# The Role of Banks in EU Emissions Trading

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**ABSTRACT**

This paper is an empirical investigation of the role of banks in the EU Emissions Trading System (EU ETS). This topic is of particular interest considering that banks are responsible for a large and increasing share of overall transactions under the EU ETS and that they provide regulated companies with services related to emissions trading. Using both semi-structured interviews as well as descriptive and regression analysis, we investigated the different roles banks play in EU emissions trading and whether their importance as trading partners differs in relation to different types of regulated companies. Our regressions based on data from the first trading period of the EU ETS show that large companies with trading experience are more likely to choose a trading strategy involving interaction with a range of financial intermediaries, in particular banks or exchanges, than smaller, less professionalized companies, which tend to follow a trading strategy involving brokers (in particular for selling allowances). These findings can help policymakers decide on the level of involvement of non-regulated companies in their systems, which is currently allowed to varying degrees under different ETS. We recommend that this decision should be closely linked to provisions of market oversight and the level of control over the different types of financial players active in emissions trading.

**Keywords:** EU ETS, Banks, Trading strategy, EUTL

https://doi.org/10.5547/01956574.41.2.jclu

## 1. INTRODUCTION

The theory of emissions trading generally focusses on the trading activities of regulated entities. In reality, however, non-regulated entities are also actively involved in the market for emission allowances. They often act as intermediaries and can improve market efficiency by reducing transaction costs (Stavins, 1995). Both in the theoretical and empirical academic literature, the role of the financial sector—in commodity markets in general and in emissions trading in particular—is under-exposed, and there seems to be limited analysis into the roles banks play in those markets.

Our aim was to better understand the importance of banks involved in EU emissions trading, especially as trading partners of companies regulated under the EU Emissions Trading System (EU ETS), the so-called regulated companies. A better understanding of the role of banks in emissions trading is important, not only in an EU context. In some countries engaging in emissions trading, policymakers are becoming reluctant to facilitate the involvement of non-regulated entities (see the Korean ETS, International Carbon Action Partnership, 2018).

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To address this issue, we formulated the following research questions: 1) What are the different roles of banks in EU emissions trading? 2) How important are banks as trading partners for different types of regulated companies? To answer these research questions comprehensively, we employed two different approaches. First, we investigated the roles of banks in EU emissions trading, combining descriptive analysis of data covering the years 2005–2013 with semi-structured interviews. Second, we used regression analysis to investigate the determinants for regulated entities to choose banks or other types of financial players as trading partners during the first trading period of the EU ETS.

The remainder of this paper is structured as follows: Section 2 provides a literature review and identifies possible research gaps. Section 3 presents the methods applied and describes the main data source, namely the European Union Transaction Log (EUTL). In Section 4, we analyze the data descriptively, linking it to interview outcomes in order to shed light on the different roles of banks in EU emissions trading. We also discuss regression results on the decision of regulated entities to interact with banks or other financial players. We summarize our findings and draw conclusions concerning policy implications in Section 5.

## 2. LITERATURE REVIEW

Several studies have analyzed the data of the EUTL to gain general insights into trading activities under the EU ETS or have linked it with other data sets to understand the impact of the EU ETS in various areas. Conducting a cluster analysis of the EUTL dataset, Betz and Schmidt (2015) found that the vast majority of market participants are rather passive and that there is a small and diverse group of active participants, a large share of which are non-regulated entities. Other authors have used EUTL data to examine the influence of the EU ETS on emissions and investment behavior (Jaraite and Di Maria, 2016) or innovation (Calel and Dechezleprêtre, 2016), assess its impact on company performance (Abrell, Faye, and Zachmann, 2011) or company share prices (Jong, Couwenberg, and Woerdman, 2014), as well as the joint impact on emissions and economic performance (Dechezleprêtre, Nachtigall, and Venmans, 2018).

Martino and Trotignon (2013) did an extensive descriptive analysis of the EUTL dataset and provided important insights into how the forward and future markets work and the role of clearing houses, while Ellerman and Trotignon (2009) used the EUTL to track the export and import of allowances out of and into national registries (using surrender data before transfer data became available). Borghesi and Flori (2018) applied network analysis to the EUTL data at country level and found that non-regulated entities have played a prominent role in the transaction of allowances and influenced the configuration of the system significantly, suggesting further research on this topic.

Another strand of literature has looked more specifically at trading practices in the EU ETS. A paper by Jaraitė-Kažukauskė and Kažukauskas (2015), which is closely related to the regression analysis carried out in this paper, assesses the impact of transaction costs on trading in the EU ETS. In this context, they also examined the determinants of firms to trade *only* indirectly (i.e., with non-regulated entities) compared to those trading directly (with other regulated firms). They found that companies with more than one installation are less likely to trade only via intermediaries. This was also found to hold for companies that are large in terms of their emissions, a result echoed by Heindl (2012a), who—using outcomes from a survey among German companies—determined that regulated companies with larger trading volumes are more likely to trade directly with other companies, while those with lower trading volumes make use of intermediaries.

Jaraitė-Kažukauskė and Kažukauskas (2015) discovered that firms in the electricity sector are more likely to trade indirectly, even after controlling for size, which they explained with the importance of hedging for these companies. Schopp and Neuhoff (2013) assessed the hedging behavior of electricity companies based on interviews and found that financial players are often used as partners in such hedges. The carbon market is a compliance market where the government is the original seller or issuer of the product (i.e., carbon allowances). Therefore, the market lacks typical sellers who want to hedge against falling prices of allowances and would act as the counterparties for buyers wanting to hedge against increasing prices (Schneck and Monast, 2011). In the EU carbon market, the financial sector, and banks in particular, have assumed the role of hedging partner.

Based on this research, Neuhoff et al. (2015) projected developments with regard to the demand for allowances taking into account the hedging behavior of electricity firms. Also using EUTL data, Zaklan (2013) looked at company-level determinants for trading and also addressed the question whether companies are more likely to shift allowances internally or trade them on the open market. He determined that active trading of EU allowances is driven by the size (measured by turnover) of a company, its sector and ownership structure, as well as the level of free allocation.

Cludius (2018) investigated the drivers for gains and losses made on the EU emissions market and found that the level of excess allocation as well as the choice of when to enter the market are important in driving gains and losses of regulated companies. She also discovered that large companies (both in terms of their emissions and the number of accounts held) and companies short on trading allowances were more likely to become active during the first period of EU emissions trading.

There is also literature that assesses the role of different players in EU emissions trading. Balietti (2016) analyzed the influence of different market participants on volatility using data from the EUTL and found that the financial sector is active during times of particularly low and high volatility, reflecting its important role as a service provider. Also using data from the EUTL, Fan, Liu, and Guo (2016) examined the influence of the trading behavior of regulated companies and financial intermediaries on the carbon price and established that such behavior is significant in explaining price movements and variance. While these two studies examine the importance of the financial sector for carbon price movements, they do not look into the different services that financial players such as banks have offered to regulated companies and how those services have influenced their trading decisions.

Overall, the focus of the empirical literature on trading activity under the EU ETS to date has been on regulated rather than non-regulated entities. In this context, non-regulated entities are often treated as a group and not differentiated further. This differentiation, however, is important as new regulations affecting trading in the EU—in particular the Markets in Financial Instruments Directive (MiFID) II, which came into force in January 2018—apply to banks, but not to other financial entities.

With this paper, we add to the literature by describing the particular role of banks compared to other financial intermediaries in more detail. We explicitly modelled the choice of regulated companies to interact with banks or other types of financial actors. Our aim was also to understand how banks differ from other financial intermediaries such as brokers and exchanges.

According to more general literature not related to the EU ETS, the key role of intermediaries is in reducing friction, such as the transaction costs of finding trading partners or evaluating assets, and in reducing asymmetric information (Leland and Pyle, 1977). Taking a functional perspective, Allen and Santomero (1998) differentiated three functions of general intermediaries: i) supporting distribution, ii) origination and servicing (e.g., commodity measurement or evaluation of creditworthiness), and iii) allocation of risk at minimum cost. In their empirical analysis, Allen and Santomero (1998) showed that risk management activities in particular become more important in financial markets over time as intermediaries increase their share in trading derivatives at exchanges or OTC, while direct participation by individuals declines significantly.

These results may be explained by the work of Pirrong (2014), who argued that the transaction cost-reducing rules of exchanges, such as mandatory membership to reduce counterparty risk and the use of clearing houses, allow exchanges to exercise market power and derive monopoly rents by limiting market entry. As a result, trading for a specific commodity is often limited to a single exchange. For EU emissions trading, this implies that, in general, only non-regulated entities and large regulated entities are likely to trade directly at exchanges.

From a functional perspective, exchanges and OTC trading with other intermediaries differ with regard to the standardization of the traded product, the counterparty risk, as well as transparency (Kachi and Frerk, 2013). While at exchanges more standardized products are traded and transparency is high, OTC allows for more specialized products traded bilaterally, which are not necessarily cleared via an exchange. This implies that even for entities that can trade directly at an exchange, the need for less standardized products or lower transparency may prompt them to trade OTC.

According to Bredin, Hyde, and Muckley (2014), the EU ETS derivative exchange market seems to be dominated by liquidity traders, such as market makers and hedgers. The largest hedging requirement in the context of the EU ETS lies with electricity producers. The financial liquidity of banks makes them the most likely hedging partner for electricity firms.

A study based on interviews by IHS Consulting Services (2013) focusing on the role of banks in commodity markets found that banks create orderly and efficient commodities markets through several specific roles. These include:

“● Market making and provision of market liquidity,
● Efficient price formation,
● Risk management solutions,
● Project finance,
● Extension of credit, and
● Bolstering industry competition.” (IHS Consulting Services, 2013, p.7)

Thus, banks have similar functions as exchanges by providing liquidity. However, while they play their traditional roles in financing they also provide risk management services (Allen and Santomero, 1998). The last role on the above list is particularly interesting as it reflects not only the direct increase in competition by including banks in the market, but also the indirect effect of increasing competition as banks support small and medium-sized companies, thus making them more competitive.

While the above mentioned studies assess the roles of different intermediaries as well as banks in physical commodity or financial markets, they do not reflect on their roles in the context of emissions trading. As has been stated, the aim of this paper is to compare the role of banks and their importance for regulated entities with those of other financial intermediaries, such as brokers or exchanges, in the EU ETS context.

## 3. METHODS AND DATA

In answering the two research questions, we employed two methods. First, we combined a descriptive analysis of data spanning the first and second trading periods (2005–2007 and 2008–

2012) and the first year of the third trading period (2013) with semi-structured interviews to describe the various roles played by banks in EU emissions trading in more detail. Second, we used regression analysis to analyze the importance of banks as trading partners for regulated companies and investigated what company-level characteristics determine the choice of regulated companies to trade with banks or other types of financial players.

As Starr (2014) pointed out, complementing quantitative methods with qualitative ones is particularly promising when "the data" is not able to answer the research questions completely. In our case, we complemented the trading patterns of banks observed in the data with information on the underlying motivations derived from interviews.

### 3.1 Semi-Structured Interviews

As a preliminary to developing the semi-structured interviews, we completed a descriptive analysis of the EUTL data in order to identify the major banks involved in carbon emissions trading and their important clients as potential interview partners (see Section 4.1). We also formed first hypotheses on the different roles that banks play in EU emissions trading, which we wanted to test and explore further in the interviews.

Misoch (2015) pointed out that the perceptions of an interviewer as a co-expert on a particular topic is an important prerequisite for collecting relevant and interesting information, as the interviewer can classify the information gained and interviewees are more likely to reveal relevant information.

We conducted interviews with five current and former employees of banks and electricity companies in 2013 and 2014. We interviewed both large and small, as well as multinational and regional entities. The interviews lasted between one and two hours and were carried out over the phone. Most interviews were conducted with groups of two or three interviewers based on a guideline of ten questions used to structure the interview sessions (see Appendix A). However, depending on an interviewee's background (such as the type of industry) and answers given, not all questions were asked in all interviews, and sometimes additional questions were asked. All interviewers took written notes, which were subsequently compared and merged in order to reflect the interview findings objectively (Misoch, 2015).

### 3.2 Regression Analysis

In a regression analysis, we examined the decision-making process of regulated companies concerning their interaction with banks or two other types of financial players, such as exchanges and brokers/traders. We modeled the decision by a regulated company of whether or not to trade with a specific financial player using a probit model with a binary outcome, where $y_2^*$ describes the propensity to trade with a certain actor (unobservable to us) and $y_2$ reflects the binary outcome we observed (trade/no trade with a particular player).

$$y_2^* = x_2'\beta_2 + u_2 \tag{1}$$

$$y_2 = \begin{cases} 1 \ if \ y_2^* > 0 \\ 0 \ if \ y_2^* \le 0 \end{cases} \tag{2}$$

However, in the context of this analysis we faced a particular decision problem as not all regulated companies (in fact, only 63%) became active on the market for EUAs. We therefore decided to model the decision to sell to/buy from one of the financial entities as a two-step process. First, a company decides whether or not to engage in trading at all and, in a second step, with whom to trade. In this context, the options are (i) another regulated company, (ii) a bank, (iii) at an exchange, (iv) with a broker or trader. This paper focuses on Options (ii) to (iv).

$$y_1^* = x_1'\beta_1 + u_1 \tag{3}$$

$$y_1 = \begin{cases} 1 \ \textit{if} \ y_1^* > 0 \\ 0 \ \textit{if} \ y_1^* \leq 0 \end{cases} \tag{4}$$

In this context, $y_1^*$ represents the propensity to trade externally. The binary outcome $y_1$ indicates, therefore, whether a company did or did not trade during the first period. The outcome $y_2$, in turn, can only be observed for companies that traded. In other words, in this model setup, $y_2$ can only be observed if $y_1^* > 0$:

$$y_2 = \begin{cases} (y_2^* > 0) \ \textit{if} \ y_1^* > 0 \\ \textit{not observed if} \ y_1^* \leq 0 \end{cases} \tag{5}$$

$$\text{Cov}(u_1, u_2) = \rho \tag{6}$$

We assumed that after deciding to become active in the market, a company decides in (one) next step to trade either with another regulated company directly, with a bank, at the exchange, or with a broker/trader. Since it is likely that companies are not randomly selected into trading or not trading and, in particular, that unobserved variables affecting this (self-)selection also have a significant effect on a company's strategy concerning the selection of trading partners/venues (e.g. exchange/OTC), we applied a probit model that accounts for self-selection (Heckman, 1979; Van de Ven and Van Praag, 1981).

In order to improve identification, we included an exclusion restriction (Puhani, 2000). We used the logarithm of the *absolute* value of the allocation position (allowances allocated—emissions). It is important that this variable influences the decision to engage in trading (first step) but does not have an effect on the decision to trade with a particular financial intermediary (second step). The allocation position should influence the decision to engage in the market: If a company is overallocated, it can make a profit. If it is underallocated and does not engage in trading, it risks a shortfall of emissions allowances and a large penalty.

Regarding the assumption that the variable is not correlated with the decision to buy to or sell from a certain financial player (second step), we assumed that the *absolute* value of over- or underallocation should not necessarily influence the decision with which type of financial actor to trade, except via the size channel, which we controlled for in the outcome equation. Furthermore, the outcome variable differentiates between purchases and sales. While the *absolute* value of over- or underallocation is expected to influence the decision to trade or not, it should not correlate highly with the decision to either sell or buy.

Our model setup is therefore similar to the ones employed by Cludius (2018) and Zaklan (2013), but somewhat different from that of Jaraitė-Kažukauskė and Kažukauskas (2015), who modeled the determinants for firms to become active in the carbon market employing a double hurdle model.

### 3.3 The EUTL Dataset

The EUTL is an electronic database managed by the European Commission that records all transactions in the EU ETS of European Union Allowances (EUAs) and Kyoto units such as Certified Emissions Reductions (CERs) and Emissions Reduction Units (ERUs). It includes the allocation of allowances to regulated entities, their surrendering of allowances, as well as all non-administrative transactions taking place between market participants. The dataset can be downloaded free of charge from the Commission's online platform with a delay of three years (previously five years).[1] The EUTL only records physical transactions; trading in derivatives is, therefore, only recorded at the time of delivery.

In our analysis, we focused on non-administrative transactions of EUAs, meaning we did not take into account allowance allocation, surrender, or cancellation. Furthermore, we only took into account transactions that occur between accounts belonging to two different parent companies (i.e., no internal shifting of allowances within a company).

The EUTL contains additional information on the account holders that are party to a specific transaction. In this context, three main account types exist: i) administrative accounts by the Commission or a government, ii) compulsory accounts of regulated installations (and aircraft operators) regulated under the EU ETS, iii) voluntary accounts, which can be opened by anyone but mostly belong to financial players or are trading accounts of regulated companies.

We used two datasets: one spanning the period of January 2005 to April 2008 (first trading period), which was downloaded in 2011–12, and one spanning the period of May 2008 to April 2014 (second trading period and first year of the third trading period), which was downloaded in 2016–17. The reason for combining two datasets downloaded at different times was that account names are constantly updated in the EUTL. If an account changes affiliation, this account name is changed for all past transactions retroactively. Thus, if an account is acquired by a different company and receives a new name (which happened on a large scale, for example, during the consolidation of the power sector in 2014–16), all transactions carried out by this account even in earlier years will be attributed to the new company. Using two datasets, we were able to reflect the changing ownership of accounts over time more accurately.

For the first dataset, all individual accounts were matched to parent companies for the purposes of this analysis. We drew on the information provided by the European University Institute (EUI) (Jaraite et al., 2013) that links individual accounts to companies using the ORBIS database. We also relied on previous work for aggregating further accounts based on company structures of the first trading period (Betz and Schmidt, 2015; Cludius, 2018). This enabled us to link all active accounts in the first dataset (12,219) to their parent companies (5,216). This dataset was used in both the descriptive (Section 4.1) and regression analysis (Section 4.2).

For the second dataset, the number of active accounts increased to over 20,000, while the number of (non-regulated) trading accounts, in particular, increased to almost 10,000. For the purposes of this paper, we therefore focused on assigning accounts belonging to banks to their parent companies in order show the development of banks' involvement in EU emissions trading also from the second trading period onwards. This dataset was only used in the descriptive analysis (Section 4.1).

Using only the first dataset in regression analysis has a number of reasons. First, data from the second trading period was affected by the VAT fraud, especially the years 2008–2010 (see below). Second, from 2012 onwards the share of auctioning in the EU ETS increased significantly,

1. http://ec.europa.eu/environment/ets/.

leading to a new and important role of banks related to auctions. While this is an interesting issue, we decided not to investigate this in detail. Our regression analysis therefore best reflects the situation at the beginning of an ETS when the share of auctioning is typically low.

## 4. RESULTS

### 4.1 The Roles of Banks in EU Emissions Trading

From the start of the EU ETS in 2005 until the first year of the third trading period (2013), the total amount of EU allowances (EUAs) transacted externally each year shows a generally increasing trend with two interim peaks in 2008 and 2009 (see Table 1). These peaks are related to a VAT (sales tax) fraud that occurred on the spot market for EUAs during this period (Europol, 2010; Frunza and Guegan, 2011).[2] After the VAT fraud was detected and to large extent terminated in April 2010, trading volumes decreased temporarily, but picked up again in 2012. This year represents the final year of the second trading period of the EU ETS, as well as the end of the first Kyoto Commitment Period.

The involvement of banks also shows a generally increasing trend with an interim peak in 2006 and 2007 and a temporary decline in 2008. This can mainly be ascribed to the fact that EUA prices fell quite dramatically during the course of 2006 (see Figure 1), when it became clear that the system was oversupplied (allowances could not be banked into the second trading period). This made participation in the system temporarily less attractive for banks. The share of transactions involving at least one account of a bank increased to above 30% by 2013. This indicates that banks played an important role in the EU ETS and that this role became more significant—in terms of volumes transacted—over the timeframe of analysis.

**Table 1: External market transactions of EUAs in 2005–2013**

| Compliance year | Total volume transacted at the company level Million EUAs | Total volume bought by banks Million EUAs | Total volume sold by banks Million EUAs | Banks' involvement in total transactions % |
|---|---|---|---|---|
| 2005 | 1,000 | 75 | 59 | 10% |
| 2006 | 2,128 | 239 | 219 | 21% |
| 2007 | 1,757 | 156 | 166 | 17% |
| 2008 | 10,610 | 619 | 615 | 12% |
| 2009 | 14,662 | 1,079 | 1,132 | 15% |
| 2010 | 6,648 | 694 | 620 | 20% |
| 2011 | 6,746 | 1,162 | 1,098 | 34% |
| 2012 | 10,108 | 1,758 | 1,527 | 32% |
| 2013 | 12,932 | 1,881 | 2,111 | 31% |

Source: EUTL, own calculation

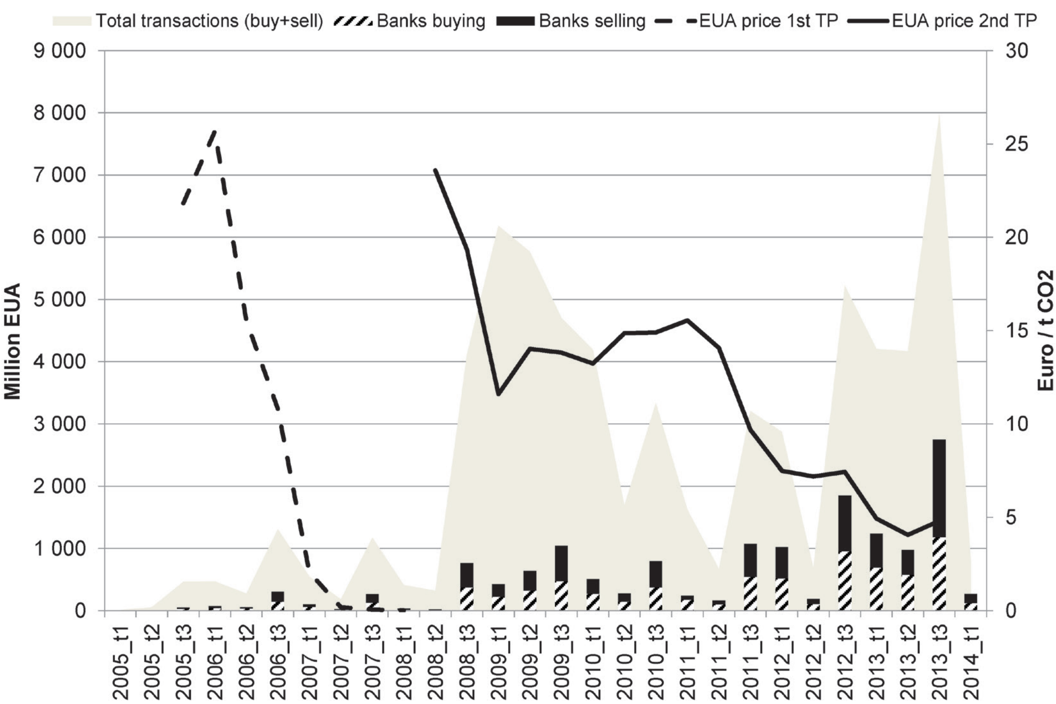
Note: Years are compliance years running until 31/03 each year. Data for 2005–2007 is from 2011–12 data download; data for 2008–2013 is from 2016–17 data download. Only external market transactions (i.e., not related to allowance allocation, surrender, or cancellation and only between accounts belonging to two different parent companies) are shown.

In order to better understand how trading in EUAs varies over the course of a compliance year, we split the transactions into trimesters. Figure 1 visualizes the effect of the VAT fraud on overall trading volumes in 2008–2010, as well as the rising involvement of banks starting in 2011. It also

2. While banks were also involved in the VAT fraud—e.g., Deutsche Bank was sued—there seems to have been no overall rise in bank transactions while the fraud was occurring in 2008—2010, probably due to a significant increase in overall transaction volumes.

exhibits the typical peak of bank involvement in the market during the third trimester (September to December) of each year. This is due to the fact that banks are important hedging partners (see below) and that December is the standard month when forward and future contracts are delivered. The first trimester (January to April) also shows increased activity. During this time, allowances for the previous year's emissions need to be surrendered and EUAs for the current year are issued. The involvement of banks did not decrease despite falling EUA prices over the course of the second trading period. In contrast to the first trading period, allowances can be banked into future trading periods from 2008 onwards. Finally, from the start of the third trading period onwards (2013), the share of auctioned allowances rose significantly; already in 2012, early auctions of permits pertaining to the third trading period were carried out. Due to their cost structure, banks are important buyers in auctions (see also below).

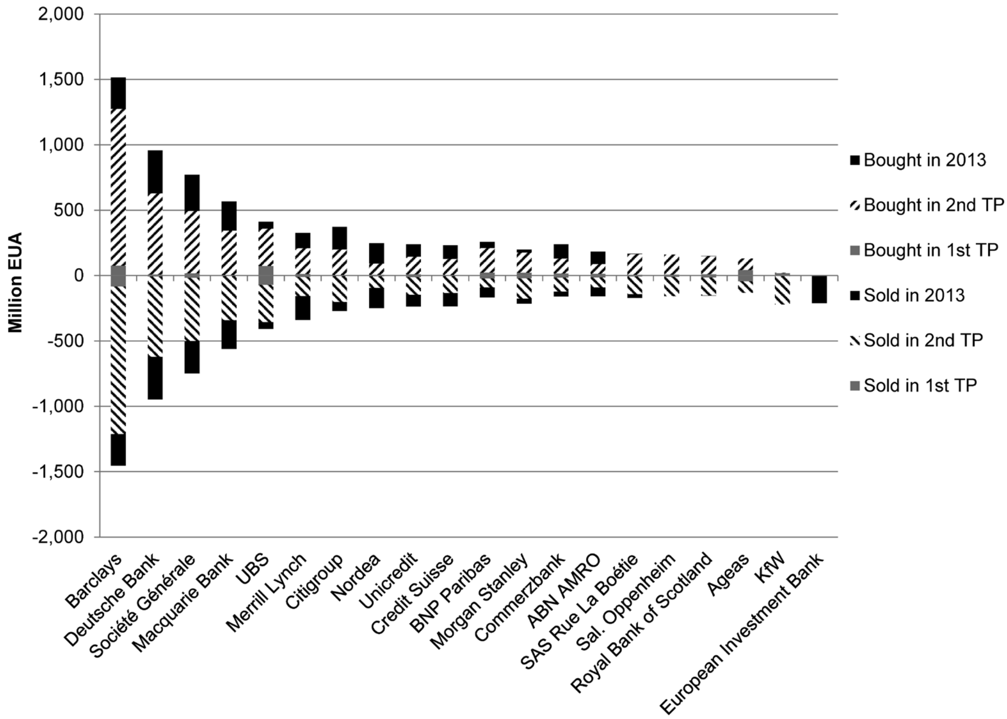
**Figure 1: EUA transactions and the involvement of banks**




Source: EUTL, Point Carbon, EEX, ICE, own calculation and illustration
Note: Transactions are shown for trimesters running from Jan-April, May-August and September-December each). Data for 2005t1–2008t1 from 2011–12 data download; data for 2008t2–2014t1 from 2016–17 data download. Only external market transactions i.e. not related to allowance allocation, surrender or cancellation and only between accounts belonging to two different parent companies, are shown.

Displaying the 30 banks most active in selling and buying EUAs, Figure 2 shows that many banks only became involved during the second trading period or increased their trading volume substantially compared to the first trading period. Barclays PLC was the most active bank (in terms of volumes transferred) up until 2013, followed by Deutsche Bank and Société Générale, but also many non-European banks (e.g., Macquarie, Merrill Lynch) were among the top 30. The German KfW and European Investment Bank (EIB) represent special cases as they only sold but did not buy any EUAs. This can be explained by the fact that the German KfW was—between 2010 and 2013—appointed by the German government to manage the New Entrant Reserve and was implementing early auctions in 2012 on behalf of the German government. Similarly, the EIB was appointed by the European Commission to auction allowances of the NER300 program established to support innovative emission reduction projects with the auction proceeds.

**Figure 2: Volumes transacted with other companies by the 20 most active banks**




Source: EUTL, own calculation and illustration
Note: January 2005 to April 2008 is included in the first trading period and May 2008 to April 2013 in the second trading period. May 2013 to April 2014 is included in the 2013 data. The data for 2005t1–2008t1 is from the 2011–12 data download; the data for 2008t2–2014t1 is from the 2016–17 data download. Only external market transactions (i.e., not related to allowance allocation, surrender, or cancellation and only between accounts belonging to two different parent companies) are shown.

Our interviews with some of the major players in EU emissions trading, confirm that banks have played very similar roles in EU emissions trading to those generally played on physical commodity markets (IHS Consulting Services, 2013). In the following, we first focus on the roles specific to EU emissions trading and then comment on the more general roles that also apply to other commodity markets.

First, banks may directly operate accounts on behalf of regulated entities. This applies to, for example, AGEAS and Unicredit. Second, banks lower transaction costs by trading with smaller regulated entities. In this case, a bank can act as an aggregator and collect the surplus allowances of its clients to bring them onto the market, which has a positive effect on the efficiency of the market.

Third, from the second trading period onwards, when Kyoto units of the Clean Development Mechanism (CERs) or Joint Implementation (ERUs) were traded, banks helped companies in swapping EUAs against those Kyoto units. In principle, this is a risk-free way of generating additional cash as long as there is a price differential between CERs/ERUs and EUAs. However, this swapping option is not unlimited since regulated companies could only use Kyoto units to cover a pre-defined share of their emissions. As KfW/ZEW (2009) noted, in Germany it was mostly large companies that took advantage of the opportunity to swap—even at relatively low spreads. Smaller companies demand larger spreads due to perceived risks related to the cap on international permits and the ban of certificates from certain projects and countries, as well as transaction costs involved in swapping Kyoto units for EUAs.

When looking at the more general roles of banks also applying to other commodity markets, we found that—similar to exchanges and brokers—banks facilitate trading in that they offer a platform on which other entities can complete trades or offer the service to facilitate trades. This intermediation service can lead to more efficient price formation.

Some banks also provide market information to their clients by publishing newsletters (e.g., Deutsche Bank, Barclays) and market analysis reports. In addition, some banks act as market makers, as do some utilities and oil companies (Betz and Schmidt, 2015). Market makers have to constantly place bids and asks within a certain price corridor on exchanges and are rewarded by being granted special access conditions to these exchanges.

Furthermore, banks may trade on their own account in order to generate profits. In contrast to *management service providers*, which make returns related to service activities offered (e.g., brokerage) or *technical service providers*, which make returns related to fees and charges, *speculative traders* try to generate returns by speculating on the market for EUAs. Speculative trading may involve very short time periods in order to make profits within hours or days. Information on speculative activities was difficult to obtain in any of the interviews since those are often carried out by a different department within the same bank. According to Wallner et al. (2014), most banks limit purely speculative trading activity given that this needs to be backed up with nearly the same amount of equity to comply with regulatory standards for banks.

For speculative reasons, some banks have also borrowed permits from companies and returned them with interest (not buying them but rather using them as speculative capital). However, as mentioned in the interviews, this practice is not very common as the contract negotiations are burdensome.

In physical commodity markets, one important role of banks is providing credit or project finance to companies (IHS Consulting Services, 2013). In the case of the EU ETS, banks are partners for so-called maturity swaps. In this context, a company sells permits for cash on the market and at the same time buys a future from the exchange backed by a bank (which will only need to be paid for at the delivery date, with the exception of margins). Through this mechanism, companies benefit from better conditions for obtaining cash compared to the conventional credit conditions offered by banks.

The interviewees confirmed our expectation that banks play a major role in providing risk management to regulated companies as they are hedging partners and develop as well as offer derivative products (e.g., transform standardized future contracts in more customized forwards contracts). Electricity generators, in particular, buy derivatives to hedge power forward sales. They acquire futures rather than EUAs in auctions or on the spot market due to lower capital costs and financial liquidity restrictions. These hedges are usually carried out by dedicated trading accounts of the electricity companies rather than the accounts of individual installations. It is attractive for banks to serve as a hedging partner as they have access to cheap capital and can, therefore, pursue cost-of-carry arbitrage. In other words, they buy, for example, spot from industry, hold EUAs, and sell forwards or futures to electricity generators (cf. also KfW / ZEW 2014; KfW / ZEW, 2015)

Finally, as IHS Consulting Services (2013) noted, banks also increase competition on the market i) directly, by trading on the market, and ii) indirectly, by supporting small and medium-sized companies that would otherwise lack the resources to compete with large integrated multinationals.

### 4.2 The Role of Banks Compared to Other Financial Intermediaries

Based on our descriptive analysis, the interviews conducted, and the literature reviewed, we formed a number of hypotheses related to the importance (or not) of banks compared to other financial intermediaries as a trading partner for regulated companies. This is discussed in the following, as part of Research Question 2 (How important are banks as trading partners for different types of regulated companies?). We expected that the decision to become active in EU emissions trading and the choice of trading partner by a regulated company would depend on several characteristics, such as its size[3], sector, and trading experience, and whether or not the company had a shortage or an excess of allowances to cover its emissions (i.e., whether it was "short" or "long").

We expected companies that are short to be more likely to become active in general (as being short at the end of the true-up period incurs a fine), while companies that are long have less pressure to trade.

Trading experience was approximated by a number of variables in our analysis, namely the total number of trades (cf. Jaraitė-Kažukauskė and Kažukauskas, 2015), how many accounts a company holds, and whether or not it has opened a voluntary trading account. In general, we expected that these companies would have a larger ETS business that warrants setting up a trading unit and that they would, therefore, follow a more involved trading strategy making use of many different trading partners, in particular exchanges and banks. However, a large number of accounts may also reduce a company's dependence on intermediaries (Jaraitė-Kažukauskė and Kažukauskas, 2015) or external trading in general (Cludius, 2018).

We further expected regulated companies that have trading experience and are sufficiently large to be more likely to trade at exchanges as prequalification requirements have to be met for these marketplaces and companies that trade in other commodities (e.g., electricity, energy) to have already met those requirements. In fact, EU allowances are often traded at the same exchanges as energy products. However, even those companies that can trade directly at an exchange may wish to trade more specialized products bilaterally (Section 2).

Electricity companies active in the EU ETS need to hedge their forward electricity sales. As mentioned in the interviews, banks are—due to their financial liquidity—able to act as hedging partners. Therefore, we expected companies active in the electricity sector to be more likely to sell to and buy from banks than companies active in other sectors.

Due to the large variety of services they offer (Section 4.1), banks are also likely to be important trading partners for small and less experienced companies. This also applies to brokers, which—as mentioned in the interviews—often help small, overallocated companies bring their excess allowances to market.

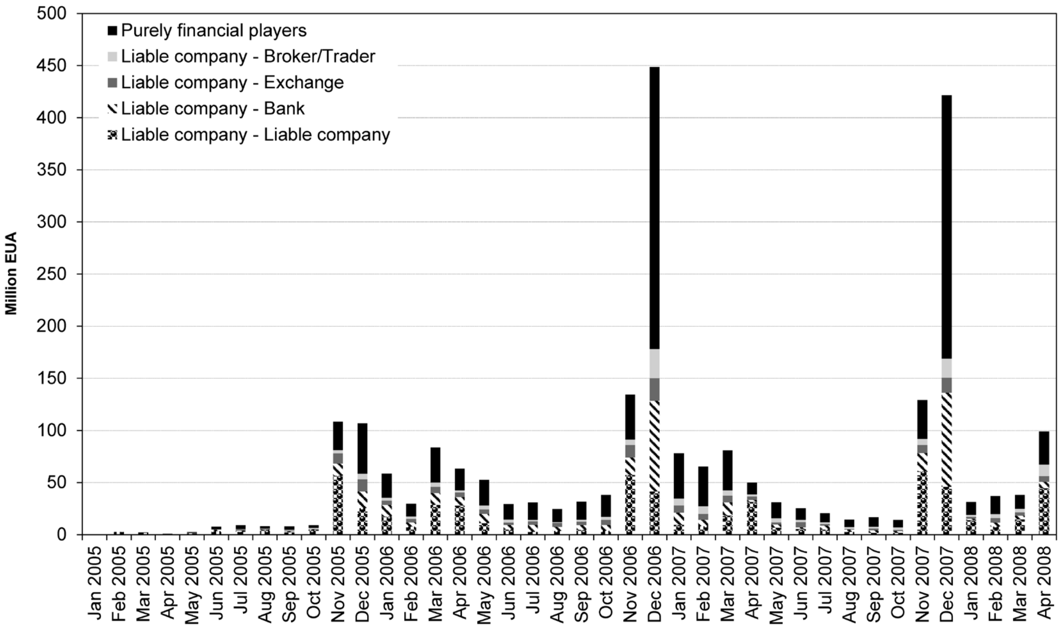
- Hypothesis I: Banks are important trading partners for all companies independent of size and experience level
- Hypothesis II: Banks are particularly important for companies active in the electricity sector.
- Hypothesis III: Exchanges are particularly important platforms for large firms with trading experience.

3. The size of a company was measured using the maximum of its emissions during the first period in logs. We used maximum rather than average emissions since this number is more representative of total production capacity (considering, for example, the case where production and emissions are low due to exceptional events such as failure, etc. during a particular year). We further took the log of the maximum since we expected the relationship between this variable and the outcome variable to be non-linear.

- Hypothesis IV: Intermediaries other than banks and exchanges (in our analysis brokers and traders) are particularly important for small firms with excess allowances.

Regulated companies had the largest transaction volume directly with other regulated companies, followed by transactions with banks, exchanges, and brokers/traders (see Figure 3). Transactions involving only financial entities represented nearly twice the volume of those transactions involving a regulated company. The involvement of financial players in the trading activities of regulated companies increased over time and banks were especially active in December when futures were cleared.

**Figure 3: Trading partners in first period EU Emissions Trading over time**




Source: EUTL, own calculation and illustration
Notes: Data for Jan 2005 to April 2008 from the 2011–12 data download. Only external market transactions (i.e., not related to allowance allocation, surrender, or cancellation and only between accounts belonging to two different parent companies) are shown.

Table 2 presents summary statistics of the variables used in regression analysis: 9 % of regulated companies sold to and 5 % bought from banks, 19 % of regulated companies sold to and 13 % bought from brokers/traders, 5 % of regulated companies sold and 6 % bought allowances via exchanges.

We used explanatory variables related to a company's sector based on the NACE code applying to the majority of emissions owned by this company, its size (measured by emissions), the number of accounts it holds, whether or not it has opened a voluntary account, whether it was short or long and by how much ('absolute position') and the number of trades carried out by this company.

### 4.3 Regression Results

The regression results are displayed in Table 3. Because the regression "bought from bank" did not converge using the probit model with sample selection ("Heckprobit"), results for a Heck-

**Table 2: Summary statistics of variables used in regression analysis**

| | | Obs. | Mean | Min | Max |
|---|---|---|---|---|---|
| Sold to bank | Dummy variable indicating whether any allowances were sold to a bank | 4,783 | 0.09 | 0 | 1 |
| Bought from bank | Dummy variable indicating whether any allowances were bought from a bank | 4,783 | 0.05 | 0 | 1 |
| Sold to broker/trader | Dummy variable indicating whether any allowances were sold to a broker/trader | 4,783 | 0.19 | 0 | 1 |
| Bought from broker/trader | Dummy variable indicating whether any allowances were bought from a broker/trader | 4,783 | 0.13 | 0 | 1 |
| Sold at exchange | Dummy variable indicating whether any allowances were sold at an exchange | 4,783 | 0.05 | 0 | 1 |
| Bought at exchange | Dummy variable indicating whether any allowances were bought at an exchange | 4,783 | 0.06 | 0 | 1 |
| Traded | Dummy variable indicating whether there was any external trade | 4,783 | 0.63 | 0 | 1 |
| Number of trades | Total number of external trades | 3,002 | 12.70 | 1 | 2,986 |
| Short | Dummy variable indicating whether allocation < emissions in 1st trading period | 4,783 | 0.27 | 0 | 1 |
| Voluntary trading account | Dummy variable indicating whether firm opened an (active) voluntary trading account | 4,783 | 0.04 | 0 | 1 |
| Number of accounts | Total number of accounts (compulsory+voluntary) | 4,783 | 2.41 | 1 | 216 |
| ln (maximum emissions) | Natural logarithm of maximum annual emissions in 1st trading period (Mio. t $CO_{2e}$) | 4,783 | 10.02 | 1 | 19 |
| ln (absolute position) | Natural logarithm of absolute value of net position (allocation-emissions) (Mio. EUAs) | 4,783 | 9.53 | 0 | 18 |
| Electricity | Dummy variable indicating NACE sector with highest share of emissions | 4,783 | 0.10 | 0 | 1 |
| Other combustion | | 4,783 | 0.53 | 0 | 1 |
| Refineries | | 4,783 | 0.01 | 0 | 1 |
| Iron, steel | | 4,783 | 0.03 | 0 | 1 |
| Cement | | 4,783 | 0.03 | 0 | 1 |
| Glass | | 4,783 | 0.04 | 0 | 1 |
| Ceramics | | 4,783 | 0.16 | 0 | 1 |
| Paper | | 4,783 | 0.10 | 0 | 1 |

Source: EUTL, European Commission 2014

man two-step model are shown, which allows an analysis of sample selection effects but does not perfectly fit the 0/1 outcome variable due to its linear specification. We therefore also show results of an ordinary probit regression, which also has to be interpreted with caution as it disregards potential sample selection. For all “Heckprobit” specifications, as well as the ordinary probit, marginal effects at the means of the independent variables are shown. This also applies to the selection equation. Estimated coefficients are shown in Appendix D.

In the outcome equation results (see upper panel in Table 3), the short dummy is significant and has the expected sign, meaning if a company was short it was more likely to buy from any of the financial intermediaries, while if it was long, it was significantly more likely to sell to any of the financial actors considered. For example, if a company is short the probability that it will buy allowances at the exchange increases by 8 percentage points, while the probability that it will sell at the exchange decreases by around 9 percentage points.

Using the logarithm of maximum emissions as a measure of the size of a company, it was shown that larger companies were more likely to engage in trading activities with any of the financial intermediaries considered here, with one notable exception: Smaller companies (again measured by their emissions) were significantly more likely to engage in selling to a broker/trader. This result supports Hypothesis IV that brokers (especially as buyers) are more important to the trading

**Table 3: Regression results: Probit model with sample selection**

| | Sold to bank | Bought from bank | | Sold to broker/trader | Bought from broker/trader | Sold to exchange | Bought from exchange |
|---|---|---|---|---|---|---|---|
| Model | Heckprob | Heckman twostep | Ordinary probit | Heckprob | Heckprob | Heckprob | Heckprob |
| | Marginal effects | | Marginal effects | Marginal effects | Marginal effects | Marginal effects | Marginal effects |
| Short | –0.24*** | 0.09*** | 0.06*** | –0.43*** | 0.15*** | –0.09*** | 0.08*** |
| | (0.04) | (0.01) | (0.01) | (0.02) | (0.01) | (0.02) | (0.01) |
| ln (maximum emissions) | 0.04*** | 0.03*** | 0.02*** | –0.02*** | 0.02*** | 0.01** | 0.01*** |
| | (0.01) | (0.003) | (0.002) | (0.01) | (0.003) | (0.003) | (0.003) |
| Number of accounts | 0.001 | 0.001* | –0.00004 | –0.001 | 0.003*** | –0.001 | 0.0002 |
| | (0.002) | (0.001) | (0.0004) | (0.002) | (0.001) | (0.001) | (0.001) |
| Voluntary trading account | 0.11*** | 0.17*** | 0.04** | 0.05 | –0.01 | 0.09*** | 0.08*** |
| | (0.03) | (0.02) | (0.02) | (0.05) | (0.03) | (0.02) | (0.02) |
| Number of trades | 0.001** | 0.0005*** | 0.001** | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.001) | (0.0001) | (0.0002) | (0.0005) | (0.0002) | (0.0003) | (0.0002) |
| Other combustion | 0.07*** | –0.01 | 0.02* | 0.01 | 0.01 | –0.04*** | –0.004 |
| | (0.03) | (0.02) | (0.01) | (0.03) | (0.02) | (0.02) | (0.02) |
| Refineries | –0.01 | –0.02 | 0.001 | –0.04 | –0.08 | –0.14** | –0.02 |
| | (0.07) | (0.04) | (0.03) | (0.09) | (0.06) | (0.06) | (0.04) |
| Iron, steel | 0.06 | 0.003 | 0.03 | 0.01 | –0.05 | –0.08** | –0.05 |
| | (0.05) | (0.03) | (0.02) | (0.06) | (0.04) | (0.04) | (0.04) |
| Cement | 0.12*** | –0.01 | 0.02 | 0.16*** | 0.03 | –0.03 | –0.002 |
| | (0.05) | (0.03) | (0.02) | (0.06) | (0.03) | (0.03) | (0.03) |
| Glass | 0.18*** | 0.04 | 0.06*** | –0.08 | –0.03 | –0.02 | 0.03 |
| | (0.04) | (0.03) | (0.02) | (0.06) | (0.03) | (0.03) | (0.03) |
| Ceramics | 0.04 | –0.03* | –0.01 | 0.14*** | 0.01 | 0.03* | 0.10*** |
| | (0.04) | (0.02) | (0.02) | (0.04) | (0.02) | (0.02) | (0.03) |
| Paper | 0.05 | –0.06*** | –0.03 | 0.02 | –0.02 | –0.05** | 0.04* |
| | (0.04) | (0.02) | (0.02) | (0.05) | (0.02) | (0.02) | (0.02) |
| Selection equation (marginal effects) | | | | | | | |
| ln (absolute position) | 0.05*** | 0.05*** | | 0.06*** | 0.05*** | 0.05*** | 0.05*** |
| | (0.01) | (0.005) | | (0.01) | (0.005) | (0.005) | (0.005) |
| Short | 0.24*** | 0.23*** | | 0.24*** | 0.23*** | 0.23*** | 0.23*** |
| | (0.02) | (0.01) | | (0.02) | (0.02) | (0.02) | (0.02) |
| ln (maximum emissions) | –0.01 | –0.002 | | –0.004 | –0.002 | –0.002 | –0.002 |
| | (0.005) | (0.005) | | (0.01) | (0.005) | (0.005) | (0.005) |
| Number of accounts | 0.05*** | 0.05*** | | 0.04*** | 0.05*** | 0.05*** | 0.05*** |
| | (0.01) | (0.005) | | (0.01) | (0.01) | (0.01) | (0.01) |
| Other combustion | –0.02 | –0.03 | | –0.03 | –0.03 | –0.03 | –0.03 |
| | (0.02) | (0.02) | | (0.02) | (0.02) | (0.02) | (0.02) |
| Refineries | –0.05 | –0.03 | | –0.03 | –0.03 | –0.03 | –0.03 |
| | (0.08) | (0.07) | | (0.08) | (0.08) | (0.08) | (0.08) |
| Iron, steel | –0.05 | –0.06 | | –0.06 | –0.05 | –0.06 | –0.06 |
| | (0.04) | (0.04) | | (0.04) | (0.04) | (0.04) | (0.04) |
| Cement | –0.14*** | –0.14*** | | –0.13*** | –0.15*** | –0.13*** | –0.14*** |
| | (0.04) | (0.04) | | (0.04) | (0.04) | (0.04) | (0.04) |
| Glass | –0.01 | –0.02 | | –0.01 | –0.02 | –0.01 | –0.02 |
| | (0.04) | (0.04) | | (0.04) | (0.04) | (0.04) | (0.04) |
| Ceramics | –0.04 | –0.05* | | –0.04* | –0.05* | –0.05* | –0.05* |
| | (0.03) | (0.03) | | (0.03) | (0.03) | (0.03) | (0.03) |
| Paper | –0.08*** | –0.08*** | | –0.08*** | –0.08*** | –0.08*** | –0.08*** |
| | (0.03) | (0.03) | | (0.03) | (0.03) | (0.03) | (0.03) |
| rho | –0.61*** | 0.27** | | –0.68* | 0.86*** | –0.12 | –0.01 |
| p-value LR test | 0.00 | 0.07 | | 0.06 | 0.00 | 0.56 | 0.98 |
| Observations (censored/ uncensored) | | | | | 3,002 / 4,783 | | |

Source: EUTL, own estimation

Note: Data for Jan 2005 to April 2008 from the 2011–12 data download. Marginal effects at means of independent variables shown for Heckprobit and ordinary probit specifications, as well as selection equation results. Robust standard errors in parentheses (***significant at the 99% level; ** significant at the 95% level; *significant at the 90% level); non-robust standard errors for Heckman two-step selection model.

strategy of smaller than larger companies. Hypothesis III that exchanges are more important for larger companies is also supported. Finally, we expected that company of any size could be equally likely to interact with banks (Hypothesis I) since they offer a wide range of services. However, our regression results showed that larger companies (in terms of emissions) are significantly more likely to buy from or sell to a bank than smaller companies. If, for example, the annual emissions of a company increase by 10%, the probability to sell to a bank increases by 0.4 percentage points.

Our results cannot be compared directly to the ones of Jaraitė-Kažukauskė and Kažukauskas (2015), who investigated what makes companies more likely to trade *only* indirectly. They were also interested in whether companies use the possibility to trade internally, which is somewhat similar to one of the regressions run by Zaklan (2013). Both papers find that larger companies (in terms of allocation) are more likely to transfer internally. In addition, we found that these large companies are more likely to approach a diverse range of financial players.

Jaraitė-Kažukauskė and Kažukauskas (2015) stated that companies with many accounts are more likely to trade directly (i.e., not only indirectly). In our specifications, this variable is generally insignificant indicating that the number of accounts has no significant influence on a company's trading strategy regarding external trading partners in the financial sector. One exception is the specification "bought from broker," which indicates that an additional account increases the probability to buy from a broker by 0.003.

Whether or not a company had opened a voluntary trading account is important and increases its likelihood of engaging in trades with both banks (probability increased by 0.04–0.17) and exchanges (probability increased by 0.08–0.09). Jaraitė-Kažukauskė and Kažukauskas (2015) found that holding a voluntary trading account significantly increases the likelihood of trading only with the financial sector. We further determined that the coefficients are insignificant for regressions involving a broker. If a voluntary trading account is indeed a good proxy for trading experience, this result supports Hypothesis III (companies with trading experience are more likely to sell or buy at exchanges).

Hypothesis I (banks are equally important for more and less professionalized companies) is, again, not supported, while Hypothesis IV (brokers/traders are more important for firms with less trading experience) is supported. The number of trades has a positive effect on the predicted probability to trade with any of the financial actors considered. This result shows that ceteris paribus companies that are more active (in terms of transactions) are more likely to trade with many different partners and across many trading platforms (e.g. exchanges and OTC).

The impact of the sector dummies is varied and no clear pattern emerges. Against the reference category of electricity generation, other sectors seem to be less likely to use exchanges. However, this does not hold true for ceramics. On the other hand, companies falling under the sectors of combustion, cement and glass seem to be more likely to engage in trades with banks than electricity providers (at least concerning the selling of allowances). Companies in the cement and ceramics sector are also more likely to sell to a broker. We had expected electricity companies to be more likely to engage in trades with banks (especially buying from banks) than other sectors in order to hedge their forward electricity sales. However, this is not supported by the regression results. Thus, Hypothesis II is not supported by the results. This may be due to the fact that some sectors are quite heterogeneous (consider, for example, the German electricity market, which has a number of large utility companies as well as many small ones).

Turning to the selection equation, as expected, a higher absolute amount of the allocation position was found to have a positive effect on the decision to engage in trading. If this position increases by 10%, the likelihood to engage in external trading increases by 0.005–0.006. As expected, companies that are short are more likely to enter the external market (probability increased by 0.23–0.24). The size of a company, measured by verified emissions, does not show up as significant for the decision to enter the market, which is likely to be due to the fact that it is highly correlated with the *absolute* position (see Table 4 in Appendix B). The higher the number of accounts, the more likely a company is to engage in external trades. These results are also supported by the findings of Cludius (2018).

An additional account increases the likelihood to become active on the market by 0.04–0–05. This is in line with the results of Jaraitė-Kažukauskė and Kažukauskas (2015), who also found that companies with more accounts are more likely to trade externally. Zaklan (2013) also determined that a higher level of allocation (which corresponds to a higher emissions level) increases the probability of a company to engage in trading. He also included company characteristics such as turnover and ownership structure (not modelled here) and found that they also have an impact on the decision to become active in trading or not.

It should also be noted that a number of sectors (especially cement and paper) are significantly less likely to engage in trading at all when compared to the reference category of electricity generation, which is in line with the results of Jaraitė-Kažukauskė and Kažukauskas (2015).

Rho is significant in a number of the regressions, indicating that the selection process may indeed play an important role, however, not for all of the regressions that were run. This result echoes Zaklan (2013) who did not find evidence of self-selection in EU emissions trading and commented that this contradicts the literature on the trade of other goods. Since rho shows up as significant in the Heckman two-step model run for the regression "'bought from bank," ordinary probit results for this regression have to be interpreted with caution.

Comparing the results of the outcome equation to an ordinary probit regression, without accounting for the selection process (Appendix C) shows that the estimated marginal effects are very similar, both in terms of magnitude and significance. For those regressions where we estimated a significant correlation between the error terms of the two equations, in particular "sold to broker/trader" and "bought from broker/trader," we discovered some differences in the magnitude and significance of coefficients. In the ordinary probit regression "sold to broker," the coefficient on the logarithm of maximum emissions is no longer significant (while owning a voluntary trading account becomes marginally significant). This indicates that ex-ante smaller firms are more likely to sell to a broker (taking the selection process into account), while among those companies that did trade small and large companies are equally likely to sell to a broker.

In the ordinary probit regression "bought from broker," the sector dummy on cement becomes significant, indicating that ex-ante companies in the cement sector are not significantly more likely to buy from a broker than electricity companies, while this does hold for the subset of companies that did trade. The estimated coefficients on these variables are therefore likely to be affected by the unobservable variables driving the selection process in these two cases.

## 5. CONCLUSION AND POLICY IMPLICATIONS

This paper analyses the role of banks in EU emissions trading using both descriptive and regression analysis on data from the EUTL, as well as semi-structured interview techniques. It contributes to the literature by discovering which roles banks play in (EU) emissions trading and investigating their importance as trading partners for regulated companies—and how this differs from other non-regulated entities.

First, we showed the significant involvement of banks in overall transactions and that this involvement had been increasing since the start of the scheme until at least 2013 (the end of our analysis timeframe). We also identified more than ten different roles of banks ranging from ETS-specific roles such as directly managing accounts of regulated companies, aggregating allowance flows, and providing swaps for Kyoto units to more general roles banks also play in other commodity markets, for example, acting as an intermediary or hedging partner, or providing easy access to cash to regulated companies.

Second, our regression analysis indicates that different types of regulated companies interact with financial players to differing degrees and that this is determined by certain company-specific characteristics. While larger companies with trading experience are more likely to interact with many different financial players in particular banks or exchanges, smaller, less professionalized companies are more likely to follow a single trading strategy and interact with brokers (in particular, when selling allowances).

Many emissions trading schemes operating today have allowed more or less unfettered participation of non-regulated entities in trading. This applies to the Californian system (Carbon Market Institute 2012a), where auction results show that financial players are active participants, such as Morgan Stanley or the Royal Bank of Canada (ARB, 2016), as well as the New Zealand scheme (Carbon Market Institute, 2012b). In their report on the $SO_2$ trading scheme, Schmalensee et al. (1998) reported the involvement of three market makers. South Korea is an exception to the rule (ICAP, 2018), while in China the situation is slightly different since financial activities are controlled by the state to a larger extent (exchanges are state-controlled).

In conjunction with the experience from other ETS, our findings are thus important for policy makers developing new carbon markets and deciding what entities should be allowed to participate. The positive contribution of banks to market liquidity—in particular at the start of an ETS—seems to be undisputed. In fact, the absence of financial players from the South Korean scheme is one of the reasons why traded volumes in this market are very low (Thomson Reuters, 2016) and has prompted the introduction of a market maker in the scheme (ICAP, 2018). As liquidity on the market is most important when the share of auctioned allowances is low, one option could be to allow government-owned banks as market makers at the beginning or to phase-out the involvement of non-regulated entities over time. However, the latter may be not attractive to banks, as their involvement would only be temporary.

The substantial losses in tax income due to VAT fraud in EU emissions trading, do, however, highlight that allowing non-regulated companies to participate in the scheme can increase the risk for market abuse. It is, therefore, vital to stress the importance of effective regulation and market oversight, which has been called for not only in the context of the EU ETS, but also other emission trading systems (Cutter et al., 2011; ICAP, 2013; Monast, 2010; Prada, 2010). In the EU, MiFID II came into force in January 2018. In contrast to MiFID I, which only regulated derivate markets, MiFID II also applies to the spot market and thus strengthens market oversight of EUA trading. While banks fall under this new regulation, other service and trading companies also active in EU emissions trading do not. It may, therefore, be necessary to also strengthen other forms of market oversight, such as stricter checks on the identity and previous records of participants in EU emissions trading (Cutter et al., 2011) in order to ensure that no new forms of market abuse emerge.

There are many areas for further research. First, we have only analyzed data up to April 2014 and, therefore, only for the first year of the third trading period. We were unable to see the impact of a potential pull-out of banks out of the EU ETS prompted by the new regulations, nor were we able to fully analyze changes in the role of banks due to the increasing amount of auctioned allowances or in the face of rapidly rising EUA prices in 2018. Furthermore, it would be interesting to investigate in greater depth how a company chooses with whom to trade allowances and how the specific type of trade (e.g., volume, level of standardization, or aim) influences this choice. A further interesting point is the political economy related to the lobbying activities of banks in the context of regulation of general financial and emissions markets (e.g. the fact that trading under the EU ETS is governed by general financial market regulations rather than individual rules). Those topics, as well as the effect of the rising share of renewables in electricity markets, which impacts hedging demand and in turn the demand for banks' services in this field, are promising areas for further research.

## ACKNOWLEDGMENTS

We want to thank three anonymous referees for their thoughtful and detailed comments, which allowed us to improve this paper substantially. We thank our interview partners for their insights into the roles of banks in EU emissions trading. We are also grateful to the researchers taking part in a project on the Market Stability Reserve, led by Climate Strategies (Neuhoff et al., 2015), in particular Anne Schopp. Some of the results presented in this paper were conceived and discussed in the context of this research project and presented at the 21st Annual Conference of the European Association of Environmental and Resource Economists (EAERE) in Helsinki (June 2015). They were also presented at the 38th International Association for Energy Economics (IAEE) Conference in Antalya (May 2015), and an excerpt was published in the relevant IAEE Energy Forum Special Issue.[4] Another presentation was held at the annual conference of the Association of German-speaking Economists—Chapter of Environmental and Resource Economists (AURÖ) in Rostock (May 2019). We also thank Marc Chesney for his input, particularly at the beginning of our research. This research is part of the activities of SCCER CREST (Swiss Competence Center for Energy Research), which is funded by Innosuisse, formerly the Swiss Commission for Technology and Innovation (CTI), under Grant No. KTI. 1155000154. Some of the findings presented in this paper were previously published as SCCER CREST Working Paper WP3-2016/02[5] and ZHAW SML Working Paper 2016/12.[6]

## REFERENCES

Abrell, Jan, Anta Ndoye Faye, and Georg Zachmann (2011). "Assessing the Impact of the EU ETS Using Firm Level Data." Document de Travail n° 2011 15, last accessed October 09, 2017. http://www.beta-umr7522.fr/productions/publications/2011/2011-15.pdf.

Allen, F., and A. M. Santomero (1998). "The Theory of Financial Intermediation." *Journal of Banking and finance* 21: 1461–85.

ARB (2016). "California Cap-and-Trade Program and Québec Cap-and-Trade System November 2016 Joint Auction #9." November, last accessed December 26, 2016. https://www.arb.ca.gov/cc/capandtrade/auction/nov-2016/summary_results_report.pdf.

Balietti, Anca Claudia (2016). "Trader Types and Volatility of Emission Allowance Prices. Evidence from EU ETS Phase I." *Energy Policy* 98: 607–20. https://doi.org10.1016/j.enpol.2016.09.006.

Betz, Regina and Tobias Schmidt (2015). "Transfer Patterns in Phase I of the European Union Emissions Trading System: A First Reality Check Based on Cluster Analysis." *Climate Policy* May 2015. https://doi.org10.1080/14693062.2015.1028319.

4. Available at: https://www.iaee.org/en/publications/newsletterdl.aspx?id=282.
5. Available at: https://www.sccer-crest.ch/fileadmin/user_upload/EPAG_CREST_WP_EUETS_RoleofBanks.pdf.
6. Available at: https://digitalcollection.zhaw.ch/handle/11475/7055.

Borghesi, Simone and Andrea Flori (2018). "EU ETS Facets in the Net: Structure and Evolution of the EU ETS Network." *Energy Economics* 75: 602–35. https://doi.org10.1016/j.eneco.2018.08.026.

Bredin, D., S. Hyde, and C. Muckley (2014). "A Microstructure Analysis of the Carbon Finance Market." *International Review of Financial Analysis* 34: 222–34.

Calel, Raphael and Antoine Dechezleprêtre (2016). "Environmental Policy and Directed Technological Change: Evidence from the European Carbon Market." *Review of Economics and Statistics* 98 (1): 173–91. https://doi.org10.1162/REST_a_00470.

Carbon Market Institute (2012a). "Integrity and Oversight of the California Emissions Trading Scheme." March, last accessed May 15, 2014. www.carbonmarketinstitute.org.

Carbon Market Institute (2012b). "Integrity and Oversight of the New Zealand Emissions Trading Scheme." March, last accessed May 15, 2014. www.carbonmarketinstitute.org.

Cludius, Johanna (2018). "Winners and Losers of EU Emissions Trading: Insights from the EUTL Transfer Dataset." *EEEP* 7(2). https://doi.org10.5547/2160-5890.7.2.jclu.

Cutter, Bowman, Rhead M. Enion, Ann Carlson, and Cara Horowitz (2011). "Rules of the Game: Examining Market Manipulation, Gaming and Enforcement in California's Cap-and-Trade Program." Last accessed December 26, 2016. https://law.ucla.edu/~/media/Files/UCLA/Law/Pages/Publications/CEN_EMM_PUB%20Rules_of_the_Game_2011.ashx.

Dechezleprêtre, Antoine, Daniel Nachtigall, and Frank Venmans (2018). "The Joint Impact of the European Union Emissions Trading System on Carbon Emissions and Economic Performance." OECD Economics Department Working Papers 1515, last accessed December 08, 2018. https://www.oecd-ilibrary.org.

Ellerman, Denny A. and Raphaël Trotignon (2009). "Cross Border Trading and Borrowing in the EU ETS." *The Energy Journal* 30(Special Issue 2): 53–76.

Europol (2010). "Further Investigations into VAT Fraud Linked to the Carbon Emissions Trading System." Press release, last accessed December 21, 2016. https://www.europol.europa.eu/newsroom/news/further-investigations-vat-fraud-linked-to-carbon-emissions-trading-system.

Fan, Ying, Yin-Peng Liu, and Jian-Feng Guo (2016). "How to Explain Carbon Price Using Market Micro-Behaviour?" *Applied Economics* 48(51): 4992–5007. https://doi.org10.1080/00036846.2016.1170930.

Frunza, M.-C., and D. Guegan (2011). "Missing Trader Fraud on the Emissions Market." *Journal of Financial Crime* 18(2): 183–94. https://doi.org10.1108/13590791111127750.

Heckman, James J. (1979). "Sample Selection Bias as a Specification Error." *Econometrica* 47(1): 153–61.

ICAP (2018). "Korea Emissions Trading Scheme." Last accessed December 03, 2018. https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=47.

ICAP (2013). "Carbon Market Oversight Primer." Last accessed December 26, 2016. https://icapcarbonaction.com/en/?option=com_attach&task=download&id=257.

IHS Consulting Services (2013). "The Role of Banks in Physical Commodities." Last accessed December 03, 2018. http://aeaep.com.ua/en/wp-content/uploads/2016/01/IHS_Role_of_Banks_in_Physical_Commodities_Final.pdf.

Jaraite, Jurate and Corrado Di Maria (2016). "Did the EU ETS Make a Difference? An Empirical Assessment Using Lithuanian Firm-Level Data." *The Energy Journal* 37(1). https://doi.org10.5547/01956574.37.1.jjar.

Jaraitė-Kažukauskė, Jūratė, and Andrius Kažukauskas (2015). "Do Transaction Costs Influence Firm Trading Behaviour in the European Emissions Trading System?" *Environ Resource Econ* 62(3): 583–613. https://doi.org10.1007/s10640-014-9831-7.

Jong, Thijs, Oscar Couwenberg, and Edwin Woerdman (2014). "Does EU Emissions Trading Bite? An Event Study." *Energy Policy* 69: 510–19. https://doi.org10.1016/j.enpol.2014.03.007.

Kachi, A. and M. Frerk (2013). "Carbon Market Oversight Primer." ICAP Report. https://icapcarbonaction.com/en/?option=com_attach&task=download&id=257.

KfW/ZEW (2014). "KfW/ZEW CO2 Barometer 2014—Carbon Edition." Last accessed January 26, 2016. https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-CO2-Barometer/CO2-Barometer-2014-Carbon-Edition.pdf.

KfW/ZEW (2015). "KfW/ZEW CO2-Barometer 2015—Carbon Edition." Last accessed January 26, 2016. https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-CO2-Barometer/CO2-Barometer-2015-Carbon-Edition.pdf.

KfW/ZEW (2009). "Leaving the Trial Phase Behind—Preferences & Strategies of German Companies Under the EU ETS: CO2 Barometer 2009." Last accessed October 09, 2017. https://www.econstor.eu/handle/10419/109793.

Leland, H.E. and D.H. Pyle (1977). "Informational Asymmetries, Financial Structure, and Financial Intermediation." *Journal of Finance* 32: 371–87.

Martino, Vincent and Raphaël Trotignon (2013). "Back to the Future: A Comprehensive Analysis of Carbon Transactions in Phase 1 of the EU ETS." Les Cahiers de la Chaire Economie du Climat 27.

Misoch, Sabina (2015). *Qualitative Interviews.* Berlin/München/Boston: De Gruyter.

Monast, Jonas (2010). "Climate Change and Financial Markets: Regulating the Trade Side of Cap and Trade." *Environmental Law Reporter* 40(1).

Neuhoff, Karsten, William Acworth, Regina Betz, Dallas Burtraw, Johanna Cludius, Harrison Fell, Cameron Hepburn et al. (2015). "Is a Market Stability Reserve Likely to Improve the Functioning of the EU ETS? Evidence from a Model Comparison Exercise." Last accessed August 14, 2015. http://climatestrategies.org/wp-content/uploads/2015/02/Climate-Strategies-MSR-Report-Final1.pdf.

Pirrong, C. (2014). "Exchanges: The Quintessential Manufactured Markets." In *the Manufacturing of Markets*, edited by J.-M. Blachant, 421–40: Cambridge University Press.

Prada, Michel (2010). "The Regulation of CO2 Markets—Assignment Report by Michel Prada, Emeritus General Inspector of Finance." Last accessed October 11, 2011. http://www.minefe.gouv.fr/services/rap10/101004prada-report.pdf.

Puhani, Patrick A. (2000). "The Heckman Correction for Sample Selection and Its Critique." *Journal of Economic Surveys* 14(1): 53–68.

Schmalensee, Richard, Paul L. Joskow, Denny A. Ellerman, and Elizabeth M. Bailey (1998). "An Interim Evaluation of Sulfur Dioxide Emissions Trading." *Journal of Economic Perspectives* 12(3).

Schneck, J. and Jonas Monast (2011). "Financial Market Reform and the Implication for Carbon Trading." Nicholas Institute Report.

Schopp, Anne and Karsten Neuhoff (2013). "The Role of Hedging in Carbon Markets." DIW Discussion Papers 1271, last accessed February 26, 2015. https://www.diw.de/documents/publikationen/73/diw_01.c.416987.de/dp1271.pdf.

Starr, Martha A. (2014). "Qualitative and Mixed-Methods Research in Economics: Surprising Growth, Promising Future." *Journal of Economic Surveys* 28(2): 238–64. https://doi.org10.1111/joes.12004.

Stavins, Robert N. (1995). "Transaction Costs and Tradeable Permits." *Journal of Environmental Economics and Management* 29: 133–48.

Thomson Reuters (2016). "Carbon Market Monitor: Review of Global Markets in 2015 and Outlook for 2016–2018." Last accessed January 19, 2016.

Van de Ven, Wynand P.M.M., and Bernard M.S. Van Praag (1981). "The Demand for Deductibles in Private Health Insurance." *Journal of Econometrics* 17(2): 229–52. https://doi.org10.1016/0304-4076(81)90028-2.

Wallner, Klaus, Dominik Glock, Patrick Runge, Ingo Tschach, and Philipp Ruf (2014). "Analysis and Assessment of Market Structure, Trading Activities and Further Developments in the EU ETS." Project No. (FKZ) 3713 41 504, last accessed January 18, 2016. https://www.dehst.de/SharedDocs/Downloads/EN/Auctioning/UFOPlan_Handelsaktivitaeten.pdf?__blob=publicationFile.

Zaklan, Aleksandar (2013). "Why Do Emitters Trade Carbon Permits? Firm-Level Evidence from the European Emission Trading Scheme." EUI Working Papers RSCAS 2013/19, last accessed October 09, 2017. http://cadmus.eui.eu/bitstream/handle/1814/26254/RSCAS_2013_19.pdf?sequence=1.

## APPENDIX A: LIST OF QUESTIONS USED IN SEMI-STRUCTURED INTERVIEWS

1. What was the bank's main strategy/main motivation in participating in the EU ETS?
2. What roles, in general, did banks play in the EU ETS market?
3. Did they play a special role with regard to Kyoto units?
4. Did they increase liquidity?
5. Did they increase volatility?
6. What were the roles of other players?
7. Did your bank open many accounts in different EU registries?
8. On which exchanges was your bank active?
9. Did the roles and participation of banks change over time?
10. What was the role of banks in the beginning and what is it today?

## APPENDIX B: CORRELATION TABLE OF INDEPENDENT VARIABLES

**Table 4 Correlation table of independent variables—All companies (n=4783)**

| | Traded | Short | Has PHA | Number of accounts | ln (maximum emissions) | ln (absolute position) |
|---|---|---|---|---|---|---|
| Traded | 1 | | | | | |
| Short | 0.18 | 1 | | | | |
| Has PHA | 0.15 | 0.01 | 1 | | | |
| Number of accounts | 0.12 | 0.00 | 0.46 | 1 | | |
| ln (maximum emissions) | 0.21 | –0.03 | 0.33 | 0.37 | 1 | |
| ln (absolute position) | 0.23 | –0.21 | 0.30 | 0.32 | 0.72 | 1 |
| Electricity | 0.07 | –0.01 | 0.13 | 0.12 | 0.16 | 0.19 |
| Other combustion | 0.01 | –0.04 | –0.02 | –0.04 | –0.09 | –0.05 |
| Refineries | 0.04 | 0.01 | 0.08 | 0.05 | 0.17 | 0.13 |
| Iron, steel | 0.01 | 0.02 | –0.01 | 0.00 | 0.11 | 0.07 |
| Cement | 0.00 | 0.01 | 0.01 | 0.03 | 0.19 | 0.11 |
| Glass | 0.02 | 0.00 | –0.01 | 0.00 | 0.04 | 0.02 |
| Ceramics | –0.07 | –0.02 | –0.07 | –0.05 | –0.20 | –0.19 |
| Paper | –0.02 | 0.08 | –0.03 | –0.02 | –0.04 | –0.05 |

Source: EUTL, own calculation

Table 4 shows the correlation among independent variables for all companies. It is noteworthy that having a PHA is correlated with being larger (in terms of emissions and number of accounts) and operating in the electricity, refineries, or cement sector. Furthermore, higher emissions are correlated with the *absolute* allocation position and the number of accounts held.

**Table 5: Correlation table of independent variables—Active companies (n=3002)**

| | Number of trades | Short | Has PHA | Number of accounts | ln (maximum emissions) | ln (absolute position) |
|---|---|---|---|---|---|---|
| Number of trades | 1 | | | | | |
| Short | 0.02 | 1 | | | | |
| Has PHA | 0.38 | –0.02 | 1 | | | |
| Number of accounts | 0.53 | –0.03 | 0.45 | 1 | | |
| ln (maximum emissions) | 0.27 | –0.11 | 0.36 | 0.40 | 1 | |
| ln (absolute position) | 0.24 | –0.38 | 0.32 | 0.34 | 0.75 | 1 |
| Electricity | 0.15 | –0.03 | 0.14 | 0.13 | 0.20 | 0.22 |
| Other combustion | –0.05 | –0.02 | –0.02 | –0.06 | –0.11 | –0.08 |
| Refineries | 0.06 | 0.01 | 0.08 | 0.04 | 0.19 | 0.14 |
| Iron, steel | –0.01 | 0.03 | –0.01 | 0.00 | 0.12 | 0.08 |
| Cement | 0.00 | –0.01 | 0.01 | 0.04 | 0.19 | 0.13 |
| Glass | –0.02 | –0.01 | –0.02 | 0.00 | 0.04 | 0.01 |
| Ceramics | –0.05 | 0.01 | –0.08 | –0.06 | –0.22 | –0.20 |
| Paper | –0.03 | 0.05 | –0.03 | –0.02 | –0.05 | –0.07 |

Source: EUTL, own calculation

Table 5 shows the correlation of independent variables for all companies trading in that period. In addition to the observations made for all companies (Table 4), it is shown that the number of trades is positively related to having a PHA and to the number of accounts a company owns.

## APPENDIX C: ORDINARY PROBIT REGRESSION

**Table 6: Regression results: Probit model without sample selection**

| | Sold to bank | Bought from bank | Sold to broker/trader | Bought from broker/trader | Sold to exchange | Bought from exchange |
|---|---|---|---|---|---|---|
| | | | Marginal effects | | | |
| Short | –0.13*** | 0.06*** | –0.35*** | 0.17*** | –0.07*** | 0.08*** |
| | (0.01) | (0.01) | (0.02) | (0.02) | (0.01) | (0.01) |
| ln (maximum emissions) | 0.04*** | 0.02*** | –0.0002 | 0.01** | 0.01*** | 0.01*** |
| | (0.004) | (0.002) | (0.01) | (0.004) | (0.002) | (0.002) |
| Number of accounts | 0.0017 | –0.00004 | 0.001 | 0.003** | –0.0005 | 0.000 |
| | (0.001) | (0.0004) | (0.001) | (0.001) | (0.0005) | (0.001) |
| Has PHA | 0.08*** | 0.04** | 0.09* | –0.02 | 0.08*** | 0.08*** |
| | (0.02) | (0.02) | (0.04) | (0.04) | (0.02) | (0.02) |
| Number of trades | 0.001** | 0.001** | 0.001** | 0.001*** | 0.001*** | 0.001*** |
| | (0.0004) | (0.0002) | (0.0004) | (0.0002) | (0.0002) | (0.0002) |
| Other combustion | 0.05*** | 0.02* | –0.001 | 0.02 | –0.04*** | –0.004 |
| | (0.02) | (0.01) | (0.03) | (0.03) | (0.01) | (0.02) |
| Refineries | –0.02 | 0.001 | –0.06 | –0.10 | –0.12*** | –0.02 |
| | (0.04) | (0.03) | (0.08) | (0.08) | (0.05) | (0.04) |
| Iron, steel | 0.03 | 0.03 | –0.02 | –0.05 | –0.08*** | –0.05 |
| | (0.03) | (0.02) | (0.06) | (0.05) | (0.03) | (0.04) |
| Cement | 0.05* | 0.02 | 0.09* | 0.10** | –0.03 | 0.00 |
| | (0.03) | (0.02) | (0.05) | (0.05) | (0.02) | (0.03) |
| Glass | 0.12*** | 0.06*** | –0.09* | –0.03 | –0.02 | 0.03 |
| | (0.03) | (0.02) | (0.05) | (0.04) | (0.02) | (0.03) |
| Ceramics | 0.01 | –0.01 | 0.11*** | 0.04 | 0.03 | 0.10*** |
| | (0.03) | (0.02) | (0.03) | (0.03) | (0.02) | (0.02) |
| Paper | 0.02 | –0.03 | –0.02 | 0.002 | –0.04** | 0.04** |
| | (0.03) | (0.02) | (0.04) | (0.03) | (0.02) | (0.02) |
| Observations | | | 3002 | | | |

Source: EUTL, own estimation
Note: Data for Jan 2005 to April 2008 from a 2011-12 data download. Marginal effects at means of independent variables shown. Robust standard errors in parentheses (***significant at the 99% level; ** significant at the 95% level; *significant at the 90% level)

## APPENDIX D: REGRESSION RESULTS: ESTIMATED COEFFICIENTS

**Table 7: Regression results: Probit model with sample selection—Estimated coefficients**

| | Sold to bank | Bought from bank | | Sold to broker/trader | Bought from broker/trader | Sold to exchange | Bought from exchange |
|---|---|---|---|---|---|---|---|
| Model | Heckprobit | Heckman twostep | Ordinary probit | Heckprob | Heckprob | Heckprob | Heckprob |
| Short | –0.86*** | 0.09*** | 0.56*** | –1.09*** | 0.68*** | –0.68*** | 0.64*** |
| | (0.08) | (0.01) | (0.08) | (0.08) | (0.05) | (0.10) | (0.09) |
| ln (maximum emissions) | 0.14*** | 0.03*** | 0.18*** | –0.05** | 0.07*** | 0.05* | 0.07*** |
| | (0.04) | (0.00) | (0.02) | (0.03) | (0.01) | (0.03) | (0.03) |
| Number of accounts | 0.002 | 0.001* | –0.0004 | –0.002 | 0.02*** | –0.005 | 0.002 |
| | (0.01) | (0.0007) | (0.004) | (0.004) | (0.01) | (0.004) | (0.004) |
| Voluntary trading account | 0.41*** | 0.17*** | 0.36** | 0.12 | –0.03 | 0.72*** | 0.65*** |
| | (0.13) | (0.02) | (0.15) | (0.14) | (0.14) | (0.15) | (0.16) |
| Number of trades | 0.005** | 0.0005*** | 0.005** | 0.003** | 0.003*** | 0.006*** | 0.005*** |
| | (0.002) | (0.0001) | (0.002) | (0.001) | (0.001) | (0.002) | (0.001) |
| Other combustion | 0.26*** | –0.01 | 0.21* | 0.02 | 0.06 | –0.32*** | –0.03 |
| | (0.10) | (0.02) | (0.11) | (0.08) | (0.08) | (0.11) | (0.13) |
| Refineries | –0.04 | –0.02 | 0.01 | –0.11 | –0.38 | –1.08*** | –0.18 |
| | (0.25) | (0.04) | (0.26) | (0.24) | (0.27) | (0.41) | (0.34) |
| Iron, steel | 0.23 | 0.00 | 0.28 | 0.03 | –0.24 | –0.65*** | –0.42 |
| | (0.18) | (0.03) | (0.21) | (0.16) | (0.16) | (0.25) | (0.29) |
| Cement | 0.44*** | –0.01 | 0.16 | 0.42*** | 0.16 | –0.24 | –0.01 |
| | (0.17) | (0.03) | (0.19) | (0.15) | (0.15) | (0.23) | (0.23) |
| Glass | 0.64*** | 0.04 | 0.52*** | –0.20 | –0.14 | –0.19 | 0.27 |
| | (0.15) | (0.03) | (0.18) | (0.15) | (0.15) | (0.20) | (0.20) |
| Ceramics | 0.15 | –0.03* | –0.07 | 0.35*** | 0.06 | 0.23* | 0.77*** |
| | (0.14) | (0.02) | (0.18) | (0.09) | (0.10) | (0.14) | (0.15) |
| Paper | 0.19 | –0.06*** | –0.28 | 0.05 | –0.07 | –0.37** | 0.34* |
| | (0.14) | (0.02) | (0.20) | (0.12) | (0.11) | (0.18) | (0.16) |
| Constant | –2.31*** | –0.28*** | –3.87*** | 0.61*** | –2.20*** | –1.73*** | –2.61*** |
| | (0.62) | (0.05) | (0.28) | (0.41) | –(0.17) | (0.42) | (0.43) |
| | | | | Selection equation | | | |
| ln (absolute position) | 0.17*** | 0.15*** | | 0.17*** | 0.15*** | 0.15*** | 0.15*** |
| | (0.02) | (0.01) | | (0.01) | (0.01) | (0.02) | (0.02) |
| Short | 0.75*** | 0.75*** | | 0.74*** | 0.74*** | 0.75*** | 0.75*** |
| | (0.05) | (0.05) | | (0.05) | (0.05) | (0.05) | (0.05) |
| ln (maximum emissions) | –0.02 | –0.01 | | –0.01 | –0.01 | –0.01 | –0.01 |
| | 0.02 | 0.02 | | 0.02 | 0.02 | 0.02 | 0.02 |
| Number of accounts | 0.16*** | 0.17*** | | 0.13*** | 0.17*** | 0.17*** | 0.17*** |
| | (0.03) | (0.02) | | (0.03) | (0.02) | (0.02) | (0.02) |
| Other combustion | –0.08 | –0.09 | | –0.08 | –0.10 | –0.09 | –0.09 |
| | (0.07) | (0.07) | | (0.07) | (0.07) | (0.07) | (0.07) |
| Refineries | –0.15 | –0.09 | | –0.09 | –0.09 | –0.09 | –0.09 |
| | (0.25) | (0.23) | | (0.25) | (0.26) | (0.26) | (0.26) |
| Iron, steel | –0.17 | –0.18 | | –0.20 | –0.16 | –0.18 | –0.18 |
| | (0.13) | (0.14) | | (0.13) | (0.13) | (0.13) | (0.13) |
| Cement | –0.43*** | –0.44*** | | –0.40*** | –0.47*** | –0.43*** | –0.44*** |
| | (0.13) | (0.13) | | (0.13) | (0.13) | (0.13) | (0.13) |
| Glass | –0.04 | –0.05 | | –0.03 | –0.05 | –0.05 | –0.05 |
| | (0.12) | (0.12) | | (0.12) | (0.12) | (0.12) | (0.12) |
| Ceramics | –0.14 | –0.15* | | –0.14* | –0.15* | –0.15* | –0.15* |
| | (0.08) | (0.08) | | (0.08) | (0.08) | (0.08) | (0.08) |
| Paper | –0.25*** | –0.27*** | | –0.25*** | –0.27*** | –0.27*** | –0.27*** |
| | (0.09) | (0.09) | | (0.09) | (0.09) | (0.09) | (0.09) |
| Constant | –1.43*** | –1.40*** | | –1.48*** | –1.40*** | –1.40*** | –1.40*** |
| | (0.16) | (0.15) | | (0.16) | (0.15) | (0.16) | (0.16) |
| rho | –0.61*** | 0.27** | | –0.68* | 0.86*** | –0.12 | –0.01 |
| p-value LR test | 0.00 | 0.07 | | 0.06 | 0.00 | 0.56 | 0.98 |
| Observations (censored/ uncensored) | | | | 3002 / 4783 | | | |

Source: EUTL, own estimation

Note: Data for Jan 2005 to April 2008 from a 2011–12 data download. Robust standard errors in parentheses (***significant at the 99% level; ** significant at the 95% level; *significant at the 90% level); non-robust standard errors for Heckman two-step selection model

**Table 8: Regression results: Probit model without sample selection—Estimated coefficients**

| | Sold to bank | Bought from bank | Sold to broker/trader | Bought from broker/trader | Sold to exchange | Bought from exchange |
|---|---|---|---|---|---|---|
| Short | –0.78*** | 0.56*** | –1.06*** | 0.59*** | –0.66*** | 0.64*** |
| | (0.09) | (0.08) | (0.06) | (0.05) | (0.09) | (0.07) |
| ln (maximum emissions) | 0.21*** | 0.18*** | –0.001 | 0.04** | 0.06*** | 0.07*** |
| | (0.03) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Number of accounts | 0.010 | –0.0004 | 0.003 | 0.01** | –0.004 | 0.002 |
| | (0.01) | (0.004) | (0.003) | (0.00) | (0.004) | (0.004) |
| Has PHA | 0.51*** | 0.36** | 0.26* | –0.09 | 0.74*** | 0.65*** |
| | (0.14) | (0.15) | (0.14) | (0.14) | (0.14) | (0.15) |
| Number of trades | 0.005** | 0.005** | 0.002** | 0.003*** | 0.006*** | 0.005*** |
| | (0.002) | (0.002) | (0.001) | (0.001) | (0.002) | (0.001) |
| Other combustion | 0.29*** | 0.21* | –0.003 | 0.08 | –0.32*** | –0.03 |
| | (0.11) | (0.11) | (0.08) | (0.09) | (0.11) | (0.13) |
| Refineries | –0.10 | 0.01 | –0.19 | –0.35 | –1.09*** | –0.18 |
| | (0.25) | (0.26) | (0.25) | (0.28) | (0.41) | (0.34) |
| Iron, steel | 0.19 | 0.28 | –0.05 | –0.20 | –0.66*** | –0.42 |
| | (0.20) | (0.21) | (0.17) | (0.18) | (0.25) | (0.29) |
| Cement | 0.33* | 0.16 | 0.28* | 0.34** | –0.26 | –0.01 |
| | (0.18) | (0.19) | (0.16) | (0.16) | (0.22) | (0.22) |
| Glass | 0.70*** | 0.52*** | –0.29* | –0.12 | –0.19 | 0.27 |
| | (0.16) | (0.18) | (0.16) | (0.16) | (0.20) | (0.20) |
| Ceramics | 0.09 | –0.07 | 0.32*** | 0.14 | 0.22 | 0.76*** |
| | (0.15) | (0.18) | (0.10) | (0.11) | (0.14) | (0.14) |
| Paper | 0.13 | –0.28 | –0.07 | 0.01 | –0.39** | 0.34** |
| | (0.15) | (0.20) | (0.12) | (0.12) | (0.18) | (0.15) |
| Constant | –3.61*** | –3.87*** | –0.34* | –1.55*** | –1.90*** | –2.62*** |
| | (0.31) | (0.28) | (0.18) | (0.19) | (0.27) | (0.26) |
| Observations | | | 3002 | | | |

Source: EUTL, own estimation

Note: Data for Jan 2005 to April 2008 from a 2011–12 data download. Robust standard errors in parentheses (***significant at the 99% level; ** significant at the 95% level; *significant at the 90% level)

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The IAEE is pleased to announce that our leading publications exhibited strong performances in the latest 2018 Impact Factors as reported by Clarivate. The Energy Journal achieved an Impact Factor of 2.456 while Economics of Energy & Environmental Policy saw an increase to 2.034.

Both publications have earned SCIMago Journal Ratings in the top quartile for Economics and Econometrics publications.

IAEE wishes to congratulate and thank all those involved including authors, editors, peer-reviewers, the editorial boards of both publications, and to you, our readers and researchers, for your invaluable contributions in making 2018 a strong year. We count on your continued support and future submission of papers to these leading publications.