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Winners and Losers of EU Emissions Trading
Insights from the EUTL Transfer Dataset

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ABSTRACT

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Abstract: This paper analyzes distributional effects the EU Emissions Trading Scheme (EU ETS) created between participants of the scheme during its first trading period. To this end, a dataset recording all transfers during the first period of the EU ETS, originally at account level, was enhanced by adding information about parent companies, firm characteristics, and carbon prices. A two-step selection model was formulated and applied to the data. To account for a number of uncertainties, sensitivity analysis with regard to forward and futures trading was carried out. Findings confirm that free allocation in excess of actual emissions (‹overallocation›) is a major source of gain generated under the Scheme. The fact that small companies are much less likely to participate in trading is a further cause of distributional effects. This paper also discusses that windfall profits obtained by passing through the cost of freely allocated allowances to consumers are likely to dwarf the gains and losses made on the market for EU Allowances. It is therefore quite likely that the majority of companies covered by the EU ETS generated gains during its first period, either through selling overallocation on the market or by generating windfall profits on product markets. Therefore, decisions about the level of free allocation not only have distributional implications for the participants of an emissions trading scheme but determine the distribution of costs and benefits between covered companies and households.

Keywords: Emissions trading scheme, EU ETS, EUTL transfer data, distributional effects, free allocation, two-step selection model

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1 INTRODUCTION

The rationale behind emissions trading rests on the principle that through making emissions certificates tradable, reductions will occur wherever it is cheapest to do so in the economy (Baumol and Oates 1988; Tietenberg 1985). However, after some years of experience with the instrument, questions emerged as to whether or not this assumption holds, especially in the context of transaction costs (Heindl 2012; Schleich and Betz 2004) or market power (Antelo and Bru 2009; Hintermann 2010). In this paper, I analyze another dimension of emissions trading, namely its distributional effects, and ask the question: Who were the winners and losers of EU Emissions Trading (EU ETS) during its first period? There exist different ways in which a company can become a 'winner' under the EU ETS. First, all companies that were allocated allowances in excess of their emissions, could sell off these allowances and realize a profit on the permit market.[1] Second, companies can speculate on the market. Speculation can be carried out both on the spot market for allowances and on forward and futures markets. Third, firms also have the possibility to pass carbon costs on to consumers. Depending on the level of cost pass-through and the actual carbon costs a firm faced (being contingent upon the level of free allocation amongst other things); this may constitute a windfall profit to firms.[2] Fourth, financial service companies, for example, can offer (costly) brokerage and management services to companies liable under the scheme or other companies that wish to participate in the market.

In this paper, emission allowance transfer data published on the European Transaction Log (EUTL) is employed, which can be used to investigate the gains made on the market for EU Emission Allowances (EUAs). Since only physical transfer data is available, derivatives trading can only partly be taken into account (i.e., at the point of delivery). Therefore, the first type of gain, which is derived from selling overallocation, is covered to a large extent, while some speculative gains may also be covered. Neither the profits from cost pass-through nor those from fees for brokerage or management services can be accounted for.

In order to calculate gains from trading, the transfer dataset has to be linked with price data. Four different approaches of combining the transfer data with carbon prices are compared, taking into account the difficulties posed in having to distinguish spot- and forward- or futures trading. The contribution of this paper to the existing literature is therefore twofold: i) I contribute to the literature on profits from emissions trading by employing a new dataset, namely the transaction data from the EUTL to verify and enhance the insights gained by researchers looking at compliance data (e.g. Sandbag 2011), ii) I link the transaction dataset to carbon prices, compare different approaches of doing so, and discuss challenges and possibilities of accounting for forward or futures trades within the analysis.

Using a two-step selection model, I find that whether a company made a gain from EU Emissions Trading in the first period is highly dependent the level of overallocation it received. I also confirm the previous finding that large emitters behave very differently from small emitters covered by the Scheme (Jaraite and Kazukauskas 2012; KfW/ZEW 2009; Martino and Trotignon 2013; Zaklan 2013). As large emitters are significantly more likely to engage in trading, they are also more likely to make gains from trading. Consequently, large industrial companies, especially in the iron and steel and cement sectors emerge as the biggest ‹winners› as they were the companies with the highest overallocation. This also applies to electricity generators located in Eastern Europe. Due to the inability to assess activity and potential gains and losses on forward and futures markets, results for large utilities and energy companies have to be interpreted carefully and are, indeed, quite sensitive to the way in which forward and futures trading is accounted for.

[1] Overallocation is, in this paper, interpreted as the difference between allowances allocated for free and verified emissions. Therefore, potential (costly) emissions reductions are not taken into account. It is a point of discussion whether emissions abatement took place during the first period of the EU ETS. While some researchers have calculated substantial abatement (Anderson and Di Maria 2011; Ellerman and Buchner 2008), others find that in its first period, the EU ETS did not provide incentives for emissions abatement (Kettner et al. 2008; KfW/ZEW 2009). Branger and Quirion (2015) point out that emissions reductions in the European cement industry until 2012 where only to a very limited extent due to technological advances as a result of the EU ETS, while most of them can be attributed to reduction in production, which in turn led to ‹overallocation profits› to the European cement industry of € 3.5 billion between 2005 and 2012.

[2] Windfall gains can describe any type of unforeseen financial gain. In the context of this paper the term is used to describe the gains arising from cost pass-through over and above actual carbon costs to a firm.

The literature review on cost pass-through of freely allocated permits, as presented in Section 5, shows that the gains and losses estimated in this paper are dwarfed when compared to windfall profits on product markets as estimated in other studies. This holds in particular for utilities, which are found to be the biggest ‹losers› on the spot market for emission permits, but are estimated to have made up for these costs many times over through windfall profits on product markets.

The remainder of this paper is structured as follows. Section 2 illustrates the data used in the analysis and some illustrative descriptive analysis. Section 3 presents the estimation method used in order to determine the influence various firm characteristics and behavior had on their level of gains and losses. Regression results are presented in Section 4 and discussed in Section 5, with a special focus on the comparison between the gains estimated in this paper and windfall profits from cost pass-through of freely allocated allowances, as estimated elsewhere in the literature. Section 6 contains policy implications derived from the previous sections and a conclusion.

2 DATA

The European Union Transaction Log (EUTL) is an electronic database managed by the European Commission that records all transactions of EU Allowances (EUAs) and international credits carried out under the EU ETS, including the allocation and surrender of allowances but also all trades taking place between market participants. Due to a delay in the publication of data (previously five years, now three) and the substantial work involved in cleaning up and augmenting the dataset (see also Jaraite et al. 2013), the data used in this paper covers the whole first trading period (January 2005 – April 2008). April 2008 has been chosen as an endpoint as companies have to submit allowances required for the previous year by the end of April of the following year.

The EUTL contains additional information on account holders that are party to a specific transaction. Besides government accounts, there are two different account types: Operator Holding Accounts (OHAs) for installations covered by the EU ETS, and Person Holding Accounts (PHAs). The latter are opened voluntarily by large, regulated firms as special trading accounts (in addition to their OHAs) or by non-regulated firms, mainly in the financial sector. These individual accounts were matched to the respective parent companies for the purposes of this analysis, drawing on information provided by the European University Institute (Jaraite et al. 2013), which links OHAs and PHAs via their IDs to IDs in the company database ORBIS and their ‹Global Ultimate Owner› (GUO). Their aggregation effort is augmented by additional desktop research specifically focusing on financial actors.[3]

In the following, ‹gains› are understood to mean the difference between the volume of permits sold ($sell_t$) - valued at the permit price ($price_t$), minus the volume of permits bought (buy_t) - also valued at permit prices. Only transfers expected to involve the transfer of money are taken into account. In other words, this does not apply to transactions involving government accounts or to transactions between two accounts of the same parent company.

$$\sum_t sell_t \cdot price_t - \sum_t buy_t \cdot price_t$$

It is necessary to determine the price ($price_t$) of a trade carried out at a certain point in time, since the EUTL does not contain any information about the prices at which a trade was carried out. This adding of prices to the data is made particularly difficult by the fact that a substantial number of trades is carried out on the forward and futures markets (Cludius 2016), and that one can only observe the delivery of allowances from a forward or future trade in the EUTL transfer dataset. In order to account for these challenges, EUA prices are matched to the data following a three-tiered approach:

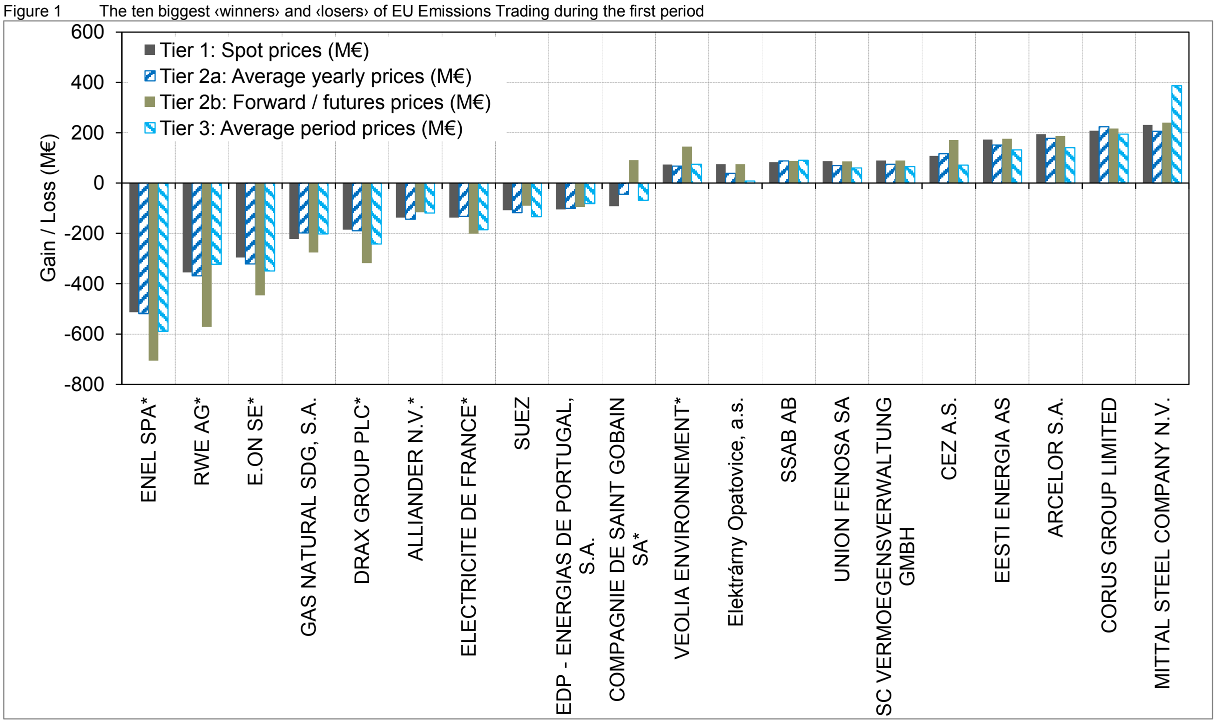
– Tier 1: ‹Daily prices›: Valuation of all trades at spot market prices. This is the simplest and most straightforward calculation. It gives an indication of the value of permits at the time of delivery. Such method cor-

[3] Also see Cludius (2015) for an in-depth description of the different datasets used in the analysis and the cleaning and modification procedures applied to them.

rectly evaluates all spot trades carried out at exchange prices, but probably assigns the wrong price to forward and futures trades, which may have been traded a long time before their delivery date.

– Tier 2a: ‹Average yearly prices›: Valuation of trades at the average CO_2 price in the relevant year. This method assumes that permits delivered in this year are most likely to have been sold or bought in the same year (Zaklan 2013). If this assumption holds, this method should give a close approximation of the average gains made. However, some information on the timing of transactions is lost.[4]
– Tier 2b: ‹Mixed prices›: Use of a mix of spot and average prices. For those days where most forward and future contracts were delivered, usually five to six days in November and December each year,[5] the average EUA price from the start of the trading period up to December of the relevant year is used, that is from January 2005 to December 2005 (19.13 €/t), December 2006 (17.74 €/t), and December 2007 (12.05 €/t). This method takes into account that these forward or future deliveries may have been made at any point in time during the whole first trading period. For trades on remaining days, spot prices are used. Such method approximates the average value of forwards and futures, but does not correctly evaluate spot trades on these days. Furthermore, if some transactions during the year are also forward or futures deliveries, those are incorrectly evaluated at spot prices.
– Tier 3: ‹Average period price›: Valuation of all market inter-company transfers at the average price of the whole first trading period, which is equal to an analysis of net trading volumes (covering spot market trades and the delivery of forwards and futures). This method avoids the problem of identifying forward and futures deliveries, but fails to acknowledge that it makes a difference at which point in time a transfer is carried out.[6]

Figure 1 The ten biggest ‹winners› and ‹losers› of EU Emissions Trading during the first period



Sources: EUTL; Point Carbon; own estimation and illustration

4 Due to the compliance cycle, average prices and traded quantities are defined on the basis of an ‘EU ETS year’, running until 30 April each year.

5 30/11-01/12/05; 19-21/12/05; 30/11-01/12/06; 18-21/12/06; 30/11/07; 03/12/07; 17-19/12/07 (Cludius 2016).

6 In this context, Martino and Trotignon (2013) find that a small number of short installations even borrowed large volumes of EUAs from later years in the first and second year of trading and likely sold these allowances at high prices before buying them back at lower prices at later stages of the Scheme. This confirms the findings of Trotignon and Delbosc (2008), who observed this behaviour mainly for German installations.

Applying these price series to the trading volumes observed on the EUTL allows us to generate different approximations of gains and losses made by companies from EU Emissions Trading, the ten biggest of which are illustrated in Figure 1. While the large utilities emerge as the biggest ‹losers›, companies in the iron, steel and cement sectors as well as utilities located in Eastern Europe emerge as the biggest ‹winners›. It can further be noted that results are most sensitive to the choice of price series for the utilities. In general, gains of companies expected to have sold forwards or futures (i.e., industrial companies) are higher using averaged prices, while gains for those companies expected to have bought those contracts (i.e., utilities due to being underallocated and because of their practice of hedging power forward sales) are lower. All companies that show especially high transaction volumes on those days when forwards and futures are typically delivered are marked with an asterisk.

While Figure 1 only shows the ten largest ‹winners and losers›, the regression analysis takes into account the full set of companies liable under the EU ETS. This is important, since previous analyses have hinted at the fact that small companies (both in terms of emissions and/or employees) have been considerably less likely to engage in the EU ETS market (Jaraite and Kazukauskas 2012; KfW/ZEW 2009). Furthermore, by accounting for the choice of a company to engage in trading or not in the regression model, it is possible to estimate the determinants for potential gains and losses for the whole set of companies liable under the scheme, rather than only for the ones that did engage in trading.

Table 1 presents summary statistics of the variables used in the regression analysis. Some variables are available for all 4,559 companies in the sample, while others (including the gains from trading) are only available for the 2,955 companies which actually traded. Companies that had the majority of their emissions in either Bulgaria or Romania are excluded from the analysis. These two countries only entered the EU ETS in 2007, and companies situated in Bulgaria or Romania were therefore faced with a decision that was fundamentally different from companies in other states, since they only participated in the last year of the first trading period. The indicator variable ‹trade› indicates that only 65% of companies engaged in trading. The number of accounts belonging to one company ranges from 1 to 216, with a large fraction of companies only featuring one account.[7] Only 4% of the companies under investigation had opened a (voluntary) Person Holding Account (PHA) in addition to their Operator Holding Account (OHA).

Table 1 Summary statistics of variables used in regression analysis

	Obs.	Mean	Min	P5	P10	P25	Median	P75	P90	P95	Max
Trade	4,559	0.65									
Number of accounts	4,559	2	1	1	1	1	1	2	4	7	216
Has PHA	4,559	0.04									
Short	4,559	0.26									
Position (Mt)	4,559	0.03	-60.96	-0.03	-0.01	-0.0002	0.01	0.03	0.15	0.33	41.90
Small	4,559	0.58									
Medium	4,559	0.24									
Large	4,559	0.13									
Very large	4,559	0.05									
Electricity	4,559	0.10									
Gains											
Tier 1: Spot prices (M€)	2,955	0.25	-512.89	-0.20	-0.05	-0.0005	0.02	0.33	1.61	3.86	231.44
Tier 2a: Avg. yearly prices (M€)	2,955	0.19	-518.28	-0.29	-0.08	-0.001	0.03	0.31	1.48	3.66	224.35
Tier 2b: Forw. / fut. prices (M€)	2,955	0.14	-705.71	-0.23	-0.06	-0.0005	0.02	0.36	1.81	4.53	240.43
Tier 3: Avg. period prices (M€)	2,955	0.16	-589.41	-0.51	-0.15	-0.03	0.05	0.34	1.60	4.23	387.63
First	2,955	0.40									
Second	2,955	0.36									
Third	2,955	0.24									
Number of trades	2,955	13	1	1	1	1	2	5	13	27	2,986
Via intermediary	2,955	0.60									

Sources: EUTL; Point Carbon; own estimation

The variable ‹position› represents the difference between the sum of allowances allocated and the sum of verified emissions during the first trading period. Therefore, it indicates whether the company had to buy additional allow-

7 This points to significant differences in the make-up of companies under the EU ETS. There are companies with one or only a few installations and very high emissions (in the electricity sector) and others with a large number of installations and low overall emissions (e.g., in the ceramics or glass sectors). The large number of companies with only one installation may also indicate that the aggregation to parent companies is not 100% complete.

ances on the market or whether it could sell excess allowances (i.e., whether it was ‹short› or ‹long›).[8] About one quarter of the companies investigated were short on allowances, while the remainder was long (in fact, seven companies received the exact amount of allowances they needed to cover their verified emissions). The allocation position varies considerably and ranges from -61 Mt to 42 Mt.

Companies were divided into size groups for the purpose of this analysis. In order to create the size categories, maximum emissions were used, as they give a better indication of actual capacity than average emissions. 58% of the companies belong to the small category (<25,000 t / year), 24% to the medium category (25,000 - 100,000 t / year), 13% to the large category (100,000 - 1,000,000 t / year), and 5% to the very large category (≥1,000,000 t / year).[9]

The electricity sector dummy shows that 10% of the companies under investigation have most of their emissions (again, maximum emissions were used) in installations that fall under this category. All installations with a NACE Rev2 code beginning with 35.1 were assigned to the electricity sector.[10] The companies of this category were jointly responsible for 60% of verified emissions - highlighting the important role of electricity generation under the EU ETS.

A number of variables are only available for those companies that engaged in market transfers during the first period of the EU ETS. The average gain (when evaluated at daily spot prices) amounts to € 250,000.[11] However, the median is only € 20,000, with gains ranging from € -513 million to € 231 million. Gains evaluated at average yearly or period prices – as well as at the mix of spot and average prices – lie in the same range, but vary significantly by company (as shown above). The dummies ‹first›, ‹second› and ‹third› represent the year of the first trading period in which the company at hand conducted its first inter-company market trade: 40% did so during the first compliance year (January 2005 - April 2006), 36% during the second year (May 2006 - April 2007) and 24% during the third year (May 2007 - April 2008). Differentiating between the time of entry takes account of the large fluctuations in price observed during the first trading period.

The number of trades of a company equaled 13, on average. However, the median is only 2, as the number of trades ranges from 1 to 2,986 (carried out by SUEZ).[12] KfW/ZEW (2009) also note that only 13% of German companies included in their survey traded more than once a year. In conjunction with the summary statistics, this may be an indication that - at least during the first period of the EU ETS – trading activities by most companies were related to pure ‹compliance trading› and that speculation on the market for EUAs only played a role for a small subset of companies or took place on forward and futures markets that cannot be observed here. (cf. KfW/ZEW (2013) who note that internal regulations prevent some companies from speculating on the market for EUAs).

A dummy variable that indicates whether a company traded via intermediaries (i.e., conducted at least one trade involving an exchange, a bank, or a broker) indicates that 60% of the companies did so. This finding corresponds to the observation made by Jaraite and Kazukauskas (2012) that: «Anecdotal evidence collected at the interviews of Irish ETS firms shows that brokers were very active in convincing over-allocated ETS firms to sell surplus allowances» (p.11 et seq.). Overall, the percentiles displayed in Table 1 highlight the fact that the regression sample consists of few very emissions-intensive, active companies, and many small ones. Finally, country dummies are included in the regression in order to account for the fact that there were differences between countries with

[8] As noted above, companies may be ‹long› because they were allocated a large amount of allowances or because they reduced their emissions by freeing up allowances that would otherwise have to be used to cover their emissions. Whether emissions abatement took place during the first period of the EU ETS is a point of contention. More recent studies estimate that the effect of the EU ETS on emission reductions was limited (see Section 1).

[9] Where no verified emissions were available for a company, the allocation in 2007 was used (this applies to 57 companies, 44 of which were small and 13 medium-sized).

[10] http://ec.europa.eu/clima/policies/ets/cap/leakage/docs/installation_nace_rev2_matching_en.xls.

[11] If all companies were included in this analysis, this number would be 0. However, companies predominantly situated in Bulgaria and Romania were excluded.

[12] Gas de France (GDF) and SUEZ were two separate companies during the first trading period; they merged in 2008.

regard to when registries and therefore trading became available (Trotignon and Ellermann 2008). Again, maximum emissions were used to define the size categories.[13]

[13] Due to the small number of companies active in Cyprus and Malta, these two countries are grouped together for the purpose of regression analysis.

3 ESTIMATION METHOD

While the previous section focuses on *actual / observed* gains and losses of the subset of companies that engaged in trading, regression analysis can be employed to find the determinants of the *potential* gains and losses of the whole set of companies liable under the scheme. For this reason, I propose to model the potential gains from EUA trading as a two-step process. In this set-up, a company liable under the EU ETS faces two consecutive and conditional decisions. First, it decides whether or not to engage in trading, and in a second step it determines how high its gains or losses from trading are, based on decisions made when trading. In this context, y_1^* represents the propensity to trade, which can be interpreted as the balance between expected gains and expected risk related to trading with y_2^* representing the potential gain made from trading.

$$y_1^* = x_1'\beta_1 + u_1$$

$$y_2^* = x_2'\beta_2 + u_2$$

In the above equations, y_1 indicates whether a company traded or not during the first period, and y_2 represents the level of actual losses or gains, which is observed only for companies that traded. In other words, in this model setup, y_2 can only be observed if $y_1^* > 0$, that is if the expected gains warrant the entry into the market of the respective firm.

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

$$y_2 = \begin{cases} y_2^* \; if \; y_1^* > 0 \\ not \; observed \; if \; y_1^* \leq 0 \end{cases}$$

$$\mathrm{Cov}(u_1, u_2) = \rho$$

If unobserved characteristics exist which are correlated with both variables that influence the decision to trade and variables that determine the level of gains (or losses), estimating them separately would lead to omitted variable bias. Only if the errors are uncorrelated and $\rho = 0$ would it be correct to estimate the equation for y_2 separately. Since it is likely that companies are not randomly selected as trading or not trading and, in particular, that unobserved variables affecting this (self-)selection also have a significant effect on the companies' gains and losses from emissions trading, a correlation in the errors of the separate estimations needs to be taken into account.

An example of such unobserved variables that would be connected with both the decision to enter the market and the level of potential gains is the ability of a company to assess its own and aggregate future emissions more accurately than other market participants, which is more likely to lower the risk associated with trading and therefore to increase the propensity to trade. Considering that it was most lucrative for a company to sell its surplus allowances at the start of the trading period when prices were still high and certainty about (aggregate) future emissions at its lowest, this ability might also play a role in determining gains and losses.

Heckman (1979) proposed a way of dealing with the sample selection problem in this kind of application. The solution involves formulating the conditional expectation of the gains or losses achieved by a company, which depends on the independent variables x, but also on the selection process: $E(y_2|x, y_1^* > 0)$. One alternative to this formal two-step procedure (‹limited information, maximum likelihood›) is the full information maximum likelihood (FIML) method, which is generally more efficient than the two-step procedure (Puhani 2000).

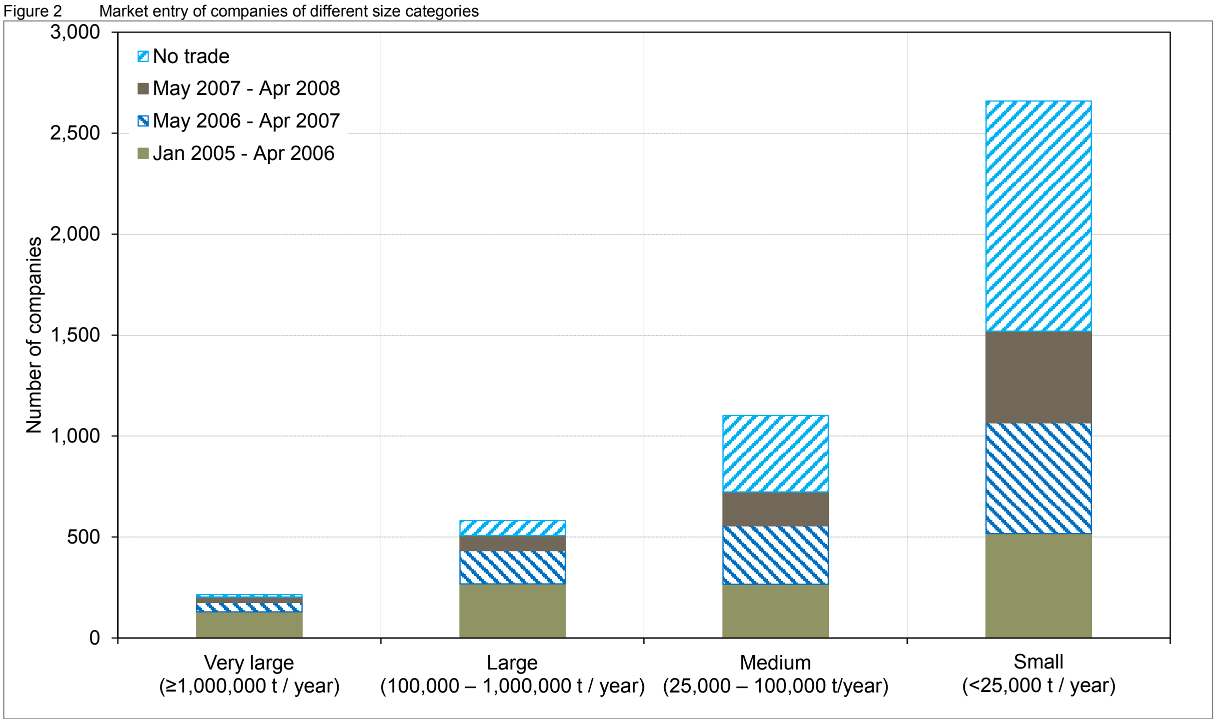
A number of researchers have noted the need to account for potential selection bias due to the fact that some companies do not engage in trading at all. Zaklan (2013) modeled the decision to engage in trading, and the ensuing decision of how many permits to trade, as a Heckman two-stage selection problem. Jaraite and Kazukauskas (2012), on the other hand, interpreted a decision to trade 0 permits as an optimal decision that is taken simultaneously along with the quantity decisions and therefore created a corner solution model estimated via a double-hurdle model, which they considered as more appropriate. In this case, however, I do not expect a gain or loss of 0 to be an active choice of some of the companies but rather the result of a choice to not engage with the market for emission permits because the potential gain does not warrant incurring the expected risks associated with trading.

In general, the same regressors can be included in both the participation and the outcome equation. However, if this is the case, identification relies on the nonlinear functional form of the selection equation, and the specification may therefore be fragile. Exclusion restrictions, that is variables that determine the decision of whether or not to trade, rather than the gains of a company, may therefore be desirable (Puhani 2000). The number of accounts a company owns seems to represent a potential candidate for an exclusion restriction. This variable may play a role that is twofold. On the one hand, the more accounts, the smaller the transaction costs to engage in trading, as a higher number of accounts may signify higher in-house trading capacity and lower search costs (Jaraite and Kazukauskas 2012). On the other hand, a larger number of installations may increase the possibility to abate and shift allowances internally, thus reducing the need to engage in inter-company market transfers of emissions (Zaklan 2013).

In order to include the number of accounts as an exclusion restriction, it is assumed that it does not influence the gains of a firm. Since the number of accounts owned does not necessarily reveal a great deal about total emissions, the level of overallocation, the sector a company belongs to, or indeed the ability to forecast emissions, this assumption seems justified. As an example, there are companies with only one very large installation (e.g., the electricity generator DRAX GROUP PLC with maximum annual emissions of 22.8 Mt) and companies with a lot of smaller installations (e.g., the ceramics producer WIENERBERGER AG with 131 installations and one PHA account and maximum annual emissions of 2.2 Mt).

Finally, a selection model may struggle to deliver meaningful results, especially with regard to the selection process, if a well-defined group that is highly likely to self-select is included in the model. As the group of ‘very large’ companies is highly likely to select into trading (Figure 2) and only 5.5% of this group did not engage in trading, the selection model was run without the ‹very large› companies. However, running an OLS regression for the group of ‹very large› companies individually revealed that the relationship between overallocation and gains for companies engaging in (i.e., 94.5%) is very similar to the rest of the sample in terms of the significance, direction, and magnitude of the estimated coefficients.[14]

Figure 2 Market entry of companies of different size categories



Source: EUTL; own estimation and illustration

[14] See Table 4 in the Appendix.

4 REGRESSION RESULTS

The results of the regression analysis are displayed in Table 2. The fact that ρ is significant and positive for three of the four regressions that have been run points to a positive correlation between the residuals of the two equations, indicating that the unobserved variables influence both outcome variables in a similar way. Coming back to the example of ability to predict future emissions, this could imply that such companies are both more likely to self-select into trading and to achieve higher potential gains. This appears to contradict the result reported by Zaklan (2013), who found no evidence of selection bias. However, he used a smaller sample of companies and estimated regressions for 2005 and 2006 separately.[15]

The results of the ‹position› variable - and its interaction with when a company entered the market - imply significant and large effects no matter which price series is used.[16] The regressions using daily spot prices, yearly average prices, or the price series approximating forwards and futures all show similar results and indicate that a company that started trading already during the first year faced a potential gain (loss), of, on average, € 7.3 – 8.5 per ton of overallocation (underallocation). For a company that entered in the second year, coefficients are reduced to € 2.5 – 3.2 per ton. In the regression using yearly average prices, the difference between companies entering in the first, second, and third years is eroded and all companies are expected to gain (lose) € 7.6 per ton of overallocation (underallocation) on average, which is fairly close to the average period price of 11 €/tCO_2. Coefficients on the size dummies indicate that medium-sized and large companies achieved significantly higher potential gains, on average, than small companies.

Results also indicate that companies that were short (i.e., underallocated) and companies in the electricity sector could, on average, expect higher gains than companies that were long (i.e., overallocated) or belonged to the industrial sector. The fact that the ‹electricity› dummy is no longer significant if the approximation of forward and futures prices is used (Tier 2b) indicates that this price series may most accurately reflect real-world conditions, as it would have been electricity companies that bought a large quantity of forwards or futures. The dummy on whether or not a company had a PHA is significant in two specifications, indicating the companies with a PHA made, on average, lower potential gains. However, results on this variable are inconclusive. The same applies to the number of trades.

To sum up, the level of overallocation and the point in time at which companies chose to enter the market seem to have been major determinants of how gains and losses were distributed amongst companies. There is a second distributional dimension connected to the fact, however, that companies that stood to generate relatively high gains still self-selected into not trading as the potential gains were perceived to be too small to cover the risk / the transaction costs associated with trading. The selection equation shows that medium-sized and large companies are significantly more likely to engage in trading than small companies. While small companies that traded achieved gains that were similar – in relative terms - to those of larger companies, there were a large number of small companies that never entered the market and therefore never capitalized on their surplus. In fact, the data reveals that 1,444 overallocated companies with a collective overallocation of 33 Mt never traded.

As noted above, a prerequisite for engaging in trading and then to make the right trading decisions is the ability to forecast emission developments (at least to some extent), which has been attributed to larger companies (KfW/ZEW 2009). Moreover, an effective mechanism for managing carbon liability (Engels 2009), as well as an understanding of commodity markets, and a certain level of trading experience are needed. Such services may have been provided to small companies that decided to trade through brokers who reportedly approached small companies, thus likely lowering the perceived risk associated with trading. In fact, the data reveals that many small companies dealt exclusively with one or two brokers. On the other hand, there were also many small companies that remained passive.

15 Including the number of accounts in the OLS regressions run in Table 3 in the Appendix, reveals that they are insignificant at any common level for three out of the four price series (the exception is Tier 1: Daily prices).

16 These effects add up if the coefficient is significant at least at the 95% level.

Table 2 Heckman selection model regression results

	Tier 1: Spot prices	Tier 2a: Average yearly prices	Tier 2b: Forward / futures prices	Tier 3: Average period prices
Short	0.30	0.41***	0.51**	0.53***
	(0.21)	(0.10)	(0.25)	(0.13)
Position	-0.08	0.19	0.33	7.62***
	(0.38)	(0.26)	(0.36)	(1.01)
PosXFirst	8.05***	8.46***	7.32***	0.45
	(1.41)	(0.75)	(1.38)	(1.20)
PosXSecond	2.55***	3.15***	2.52***	-0.72
	(0.62)	(0.48)	(0.63)	(1.22)
First	0.23***	0.11*	0.01	-0.06
	(0.09)	(0.06)	(0.08)	(0.06)
Second	0.05	0.06**	-0.02	-0.004
	(0.03)	(0.02)	(0.03)	(0.03)
Medium	0.21	0.21**	0.47**	0.19
	(0.17)	(0.09)	(0.22)	(0.12)
Large	0.94**	0.88***	0.74*	0.57**
	(0.39)	(0.22)	(0.43)	(0.23)
Electricity	0.37**	0.34***	-0.01	0.13*
	(0.15)	(0.12)	(0.26)	(0.07)
Number of trades	-0.02***	-0.02***	0.03***	-0.003
	(0.005)	(0.003)	(0.01)	(0.005)
Has PHA	-0.95***	-0.68**	-0.53	-0.29
	(0.37)	(0.32)	(0.60)	(0.32)
Via intermediary	0.06	0.05	-0.01	0.06**
	(0.05)	(0.04)	(0.05)	(0.03)
Constant	-0.69	-0.80***	-1.16**	-0.94***
	(0.43)	(0.19)	(0.51)	(0.25)
Country dummies	X	X	X	X
	Selection equation			
Number of accounts	0.14***	0.14***	0.14***	0.18***
	(0.03)	(0.03)	(0.03)	(0.05)
Short	0.87***	0.82***	0.83***	0.82***
	(0.10)	(0.09)	(0.10)	(0.09)
Medium	0.31***	0.30***	0.30***	0.29***
	(0.05)	(0.05)	(0.05)	(0.05)
Large	0.95***	1.04***	1.01***	0.94***
	(0.19)	(0.14)	(0.11)	(0.13)
Electricity	0.11	0.13	0.14*	0.09
	(0.09)	(0.08)	(0.08)	(0.08)
Constant	-0.09*	-0.12	-0.12	-0.19**
	(0.08)	(0.08)	(0.08)	(0.09)
Country dummies	X	X	X	X
ρ	0.42	0.62**	0.59*	0.67***
	(0.38)	(0.18)	(0.23)	(0.14)
Observations Traded (Total)	2751 (4343)			
*** Significant at the 99% confidence level, ** at the 95% level, * at the 90% level				

Sources: EUTL; Point Carbon; own estimation
Notes: Newey-West standard errors in parentheses; *** denotes significance at the 99% confidence level, ** at the 95% level, * at the 90% level

Turning to the remaining coefficients of the selection equation, the significant and positive estimated coefficient on the ‹account› variable supports the hypothesis that a larger number of accounts may lower fixed transaction costs associated with emissions trading and may therefore make it more likely for a company to engage in trading during the first trading period. This indicates that transaction costs may indeed have played a role during the first trading period of the EU ETS (Betz 2003; Jaraite and Kazukauskas 2012; Schleich and Betz 2004). Furthermore, companies that were ‹short› were more likely to trade than companies that were ‹long›. This can mainly be attributed to the fact that being ‹long› does not entail a penalty under the EU ETS, but being short of allowances at the end of one period, or rather not surrendering the right amount, does.[17]

Comparing these results to individual OLS regressions of the observed gain for the subset of companies that engaged in trading on the same explanatory variables (i.e., estimating the regression equation for y^2 separately) reveals that while a large number of regressors have the same order of magnitude and significance (Table 3 in the Appendix), the ‹short› dummy is no longer significant in three of the four regressions. The same is true for the ‹large› dummy, which is smaller than in the Heckman model for the first two price series and insignificant for the last two. This downward bias in the OLS regression results is typical in cases where a selection process is involved. It is related to the fact that the long and small companies (the reference categories for the ‘short’ and ‹large› dummies) that are included in the subset of companies engaged in trading are not representative of the whole population of long and small companies, but have made rather high potential gains, which affects the estimation of the ‹short› and ‹large› coefficients. Large companies that were ‹short› during the first trading period of the EU ETS were predominantly large electricity providers situated in Western Europe which should have ability to forecast emissions (a candidate for the unobserved variables driving both the decision to engage in trading and the level of gains). The OLS regression results indicate that they have an ex ante advantage when compared to the whole set of companies liable under the scheme, but that this advantage erodes when only the subset of companies that traded is considered.

Running individual OLS regressions for the different size samples (using the daily price series) reveals that the coefficient on the allocation position is of a similar magnitude for all samples and even slightly larger for the ‘small’ sample (Table 4 in the Appendix). This confirms the hypothesis made above that small companies that decided to enter the market seem to have been informed well enough to capitalize on their overallocation, which may have been due to their intrinsic abilities, or to the help they received from brokerage agencies.

Overall, results confirm that the level of overallocation did indeed play a big role in determining gains from trading. For each ton that had been overallocated, participating companies are estimated to have earned an average € 8, if they entered in the first year, and € 3 if they entered in the second year – or about € 8 no matter when they entered, if average prices are used for the whole period. Furthermore, the decision to enter the market and enter it early was a prerequisite for a company to capitalize on its overallocation.

[17] The penalty for non-compliance in the first period amounted to € 40 for each tCO_2 for which no permit was submitted; additionally, the shortfall had to be compensated for by submitting the missing permits in the following year.

5 DISCUSSION

A number of the companies investigated in this paper experienced substantial gains and losses, with maximum gains ranging from € 220 to 390 million, depending on the prices used in the analysis, and maximum losses ranging from € -710 to -510 million. Since no accounting standard is available for emissions permits to date, disclosure of gains and losses on the carbon market is voluntary (Balatbat and Wang 2010). Therefore, it is, in most cases, impossible to compare the gains and losses estimated in this paper to numbers given in annual reports, as most companies only started reporting their profits from CO_2 trading after the end of the first trading period. An exception is cement producer Cemex: «During 2007, 2006 and 2005, CEMEX's purchase or sale transactions of EUAs were not significant.» (CEMEX 2008). From the EUTL transfer data, I calculated a total profit of € 1.23 million for this company, which at an operating income of US$ 3 billion (€ 2.2 billion) may not actually be very significant. The number of companies that voluntarily disclose their gains and losses from trading has, however, grown since the start of the EU ETS. For 2012, cement producer Holcim reported revenues from carbon trading of CHF 62 million (€ 51 million), which amounts to 4% of their annual operating profits of CHF 1.5 billion (Holcim 2013). In the same year, the steel producer ArcelorMittal reported profits from CO_2 sales of U$ 220 million (€ 165 million), which is 7 % of its operating loss of U$ 3.2 billion, noting the importance of this revenue stream: «Operating loss for the year ended December 31, 2012 was reduced by a net gain of $220 million recorded on the sale of carbon dioxide credits» (ArcelorMittal 2013). In the same year, cement producer Lafarge reported that «[s]ignificant cost-cutting achievements and lower cost inflation helped mitigate the impact of lower volumes and lower carbon credit proceeds. The sales of carbon credits were 73 million euros year-to-date versus 136 million euros in 2011» (Lafarge 2013, p.53).

It is mostly utilities that were identified as having had to buy additional permits on the market for EUAs. However, it is exactly for those companies that other studies have estimated the highest windfall profits due to pass-through of carbon costs over and above the level these companies actually faced. This mechanism works in two ways: i) Companies can pass through the (opportunity) cost of freely allocated allowances, and ii) due to the way in which electricity prices are set in a competitive wholesale market, windfall profits may arise even for the share of allowances that has to be purchased on the market. This happens if an emissions-intensive producer, for example a coal plant, sets the price according to its marginal costs including high CO_2 costs. In this case, all less emissions-intensive plants that are generating power during the same time, for example nuclear power and renewables, also are also given this price, although their CO_2 costs are much lower than those of the coal plant (Hintermann 2010).

Sijm et al. (2006) estimated annual windfall profits for electricity generators situated in Belgium, France, Germany, and the Netherlands at between € 5.3 and € 7.7 billion at a carbon price of 20 €/tCO_2 and a level of free allocation of 90%. Matthes (2008) estimated that at free allocation levels in the second trading period the four large utilities situated in Germany generated annual windfall profits of between € 1.2 – 2.2 billion each at carbon prices of 25 €/tCO_2. Keppler and Cruciani (2010) came to the conclusion that during the first trading period European power producers generated more than € 19 billion in annual windfall profits. Moreover, Zachmann and Hirschhausen (2008) found that there is asymmetric pass-through of carbon costs, with rising carbon prices having a larger effect on electricity prices than falling ones. One has to keep in mind, however, that in some countries it is not possible for electricity producers to pass forward the (full) cost of carbon, because of regulated retail prices. In the first trading period, this applied to France and Spain (Grubb and Neuhoff 2006), but also to some Central and Eastern European member states.

For the industry sectors, considerable windfall profits have been calculated, as well. Martin et al. (2012) estimated an annual windfall profit of € 6.7 billion through freely allocated permits to industry during the third period of the ETS. Bruyn et al. (2010) estimated total windfall profits of € 14 billion for the period between 2005 and 2008 for refineries as well as the iron and steel sector. However, there is less consensus on whether or not industrial companies in some sectors can pass through the costs of carbon. Demailly and Quirion (2008) note that results in the iron and steel sector are highly dependent on the degree of competitiveness assumed in the market, while Ponssard and Walker (2008) note the importance of regional differences for the cement sector.

To sum up, the magnitude of windfall profits due to carbon cost pass-through during the first trading period, as estimated in other studies, dwarf the size of the profits and losses estimated in this paper. In particular the companies identified as 'losers' in EU Emissions Trading (e.g., utilities), may indeed have made windfall profits that far outstripped any of the costs they incurred on the market for EUAs.

6 CONCLUSION AND POLICY IMPLICATIONS

This paper investigates transactions of carbon allowances during the first trading period of the EU Emissions Trading Scheme (January 2005 – April 2008) with a view to calculating gains and losses from EU Emissions Trading. It explores different ways to account for forward and futures trading, of which only deliveries can be observed in the EUTL data. Results are particularly sensitive for large utilities and energy companies. Therefore, the estimated gains and losses in this paper are likely to present a relatively complete picture for those companies that did not engage in a lot of trading on the forward and futures market (i.e., smaller companies or companies in industrial sectors that do not have a separate trading unit), while they may represent only a small glimpse of the total volume of trading activity for companies with high involvement in forward and futures markets.

Results indicate that significant wealth transfers took place during the first trading period of the EU ETS and that the level of excess allocation was a major determinant for who would become a potential 'winner' or 'loser' from EU Emissions Trading as observable in the EUTL data. However, whether or not a company could make a gain from being overallocated depended on its decisions whether to enter the market and at which point in time to do so. Small companies in particular, were less likely to participate. The fact that small companies were less likely to enter the market implies the existence of significant transaction costs higher than the perceived potential gains preventing these companies from trading. Small companies that did enter the market generated gains (per ton of overallocation) which were equal or even higher than those of larger companies, which may be an indication of the important role of brokers and financial service providers.

It should be kept in mind that the EUTL only reveals a fraction of the gains that could be made under the EU ETS, as two other important sources of profits cannot be accounted for by using the EUTL data. First, this applies to windfall profits from the pass-through of carbon costs in the electricity sector, but also in industry sectors. The additional costs estimated for electricity companies in this paper are likely to be dwarfed by windfall profits on product markets, as estimated by other researchers. Second, it also applies to trading on the forward and futures market, which would have been relevant for utilities, large energy companies, and some large industrial companies. This is further accentuated by the fact that accounting for forward and futures trades makes a large difference for a number of very large companies.

Taking into account the profits made from selling overallocation or the cost pass-through of freely allocated allowances, the question arises: Who were the real ‹losers› of EU Emissions Trading during its first period? Both industrial companies and utilities made profits, the former through selling their overallocation, the latter by passing through the cost of freely allocated allowances. On the one hand, during the first trading period it seems to have been small companies which did not realize their potential profits. On the other hand, it is likely that, ultimately, the end users footed the bill. Policy makers therefore have to keep in mind that decisions regarding the level of free allocation to individual sectors and companies does not only have implications for distributional effects between different companies covered by the Scheme, but – to a much larger extent – they determine the distribution of costs and benefits between households and those companies.[18] It is debatable whether free allocation under the EU ETS is an effective instrument for generating (windfall) profits for companies. A higher level of auctioning rather than free allocation would permit governments to utilize auctioning revenue for the mitigation of potential

[18] Free allocation under the EU ETS ultimately reaches households by way of its impact on share prices and both labor and capital market effects. Although some of these factors may have the potential to render the policy less regressive, that is if some of the burden is passed back to capital (Fullerton and Monti 2013; Rausch et al. 2011) predominantly owned by high-income households, other factors, such as an increase in the share price of an overallocated firm will most likely accrue to higher-income households, as they are more likely to own companies, either directly or via shares (Parry 2004).

adverse distributional effects. Furthermore, it might also provide additional incentives for companies to focus resources on reducing emissions rather than lobbying for free allocation.

As free allocation based on National Allocation Plans (NAPs) was still the norm during the second trading period, I expect an analysis of the transfer data for 2008 – 2012 to yield similar results as the ones presented in this paper. Since rules for free allocation of permits have been harmonized at the EU level from the third trading period (2013 - 2020) onwards, there is less concern about distributional effects between sectors and installations situated in different countries. Furthermore, the electricity sector generally has to buy its allowances starting from 2013 (with the exception of generators located in Central and Eastern Europe). However, industrial companies continue to receive fairly generous free allocation under the EU ETS up until 2020 (Cludius and Hermann 2014).

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APPENDIX

Table 3 presents OLS regression results of the observed gains on the same variables as the Heckman model. Many of the regressors have the same significance and order of magnitude. The dummies on 'short' and 'large' are either significantly smaller or insignificant as in the Heckman selection model. As is discussed in Section 4, this represents a typical downward bias if self-selection is at play.

Table 3 OLS regression results with regard to observed gains and losses

	Tier 1: Spot prices	Tier 2a: Average yearly prices	Tier 2b: Forward / futures prices	Tier 3: Average period prices
Short	0.03	0.06	-0.06	0.15***
	(0.07)	(0.05)	(0.10)	(0.05)
Position	-0.24	-0.04	-0.06	7.37***
	(0.37)	(0.26)	(0.31)	(1.04)
PosXFirst	8.33***	8.75***	7.95***	0.73
	(1.28)	(0.72)	(1.31)	(1.21)
PosXSecond	2.49***	3.05***	2.32***	-0.72
	(0.64)	(0.50)	(0.66)	(1.26)
First	0.22**	0.14**	-0.01	-0.07
	(0.09)	(0.07)	(0.09)	(0.07)
Second	0.06*	0.07***	-0.02	0.001
	(0.03)	(0.02)	(0.03)	(0.03)
Medium	0.08	0.05	0.20**	0.01
	(0.06)	(0.04)	(0.08)	(0.05)
Large	0.60***	0.46***	0.05	0.10
	(0.17)	(0.14)	(0.22)	(0.15)
Electricity	0.36**	0.33***	0.00	0.12*
	(0.15)	(0.12)	(0.26)	(0.06)
Number of trades	-0.02***	-0.02***	0.03***	-0.0004
	(0.005)	(0.003)	(0.01)	(0.005)
Has PHA	-0.96**	-0.61*	-0.48	-0.16
	(0.39)	(0.33)	(0.61)	(0.39)
Via intermediary	0.06	0.06	0.00	0.07
	(0.06)	(0.05)	(0.06)	(0.03)
Constant	-0.23***	-0.23***	-0.22**	-0.33***
	(0.07)	(0.06)	(0.09)	(0.06)
Country dummies	X	X	X	X
Observations	2,751			
R2	0.54	0.67	0.47	0.59
*** Significant at the 99% confidence level, ** at the 95% level, * at the 90% level				

Sources: EUTL; Point Carbon; own estimation
Notes: Newey-West standard errors in parentheses; *** denotes significance at the 99% confidence level, ** at the 95% level, * at the 90% level

In order to further investigate the impact of self-selection on companies of different size categories, Table 4 presents OLS regression results of the observed gains by size category subsets. As discussed in Section 4, small companies that engaged in trading seem to have been informed well enough to capitalize on their overallocation to the same extent or even exceeding the level of larger companies.

Table 4 OLS regression results by size category

	Small	Medium	Large	Very large
Short	0.11***	0.23	-0.30	-0.74
	(0.03)	(0.14)	(0.45)	(4.37)
Position	0.72*	1.05	-0.16	2.11
	(0.38)	(0.76)	(0.96)	(1.74)
PosXFirst	12.59***	8.14***	8.03***	6.10***
	(1.37)	(1.89)	(1.38)	(1.72)
PosXSecond	5.94***	2.83***	1.90*	1.20
	(0.87)	(1.02)	(1.05)	(1.87)
First	0.04	0.18*	0.85**	10.26*
	(0.03)	(0.11)	(0.39)	(5.35)
Second	0.04*	0.12	0.31*	5.73*
	(0.02)	(0.08)	(0.18)	(3.40)
Electricity	0.09**	0.20	1.07*	2.90
	(0.05)	(0.17)	(0.63)	(3.20)
Number of trades	-0.04*	-0.02***	-0.01	-0.02
	(0.02)	(0.005)	(0.01)	(0.01)
Has PHA	-0.19	-2.01	-1.07**	-6.17
	(0.28)	(1.84)	(0.53)	(4.88)
Via intermediary	0.02	-0.01	0.23	1.29
	(0.02)	(0.06)	(0.28)	(3.61)
Constant	-0.04	-0.15**	-0.49	-13.44**
	(0.03)	(0.06)	(0.32)	(6.00)
Country dummies	X	X	X	X
Observations	1,520	724	507	204
R2	0.49	0.46	0.57	0.88
*** Significant at the 99% confidence level, ** at the 95% level, * at the 90% level				

Sources: EUTL; Point Carbon; own estimation

Notes: Newey-West standard errors in parentheses; *** denotes significance at the 99% confidence level, ** at the 95% level, * at the 90% level

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