers one ton of carbon dioxide equivalent. Other greenhouse gases are converted carbon dioxide equivalents according to their climate impact.

8 See J. Diekmann, "Emissionshandel krankt an Überschüssen – Kommentar," *DIW Wochenbericht*, no. 47 (2012).

9 Proposal for a Decision of the European Parliament and of the Council. COM(2014) 20/2. For more details, see also K. Neuhoff et al., "Marktstabilitätsreserve stärkt den europäischen Emissionshandel," *DIW Wochenbericht*, no. 21 (2015).

Figure 2

Price of allowances in the European Emissions Trading System
In Euro

Source: Intercontinental Exchange (2016).

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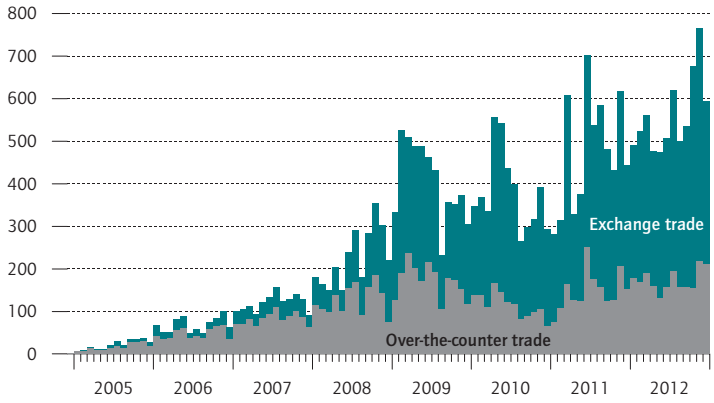
Allowance prices have been lower than 10 euro during the past four years.

Figure 3

Monthly trading volumes of emissions allowances
In million allowances



Source: Point Carbon (2012).

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The trade through exchanges grew strongly during Phase II.

Box 2

Matched difference-in-differences regression model

The matched difference-in-differences estimation method is based on the fundamental idea of Rubin's causal model.[1] This model shows the causal effect of an intervention on an outcome variable from the comparison of a group of subjects affected by the measure (*treatment group*) with the same subjects in a counterfactual situation where they are not affected by the measure (*control group*). Under laboratory conditions, an intervention can be conducted on a randomly selected subset of a population so that both the control and treatment groups behave identically on average. In this case, it is possible to precisely measure the effect of the intervention.

1 D. B. Rubin, "Estimating Causal Effects of Treatments in Randomized and Non-Randomized Studies," Journal of Educational Psychology 66 (5) (1974): 688–701.

Microdata enable accurate ex-post evaluation of EU ETS

Many questions surrounding the precise functioning and effects of the EU ETS on participating companies cannot be addressed using aggregate data but rather require us to analyze data on the individual participating companies and installations. Microdata such as these also allow us to test hypotheses on company behavior using causal methods. For example, the cost efficiency of a market-based instrument such as emissions trading relies, *inter alia*, on all companies being able to participate in the trading system without incurring significant costs or facing other obstacles. An analysis based on company- and/or installation-level data can provide information on possible distortions in company behavior.

The following sections will present three microeconometric studies to illustrate company behavior in the context of European emissions trading. The first study analyzes the trading behavior of companies during the pilot phase of the EU ETS. A second analysis examines how the type of allocation of allowances (free allocation or auctioning) impacts on power plant emissions. A third study looks at the extent to which companies use the offset credits from the flexible mechanisms of the Kyoto Protocol. Taking different perspectives, these three studies all assess whether there are distortions in company behavior.

However, such research designs are usually not possible in economic research. Instead, we examine exogenous events that lead to the creation of the treatment and control groups. In the study featured in this issue of DIW Economic Bulletin on the effect of allocation rules on emissions behavior, the intervention is a shift from free allocation to auctioning of all emission allowances. The outcome variable is the growth of emissions at installation level. The treatment group consists of power plants subject to the change from free allocation to full auctioning since 2013, while the control group consists of installations that continue to benefit from the allocation.[2] The difference-in-differences regression estimates the effect of the intervention as a statistical comparison of the change in both groups during the intervention. Since the installations can be tracked over time, it is possible to include installation-specific features and installation-independent influences over time.

Matching improves the comparability of the treatment and control groups by weighting observations in the control group on the basis of observable characteristics. The method of *synthetic matching*[3] employed here contains a weighting of observations made in the control group, so that on average they are identical to the treatment group with regard to certain important criteria, such as the level of historical emissions and the capacity of the power plants. A change in the growth rate of installation-specific emissions can then be interpreted as a causal effect of the shift from free allocation to full auctioning of allowances.

2 Article 10c of Directive 2009/29/EC of April 29, 2009.

3 J. Hainmueller, "Entropy Balancing for Causal Effects: A Multivariate Reweighting Method to Produce Balanced Samples in Observational Studies," Political Analysis 20 (2012): 25–46.

Smaller companies less active in emissions trading

An analysis of the trading behavior of the companies covered by the EU ETS suggests distortions in the behavior of small enterprises during Trading Phase I.[10] An equivalent analysis of data on Trading Phase II is hampered by significant delays in the provision of transaction data and problems with data quality.

The study links emissions trading data with the balance sheet data of the participating companies in order to analyze determinants of companies' participation in trading as well as the extent of that trading. The study established, *inter alia*, a positive relationship between the size of the company—based on turnover—and the probability of a company participating in emissions trading. This finding remains valid when other factors are taken into account—such as a company's profitability, sector, and whether it is publicly or privately owned. Hence, smaller enterprises participate less actively in emissions trading. Consequently, emissions trading, at least during Trading Phase I, has not been free from distortions. To ascertain whether more recent data will also confirm this finding requires a continuation of this research which will be conducted as soon as relevant data become available.

10 A. Zaklan, "Why Do Emitters Trade Carbon Permits? Firm-Level Evidence from the European Emission Trading Scheme," *DIW Discussion Paper* 1275 (2013).

Evidence of distortions in behavior of small power producers due to free allocation

Available data on carbon emissions from individual installations allow us to examine whether the volume of emissions at the installation level depends on how allowances are acquired (through free allocation or auctioning).[11] The independence of the allocation process from emissions levels is a fundamental prerequisite for cost-effective emissions trading.[12] This means that emissions allowances can be allocated to individual companies and sectors arbitrarily—for example, based on distributional preferences—without impairing the cost effectiveness of the trading system. If emissions were affected by the type of allocation, however, this would lead to distortions in the behavior of companies and, in turn, inefficiencies.

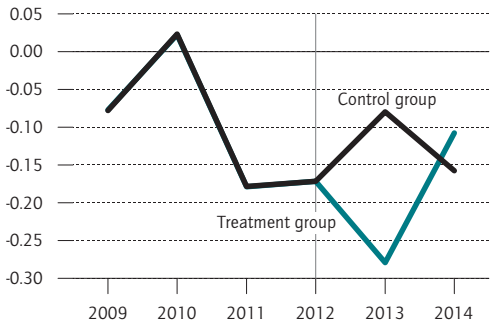
The research design used for the present study is based on a matched difference-in-differences regression model applied to power plant data from European electricity producers (see Box 2). A natural experiment created by the applicability of different rules is used to identify a causal effect of the mode of allocation on emissions levels.

11 A. Zaklan, "Free Allocation and the Endowment Effect in Cap-and-Trade Systems: Evidence from the European Electricity Sector," (Mimeo, DIW Berlin, 2016).

12 R. H. Coase, "The Problem of Social Cost," *Journal of Law and Economics* 3 (1960): 1–44.

Figure 4

Average growth rates of emissions by small power plants[1]



1 Installations with a nominal capacity of up to 50 MW.

Source: Zaklan (2016).

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The emissions level in the treated group has been lower since 2013.

Since the beginning of Trading Phase III in 2013, power producers in the majority of EU member countries have been required to buy all the emissions allowances they require at auction. However, eight new member countries have made use of a derogation allowing them to continue to give free allocations to power plants.[13] Consequently, for some of the European power plant fleet, the allocation process is moving away from free allocation toward full auctioning (*treatment group*), whereas the rest of the fleet will continue to receive allowances through free allocation (*control group*).

The findings do not indicate that the emissions of European power producers in the eight EU countries that made use of the derogation were significantly distorted through the free allocation. The shift to auctioning therefore primarily had distributional effects, particularly with regard to government auction revenue.

However, there is evidence of a greater reduction in emissions in response to the introduction of full auctioning for small power plants with a nominal capacity of up to 50 MW. This finding applied to 2013 which was the first year after full auctioning for power producers was introduced. The following year, the rates of change in the emissions of the two groups converged again but a level effect remains (see Figure 4).

The larger reduction in emissions in the short term when allowances are purchased at auction indicates a certain level of interdependence between allocation rules and emissions for small power plants. Thus, different allocation processes in EU member countries can result in unfair treatment of small plants. These distortions would disappear with full auctioning of allowances in all member countries.

Not all firms used the savings potential of offset credits

In addition to allowances from the EU ETS, companies can, to a limited extent, use international offset credits from the flexible mechanisms of the Kyoto Protocol to cover their emissions (see Box 1). An EU-wide limit for these offsets was allocated to each installation in the form of an individual fixed entitlement limit. In principle, these could be used in Trading Phase II (2008 to 2012). During the transition to Trading Phase III, companies were allowed to transfer their unused offset entitlements and previously purchased credits, but no additional offset entitlements were created. Companies can replace European emissions allowances one-to-one with international offset credits up to the installation-specific entitlement. International offset credits were always cheaper than the European allowances because supply was relatively high compared to demand and so, in theory, companies should have an incentive to make use of offsets.

Companies that used the cheaper offset credits instead of the European allowances were able to cut costs as a result. If we look at the average price difference between European allowances and international credits during Trading Phase II, the savings for each company can be calculated by multiplying the number of used offsets by the price difference.[14] This calculation shows the lower limit of the savings potential because it does not account for general equilibrium effects. Since the additional offset credits have increased the overall supply of allowances in the EU ETS, the price of European allowances would have been higher without them. Consequently, total savings would be greater if this counterfactual price effect were factored in.

The price difference between international and European credits during Trading Phase II averaged 3.64 euros

13 Article 10c of Directive 2009/29/EC of the European Parliament and of the Council of 29 April 2009 indicates that, under certain conditions, member states may continue to give power producers a free allocation of emissions allowances. The purpose of this derogation is to promote the modernization of electricity generation in the relevant countries.

14 H. Naegele, "Offset Credits in the EU ETS: A Quantile Estimation of Firm-Level Transaction Costs," DIW Discussion Paper 1513 (2015).

per tonne of carbon dioxide. Exploiting this price difference allowed companies to make substantial savings of almost 800,000 euros on average. Since companies affected by the EU ETS have widely varying emission levels and offset entitlements, the cost reductions achieved also varied considerably. The maximum savings by any one company during Trading Phase II was 217 million euros, while the savings of the smallest 25 percent of offset users was less than 20,000 euros per company (see Figure 5). Total savings for all companies during Trading Phase II came to around 3.6 billion euros.

Incomplete use of offset entitlement indicates relevant transaction costs for small enterprises

The majority of businesses have exploited this savings potential from the use of offset credits. In contrast, around one thousand companies—22 percent of all companies participating in the EU ETS and predominantly smaller companies—have made no use of the credits at all (see Figure 6) and have therefore not been able to benefit from potential average cost savings of 31,000 euros per company. Based on the average price difference during Trading Phase II, a total of 31 million euros in possible savings from credits initially remained unused.[15] This represents less than one percent of total possible savings from credits in Trading Phase II. We assume that companies make rational decisions: if they do not take advantage of these potential savings, there must be a corresponding financial or non-financial obstacle preventing them from doing so. These obstacles can be summarized as *transaction costs*.

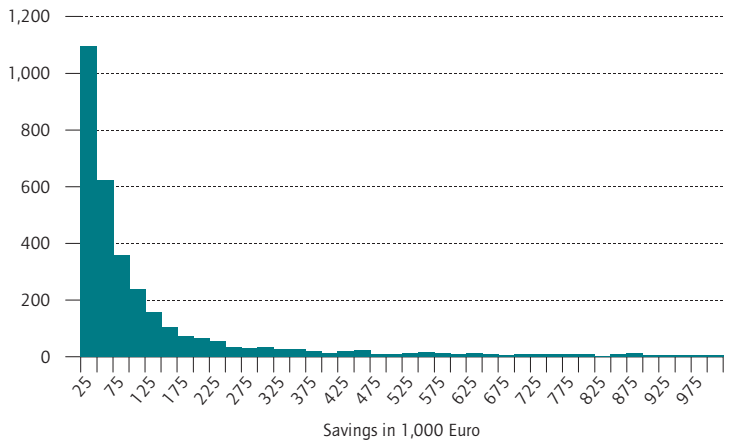
Virtually all enterprises use either all of their offset entitlement or no offsets at all (see Figure 6). This indicates that the transaction costs of using the offset credits consist primarily of fixed transaction costs, such as information costs, costs of setting up a trading account, or employing an additional staff member to take charge of trading allowances.

Moreover, companies whose free allocation was less than their actual emissions, forcing them to actively participate in the EU ETS, more frequently took advantage of offset credits. This suggests that these transaction costs are not limited to offset credits but are also linked to the general trade in emissions allowances. When companies are forced to actively participate in the EU ETS due to a shortage of grand-fathered credits, there are large synergies in gathering information required for both the auctioning of European allowances and international offset credits, particularly since both types of credits are traded on the same platforms.

Figure 5

Cost savings through the use of offset certificates per firm[1]

Number of firms



1 During Phase II (2008–2012).

Source: Naegele (2015).

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The majority of firms could only achieve modest cost savings.

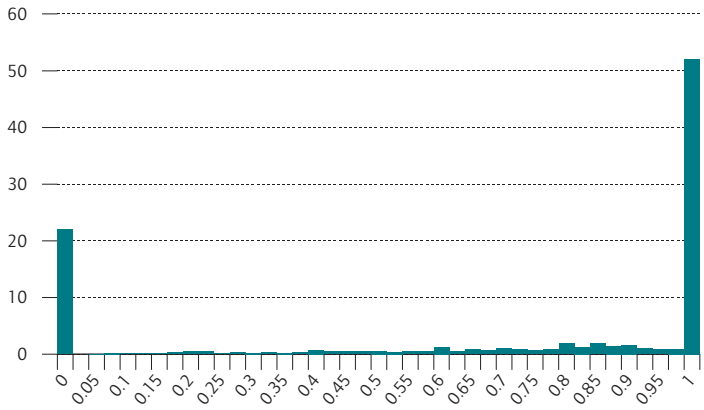
Transaction costs can therefore be divided into two components: costs of active participation in the EU ETS in general and specific costs for participating in the trade of offset credits. An estimate of these two cost components using a quantile regression shows that the fixed transaction costs of general participation in the EU ETS predominate for most companies. If a company is already taking part in the trading system, the extra costs for trading in offset credits are usually low. The average estimated cost is considerably higher than the median: a large number of companies have moderate fixed transaction costs, while the few companies that have not taken up large offset entitlements have driven up the average.

The fixed costs of actively participating in the EU ETS are therefore more of a problem for small emitters. If it is not worthwhile for small enterprises to take part in the EU ETS due to high fixed transaction costs, this leads to different-sized companies being treated unequally. This creates inefficiency, since the incentives for small firms do not depend entirely on the price they have to pay for their emissions.

15 Even if unused offset entitlements were subsequently transferred from Trading Phase II to Trading Phase III, enterprises could not assume their transferability with any certainty at the end of Trading Phase II. See Naegele (2016).

Figure 6

Proportion of offset entitlement used per firm
Share of all firms in percent



The graph depicts the proportion of the total allowed offset entitlement used by firms. A proportion of 1 indicates that a firm has fully exhausted its entitlement.

Source: Naegele (2015).

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Most firms use their offset entitlement either fully or not at all.

Conclusion

There is a great deal of research interest in the behavior of companies in the EU ETS, the EU's core climate policy instrument. The use of microdata at company or installation level allows us to conduct quantitative *ex-post* analyses of the functioning of emissions trading. The findings of three econometric studies by DIW Berlin indicate that there are only minor distortions in company behavior. There is, however, some distinctive behavior by small enterprises which can result in inefficiencies.

Small firms participated—at least in Trading Phase I—less actively in the EU ETS than companies with higher turnover. It is difficult to determine whether this trend continues in subsequent Trading Phases due to incomplete data and delays in making data available. The timely provision of user-friendly emissions trade data at the installation level would be very beneficial for policy-relevant *ex-post* analyses. Accordingly, it would be very welcome if a higher priority were given to the transparency and accessibility of data in the policy-making process at the European level, particularly with regard to transaction data on the European emissions allowances market at the installation level.

An analysis of the effects of the allocation rules in the allowance trade suggests that the emissions of European electricity producers are not significantly distorted overall due to free allocation. Nevertheless, there are indications that the emissions of small power plants depend on the allocation rules to a certain extent. These distortions arising from different allocation rules in different EU member states would be removed if emissions allowances were auctioned fully in all member states.

There are also differences between large and small companies in the uptake of potential savings from international offset credits. Overall, more than 99 percent of all savings possible through offsets in Trading Phase II were achieved. However, some small emitters did not take advantage of this option. As a result, 22 percent of all companies, predominantly small emitters, did not realize potential cost savings from the use of offset credits worth an average of 31,000 euros. Relevant obstacles, which can generally be interpreted as fixed transaction costs, prevented small enterprises from benefiting from these potential cost savings. While developing the EU ETS, the problem of transaction costs for small enterprises has been addressed, for example by simplifying reporting requirements and other special rules.[16] Future evaluations must show the impact of these changes.

There is a need for further microdata-based research into the development and relevance of barriers to market entry for small companies, for example, on the question of whether these are primarily information barriers or monetary costs, such as setting up a trading account. Further research is needed to determine whether the allowance trade overall is strongly influenced by these distortions. This is unlikely because small firms only account for a fraction of total emissions in the EU ETS.

16 See, for example, Article 27 of Directive 2009/29/EC.

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