Home Country Bias in International Emissions Trading: Evidence from the EU ETS*

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Abstract

We examine the pattern of allowance trades in the European Union Emissions Trading Scheme using highly disaggregated trading data and identify a significant and robust home market bias. Our results point to informational transactions costs that increase when trading across national borders. The existing trade pattern in goods and services explains two thirds of the home bias, with the remainder due to other causes. Our finding suggests that firms make use of existing trade networks to overcome search costs in bilateral allowance trade. Since the home bias differs across firms, it follows that marginal abatement costs are not equalized across market participants.

JEL CLASSIFICATION: F14, F18, Q52, Q54, Q58

KEYWORDS: Emission permit market, EU ETS, transactions costs, gravity equation, home bias

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1 Introduction

The signatories of the Paris Agreement agreed on nationally determined contributions towards the global reduction of greenhouse gas (GHG) emissions. Many countries decided to introduce (or expand) a domestic cap-and-trade market for GHG emissions. Because the costs of emissions reduction vary significantly across countries, national regulators hope to link domestic systems into multinational markets (Green et al., 2014). The expected gains from trade stem from the equalization of marginal abatement costs across all firms in the linked markets. The success in achieving the emissions target at least cost, however, depends on the efficient functioning of the multinational market.

In this paper, we investigate the efficiency of the European Union emission trading system (EU ETS) by examining trade flows between individual market participants. The EU ETS is the flagship of the EU's climate policy, and the only truly multinational permit market to date. Our analysis is based on the universe of allowance transactions during the years 2005-2013 and uses gravity framework developed in the context of international trade. We find robust evidence for a home (country) bias in the sense that market participants are significantly more likely to trade within than across national borders, ceteris paribus.[1] The home bias is robust to using alternative sub-samples, and it is manifested along both margins of trade: Firms are more likely to purchase allowances from domestic trade partners than international ones, and conditional on a trade taking place, the volume is greater for domestic purchases. Because emissions allowances are perfectly homogenous goods transmitted electronically at no explicit cost, the presence of a home bias points to the presence of transactions costs that accrue when trading emissions allowances across national borders.

Our paper makes two contributions. The first pertains to the empirical literature on permit markets. Early studies show that transactions costs can keep certificate markets from functioning efficiently.[2] Transactions costs have been shown to be present in the EU

[1] Throughout this paper, we mean home country bias when we refer to home bias, using the convention from the literature on international trade. Naturally, one could define "home" to mean other territorial units such as regions or metropolitan areas.

[2] This literature includes Hahn and Hester (1989), Kerr and Mare (1998) and Gangadharan (2000); for a review, see Krutilla et al. (2011).

ETS, mostly in the context of monitoring, reporting and verification (Jaraitė et al., 2010; Heindl, 2012; Sandoff and Schaad, 2009; Heindl and Lutz, 2012), and they can potentially explain the puzzle of why some firms completely abstained from the market (Jaraitė et al., 2010; Zaklan, 2013; Hintermann, 2017).

Zaklan (2013) investigates the determinants of trading behavior of firms covered by the EU ETS during the first two years of the market. He finds that larger firms are more likely to buy (but not to sell) allowances, and that firms' ownership structure and industrial classification affect the propensity to trade. However, neither productivity nor profitability appear to play a role. Jaraitė-Kažukauskė and Kažukauskas (2014) also examine allowance trade during the first market phase and find that firms that own several installations covered by the EU ETS, as well as firms that have previously traded, are more likely to participate in trade (and trade larger amounts), which they interpret as evidence for the importance of transactions costs. Our analysis differs from these two papers in that we (i) include all market participants (i.e., not only firms covered by the EU ETS), (ii) use data from 2005 through 2013 (thus covering the full first two phases plus the beginning of the third phase), and (iii) focus on the international component of allowance trade by creating a trade matrix and using a gravity model. To our knowledge, the only other paper that explicitly focuses on cross-border allowance trade is by Ellerman and Trotignon (2009), who present evidence for the existence of international trade on a country level and without examining the presence of a home bias.

We identify substantial heterogeneities in the magnitude of the home bias across firms of different size and location, which implies that total allowance costs (the sum of EUA price and transactions costs) are not equalized. Since cost-minimizing firms set their marginal abatement costs equal to the total costs of allowances, the presence of heterogeneous transactions costs indicates that marginal abatement costs are not equalized across polluters in the EU ETS (Stavins, 1995; Montero, 1997; Hahn and Stavins, 2011).[3]

[3]Given heterogeneous marginal transactions costs, mtc_i, across polluters i, we have $mac_i = p - mtc_i$, where p is the permit price and mac_i refer to marginal abatement costs. Note that even if transactions costs were homogenous and marginal abatement costs thus equalized, they still lead to a price wedge between marginal abatement costs and the allowance price. This increases the overall social cost of achieving the emissions cap, because allowance prices are passed on to consumers, e.g., in the form of higher electricity prices (Fabra and Reguant, 2014; Fell et al., 2015; Hintermann, 2016).

Our second contribution is to the gravity literature in international trade, on which we build methodologically. A number of papers have documented a home bias in the trade of goods and commodities (McCallum, 1995; Evans, 2003; Anderson and van Wincoop, 2003; Wolf, 2000), which has been described as one of the major puzzles in international macroeconomics (Obstfeld and Rogoff, 2001). The literature has identified various potential channels to explain this phenomenon, such as differences in the elasticity of substitution in production, preference heterogeneity, explicit trade barriers arising at national borders or the exercise of market power.[4]

The EU ETS features three characteristics that are special from a trade point of view. First, because allowances are perfectly homogenous, the home bias cannot be due to a difference in consumer preferences across borders (or the nationality of the product), which, in the context of differentiated goods, are empirically not distinguishable from transactions costs (Anderson and van Wincoop, 2004). Second, allowances exist only electronically and are therefore traded without transportation costs. And third, since we observe all allowance transactions, we know that the trade connections with zero activity in fact represent an absence of trade as opposed to missing data, a problem that routinely plagues the analysis of trade in physical goods. Using the example of the EU ETS, we contribute to the literature by providing empirical evidence for a home bias in international trade that is unrelated to transport costs, preferences, tastes or missing data.

We find that an important part of the informational trading costs are sunk, which is consistent with foreign market entry costs related to cross-border information frictions (Chaney, 2014; Rauch, 2001; Melitz, 2003). Although the magnitude of the home bias decreases over time as new trade connections are established, it persisted in 2013, the ninth year of operation of the EU ETS. About three quarters of the home bias can be explained by the trade pattern in goods and services, for which a well-documented home

[4]Evans (2003) focuses on differences in production elasticites, Brülhart and Trionfetti (2009) and Coşar et al. (2018) on differences in preferences across countries, and Blum and Goldfarb (2006), Atkin (2013) and Auer (2017) on taste differences across regions. Anderson and van Wincoop (2004) and Obstfeld and Rogoff (2001) explain the home bias with explicit trade barriers. Roux et al. (2016) examine the effect of market power on the home bias. Blum and Goldfarb (2006) document a negative effect of geographical distance on bilateral trade volumes of differentiated digital (online) goods that are traded without transportation costs, a feature shared by allowance trade.

bias exists (see, e.g., Wolf, 2000; McCallum, 1995). This indicates that firms make use of existing trade networks to overcome information asymmetries and/or search costs in bilateral allowance trade. This result is consistent with the work of Aviat and Coeurdacier (2007), who demonstrate a home bias in financial asset holding that is closely related to the bilateral trade pattern in goods.[5]

Our results imply that international trade frictions exist even in the absence of transportation costs and, what is particularly striking, among countries that share a common market for goods and services, such as the members of the EU. However, the economic significance of the transactions costs implied by the home bias in the EU ETS is not obvious. Since allowances are homogenous goods, even small deviations in transactions costs can lead to an almost complete home bias, which then would be associated with a small welfare loss (Evans, 2003). In contrast, if total allowance costs differ significantly across market participants, the associated welfare loss could be large. Unfortunately, the total allowance costs are not observable. Considering that allowances are traded only on a few exchanges (currently only one) and the associated fees are prohibitively high for firms that trade small amounts of allowances, the total cost differential may be significant.

In the next section, we present the data and the econometric model. In section 3, we present our results, investigate potential mechanisms and carry out a series of robustness tests. Section 5 concludes.

2 Data and empirical strategy

We start by providing some background information about allowance trade in the EU ETS before describing the data and our empirical strategy.

[5]Rauch (2001) and Combes et al. (2005) discuss the importance of business networks in domestic and international trade. On average, firms can rely on a less extensive international trade network, relative to their domestic trade network, which decreases the probability of finding an international trade partner in bilateral allowance trade.

2.1 Allowance trade in the EU ETS

The EU ETS is a cap-and-trade system in operation since 2005 and covers energy-intensive installations from all EU members and from additional countries that have linked into the system over time. Installations covered by the EU ETS have to surrender one EU allowance, or EUA, for each metric ton of CO_2 that they emitted during the previous calendar year. The total number of allowances that are distributed each year, either for free or in auctions, constitutes the annual CO_2 emissions cap in the EU ETS. For a review of the EU ETS and the related literature, the interested reader is referred to the recent symposium by Ellerman et al. (2016), Hintermann et al. (2016) and Martin et al. (2016).

Allowances are issued electronically and held in different types of accounts owned by *account holders*, who may hold several accounts. The accounts are located in national registries established by each country participating in the EU ETS. The national registries are joined in the EU Transactions Log (EUTL), which is centrally managed by the EU.[6] Within this system, transfers of permits are only possible through accounts. Furthermore, transfers of permits across accounts are not subject to explicit transactions costs.

All installations covered by the EU ETS are assigned what is called an operator holding account (OHA). Holders of OHA accounts are firms by definition. The national governments use government accounts to distribute allowances into firms' OHAs. Each April, firms transfer the number of allowances required to cover their emissions during the previous calendar year from their OHAs into a different government account. These allowances are then canceled. In addition to government accounts and OHAs, allowances can be held in a personal holding account (PHA). A PHA can be set up by a covered firm to collect allowances from different OHAs that it owns, and thus serve as a centralized trading account. Furthermore, any firm or person that wishes to trade allowances can open a PHA in one of the national registries, and some financial institutions (which themselves are not covered by the ETS) have engaged in extensive allowance trading via PHAs.

Allowance trade can take place bilaterally between two account holders, via brokers or

[6]The EUTL replaced the Community Independent Transactions Log (CITL), which was a web interface that joined the independently managed country registries. The data previously contained in CITL data has been transferred to EUTL.

on exchanges. Currently, the exchange that dominates allowance trade is the European Energy Exchange (EEX).[7] In the beginning of the EU ETS and during most of our sample period, the exchange with the largest allowance trade volume was BlueNext. This exchange was located in France but closed in December of 2012. The majority of countries that are part of the EU ETS do not have a formal exchange within their borders.

The (mostly fixed) fees make exchange trades attractive only for firms that trade significant volumes of allowances per year. For example, the EEX charges a fee of 2,500 Euro per year for the trading license, plus 3 Euro per 1,000 traded allowances.[8] Firms that trade relatively small amounts can therefore be expected to use intermediaries in an over-the-counter (OTC) trade. Unfortunately, our data does not include the information whether a trade took place bilaterally, via OTC or on an exchange.

2.2 Data and aggregation

We limit our analysis to transactions between firms and thus exclude transactions related to the allocation and surrender of allowances. Our data comprises the universe of transactions between operator holding accounts (OHAs) and personal holding accounts (PHAs) between 2005 and 2013.[9] Besides the transaction amount, the data includes the date of the transaction, the account identifiers of the buying and selling accounts and the names and addresses of the involved account holders. Transactions data are published with a delay of three years. Annual updates occur each June and include transactions through April the calendar year three years prior to the update. For example, in June 2017, transactions data became available through April 2014. Since we aggregate to the yearly level, we use data through 2013, which include a total of 436,650 individual transactions between OHAs and PHAs.

Firms owning several plants can concentrate allowances in a centralized PHA and use this account to buy and sell allowances on the market in order to minimize transactions

[7] Allowances can currently also be traded on Nasdaq Commodities, Climex and NYMEX, but the trading volumes on these exchanges is negligible relative to that on the EEX. Until 2011, allowances could also be traded on the Austrian Energy Exchange.

[8] See www.eex.com/en/products/environmental-markets/emissions-secondary-market/feesEEX, last accessed on April 20, 2018.

[9] The data is freely available at `http://ec.europa.eu/environment/ets/`.

costs. In order to surrender the allowances to cover their emissions for the previous calendar year, the firm-level PHA transfers the appropriate number of allowances to each OHA before the submission date. Defining trades between accounts belonging to the same firm as regular allowance trade would artificially inflate the home bias if the different accounts are located within the same country (which would be expected). For our empirical analysis, we therefore aggregate the data from the account to the firm level, thus making the firm the unit of analysis. We do this by linking the EUTL accounts to Bureau van Dijk's Orbis database, using a similar approach as Zaklan (2013) and Jaraitė-Kažukauskė and Kažukauskas (2014).[10] We accomplish the merging between the EUTL and Orbis data based on firm names and addresses (i.e., countries and sometimes zip codes). This removes 41,992 transactions between accounts belonging to the same firm. We retain accounts for which we find no entry in Orbis under the assumption that these belong to small firms that are simply not listed. In the robustness section, we present results where we limit the analysis to firms that we can locate withing Orbis, thus making sure that no intra-firm trade is counted as a "real" trade (but at the cost of losing a significant number of observations).

Whereas most exchanges directly connect buyers and sellers, the BlueNext exchange routed all allowance trades via its own PHA. As a consequence, all transaction made on BlueNext appear twice in our data—as a sale to BlueNext as well as a purchase from BlueNext. To control for this, we delete all observations with BlueNext as a buyer (66,138 observations). We further remove 8,457 trades carried out by a single trader that was later convicted of VAT tax fraud.[11] This leaves us with 326,873 transactions in total. There are 7,221 unique OHAs and 3,435 unique PHAs, belonging to 6,968 different firms, with at least one active purchase in our sample period. In 87% of all transactions, the purchasing account is a PHA. We address the sensitivity of our results to these and additional sample restrictions in a series of robustness tests in Section 4.

[10] As in Jaraitė-Kažukauskė and Kažukauskas (2014), we aggregate the data to the country-firm level. This means that if a firm has accounts in N countries, we treat it like N different firms. Contrary to intra-firm trade within a country (which we exclude from our analysis), cross-country trade within the same firm would reduce our estimate for the home bias by increasing cross-border trade.

[11] This trader was Mr. Klapucki; more information about the VAT tax fraud is provided below.

We denote an allowance transfer by $x_{bf,bc,sf,sc,t}$ (in tCO_2), with the subscripts defined as follows: bf refers to the firm that makes the purchase ("buying firm"), bc is the "buying" country where the firm is located, and sf and sc refer to the seller firm and seller country, respectively. The time subscript t marks the date of the transfer.

To reduce the computational burden of our analysis, we aggregate our data to the country-level on the selling side and to the yearly level on both sides of the trade:[12]

$$X_{bf,bc,sc,y} = \sum_{sf \in sc} \sum_{t \in y} x_{bf,bc,sf,sc,t} \tag{1}$$

We then build an empty trade matrix where we associate each firm, for which we observe at least one purchase, with a potential selling country participating in the EU ETS.[13] Since we are primarily interested in the behavior of firms covered by the EU ETS, we drop all trades in which the buyer is located outside the EU ETS and aggregate all remaining transactions in which the seller is outside the EU ETS into one foreign account. Our sample contains a total of 6,968 unique firms with at least one active purchase in our sample period. After removing countries with insufficient trade, this gives us a total of 28 possible seller countries per year (for each firm).[14] This results in a trade matrix of 1,629,730 cells, which we populate with the EUTL transactions data according to (1).

In order to assess a potential home bias within allowance trading, we construct a dummy for each trade connection that is equal to one if the buying firm is located in the selling country, and zero otherwise:

$$INTRA_{bf,bc,sc,y} = \mathbb{1}\{bc = sc\} \tag{2}$$

[12]Note that the EUTL database lists the date when the allowances were actually transferred. For forward trades, the date when the deal was made therefore differs from t. Aggregating the data to the yearly level removes this problem for end-of-year forward contracts, but not for trades that clear in a different calendar year.

[13]We focus on allowance purchases. Naturally, the total number of purchases has to equal the total number of sales. However, it is possible that aggregating over the buyer rather than the seller side would change the results. We address this issues in section 4 below.

[14]The EU ETS started out with 25 countries in 2005. In 2007, Romania and Bulgaria joined the EU (and thus the EU ETS). Norway, Iceland and Liechtenstein linked their domestic cap-and-trade systems to the EU ETS in 2008. Because Iceland did not purchase allowances and the number of transaction in the case of Malta is too limited, we removed these two countries. Croatia joined the EU and the EU ETS in 2013, but did not start trading in a significant dimension before 2014, which is outside of our sample period.

We use the 2016 release of the World Input-Output Tables (WIOD) to measure trade patterns in goods and services between countries. This data set covers all countries in our sample and provides bilateral—including intranational—trade flows across 56 sectors that include food, manufacturing and services.[15] We aggregate the data to the importer-exporter-year level.

Table 1 contains descriptive statistics of the key variables used in the regression analysis. The "Overall" sample represents the unrestricted dataset; the sample labeled as "Intensive" only contains positive purchases, and "Extensive" gives information about the unconditional probability of an active trade connection between a firm and a selling country.[16] The probability of observing a positive purchase volume for any given firm(bf)-country(sc) pair in a given year is 1.9%. The data further reveal a substantial variation in the number of traded allowances across the sample, with annual purchases from a specific country ranging to almost 300 million allowances. Many of these large trade volumes are related to institutional traders using PHAs; the descriptive statistics for the sub-sample consisting only of transactions among OHAs can be found in Table A2 in the Appendix.

Table 1: Descriptive Statistics Key Variables

		Full Sample					
Variable	**Margin**	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Obs.**	**Units**
			Dependent Variable				
Purchases CO2 allowances	Overall	15,329	673,069	0	293,561,775	1,629,730	tCO2
	Intensive	812,517	4,833,840	1	293,561,775	30,746	tCO2
	Extensive	0.019	0.136	0	1	1,629,730	-
			Explanatory Variables				
INTRA	Overall	0.038	0.190	0	1	1,629,730	-
	Intensive	0.398	0.489	0	1	30,746	-
Log imports goods & services	Overall	7.775	2.351	0.090	14.834	1,629,730	millions of US dollars
	Intensive	10.884	2.703	1.094	14.834	30,746	millions of US dollars

Before moving on to the regression analysis in the next section, we present a descriptive indication of the presence of a home bias in the EU ETS transaction data. In order to obtain a meaningful descriptive measure for the home bias on an aggregate level, we

[15]The WIOD is a standard dataset that is regularly used in the trade literature, e.g., Fajgelbaum and Khandelwal (2016) or Costinot and Rodríguez-Clare (2014). For a detailed description, see Timmer et al. (2015).

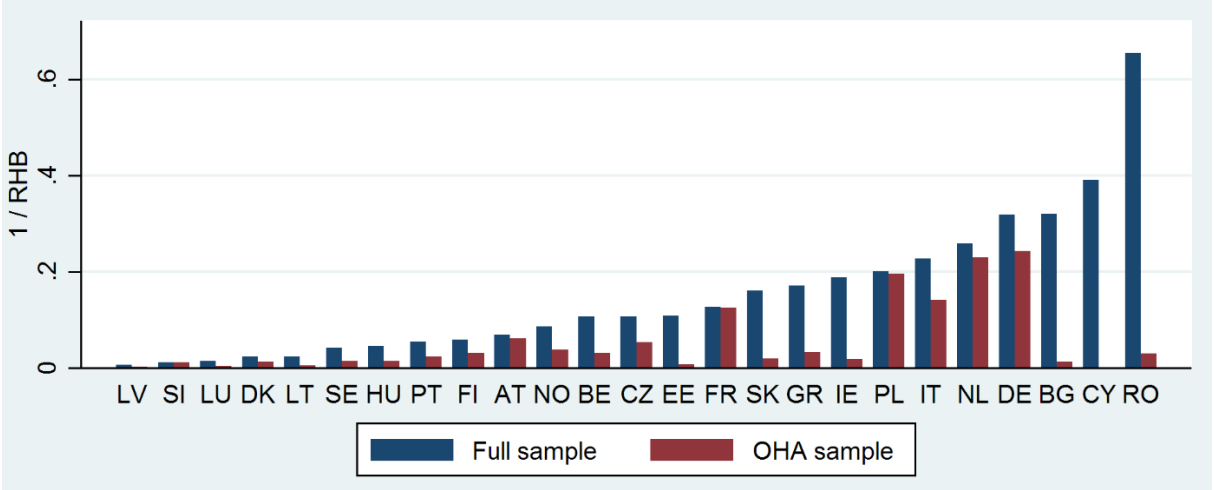
[16]The decomposition of trade flows into extensive and intensive margins builds on the seminal work of Helpman et al. (2008).

have to correct for a country's market share. We expect that, on average, the share of domestic allowance purchases in a particular country is same as the country's share in the total emissions cap. In other words, German firms can be expected to trade more domestically than Austrian firms, simply because German firms own a larger share of the initial allocation. Corrected for the allocation share, the relative home bias for country bc is given by

$$RHB_{bc} = \left(\frac{\sum_{y} \sum_{bf \in bc} \sum_{sc=bc} X_{bf,bc,sc,y}}{\sum_{y} \sum_{bf \in bc} \sum_{sc} X_{bf,bc,sc,y}} \right) \Bigg/ \left(\frac{\sum_{y} \sum_{bf \in bc} A_{bf,bc,y}}{\sum_{y} \sum_{bf} A_{bf,bc,y}} \right) . \tag{3}$$

The numerator represents the home market share of country bc's total purchases, and the denominator is the share of this country's allocations in the total emissions cap. In the absence of a home bias (and any other distortion that could affect trade), RHB_{bc} would be unity for each country, whereas a greater value would imply a home bias. Figure 1 shows the inverse of RHB_{bc} (such that, in our case, the measure falls between 0 and 1) for the full sample as well as for the sub-sample involving trades among OHAs only (thus removing all trades that are unrelated to compliance). The inverse relative home bias of all countries is well below unity in all samples, which suggests a strong home bias in the data. The home bias is stronger for OHAs, which points to the fact that an important share of international allowance trades are carried out by PHAs.

Figure 1: Inverse home bias by country for the full sample and for operator account purchases only



2.3 Econometric model

Our regression setup builds on a parsimonious specification of the gravity equation, which has been extensively used in the economic literature to model bilateral economic relationships. Applications include flow variables such as bilateral trade in goods and services or financial assets (e.g., Aviat and Coeurdacier, 2007; McCallum, 1995) . The gravity equation has also been used to model migration or genetic distance between ethnic groups (e.g., Beine et al., 2016; Spolaore and Wacziarg, 2009).

We use the gravity framework to model bilateral CO_2 allowance purchases as a function of a dummy variable that captures domestic (as opposed to international) trade and a set of control variables. We include seller-country- and buyer-country-specific time-fixed effects to control for trade partners' GDP, emissions, allowance allocation and any other potential confounding effects that vary over time and/or country. In addition, we include firm-level fixed effects to control for any systematic heterogeneity in the trading behavior of firms. However, we also present results for less restrictive specifications with fewer controls.

In our preferred specification, the identification of the effect of trading domestically is based only on the within-firm variation over time. This variation might stem from the extensive margin (i.e., firms may change the number of countries from which they purchase allowances in a given year) or from the intensive margin (i.e., changes in the trade volume within existing trade relationships).

Formally, we carry out our regression analysis at the firm(buyer)-country(seller) level using the following gravity equation:

$$X_{bf,bc,sc,y} = \beta_0 \cdot e^{\beta_1 INTRA_{bf,bc,sc,y}} \cdot e^{\beta_2 \lambda_{bc,y}} \cdot e^{\beta_3 \lambda_{sc,y}} \cdot e^{\beta_4 \gamma_{bf}} \cdot \eta_{bf,bc,sc,y} \tag{4}$$

The dependent variable represents allowance trades as defined in Eq. (1), either overall, or on the intensive (i.e., conditional on $X_{bf,bc,sc,y} > 0$) or the extensive margin. The dummies $\lambda_{bc,y}$ and $\lambda_{sc,y}$ are country-year fixed effects for the buyer and the seller country, respectively, and γ_{bf} are firm-level fixed effects. The unobservable determinants of certificate

trade are captured by the error term, with $E[\eta_{bf,bc,sc,y}|INTRA_{bf,bc,sc,y}, \gamma bf, \lambda_{bc,y}, \lambda_{sc,y}] = 1$.

Conditional on the fixed effects (and any other covariates, if included), the null hypothesis is that $\beta_1 = 0$, whereas $\beta_1 > 0$ indicates the presence of a systematic home bias, and thus of transactions costs that are lower when trading within a country than across borders. To preserve the overall margin of trade and to obtain consistent coefficient estimates in the presence of heteroskedasticity, we employ the Poisson Pseudo-Maximum Likelihood (PML) estimator proposed by Santos Silva and Tenreyro (2006).[17] To estimate the extensive margin, we run a Probit model on the log-linearized version of (4).

3 Results

We start by presenting our main results and then investigate potential mechanisms to explain the home bias.

3.1 Home bias

Table 2 shows the results from the baseline model, using the allowance transaction data (purchases) of the full sample. Column (1) shows the unconditional bi-variate regression of the overall purchase volume on the dummy for intra-national trade. This unconditional regression does not control for any potentially confounding effects that vary by country and year, and which could co-determine the extent and pattern of allowance trade. Moving from left to right across columns (1) to (3), we subsequently add buyer- and seller-country fixed effects as well as buyer- and seller-country-year fixed effects. Adding fixed effects

[17] In most trade literature, the gravity equation is log-linearized and estimated in the following form:

$$ln(X_{bf,bc,sc,y}) = ln(\beta_0) + \beta_1 INTRA_{bf,bc,sc,y} + \beta_2 \lambda_{bc,y} + \beta_3 \lambda_{sc,y} + \beta_4 \gamma_{bf} + ln(\eta_{bf,bc,sc,y})$$

However, log-linearizing (4) would lead to a substantial loss of observations in our context, since many firm-country pairs have no transactions in a given year (and the log of zero is not defined), and thus would restrict the analysis to the intensive margin of trade. Furthermore, estimating the log-linearized equation may lead to inconsistent estimates if allowance trade is heteroskedastic, because the expected value of the logarithm of a random variable depends both on its mean and its variance. More specifically, if the variance of $\eta_{bh,bc,sc,y}$ depends on the regressors, then $ln(\eta_{bh,bc,sc,y})$ will depend on (the log of) these regressors too. Because permit purchases cannot be negative by definition, this means that as $X_{bh,bc,sc,y}$ approaches zero, the variance of $\eta_{bh,bc,sc,y} = X_{bh,bc,sc,y} - E[X_{bh,bc,sc,y}|INTRA_{bc,sc}, \gamma_{bh}, \lambda_{bc,y}, \theta_{sc,y}]$ has to vanish. This variance can furthermore be expected to depend on the observable determinants of trade. For more details, see Santos Silva and Tenreyro (2006).

reduces the risk of omitted variable bias, but reduces the sample variation.

We find a positive and significant coefficient of the dummy variable for intra-national trade. For example, the coefficient in column (3) implies that the average firm's total purchase volume on the home market is ($e^{1.832}$=) 6.2 times larger than the total purchase volume from the average foreign country (i.e., the average purchase volume is 520% larger within than across countries). The fact that the coefficient on INTRA declines from column (1) to (3) suggests the presence of an omitted variable bias in the unconditional regression results.

Table 2: Home bias in allowance trade, 2005–2013

Dependent Variable:	Allowance purchases							
	Poisson PML				Probit	Poisson PML		Probit
	Overall (1)	Overall (2)	Overall (3)	Intensive (4)	Extensive (5)	Overall (6)	Intensive (7)	Extensive (8)
INTRA	2.911*** (0.314)	1.936*** (0.197)	1.832*** (0.193)	-0.017 (0.091)	0.139*** (0.017)	1.832*** (0.193)	0.782*** (0.094)	0.141*** (0.013)
Buyer-country (BC) FE	no	yes	-	-	-	-	-	-
Seller-country (SC) FE	no	yes	-	-	-	-	-	-
BC-year FE	no	no	yes	yes	yes	yes	yes	yes
SC-year FE	no	no	yes	yes	yes	yes	yes	yes
Firm FE	no	no	no	no	no	yes	yes	yes
Obs.	1,629,730	1,629,730	1,629,730	30,746	1,629,730	1,604,295	30,746	1,629,730

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors (in parenthesis) are clustered on the buyer-seller country pair level. Overall: All allowance purchases within the full sample. Intensive: Observations with a positive transaction volume only. Extensive: Indicator function that is 1 in case of positive trade connections, and 0 otherwise. For Probit estimations, the average marginal effects are reported.

In columns (4) and (5), we decompose the overall trade volume into an intensive and extensive margin, respectively. For the extensive margin, we report the marginal effects (i.e., the change in the probability if the INTRA-dummy switches from 0 to 1). The coefficient on INTRA is not statistically different from zero on the intensive margin, indicating that, conditional on a trade taking place, domestic trades are not larger in volume than international trades. On the extensive margin, however, the analysis again reveals a strong home bias: The probability of observing an active trade connection with another firm in the home market is on average 13.9 percentage points larger than with firms located in any foreign country. Given that the probability to observe an active trade connection between the average firm-country pair is only 1.9 % (see Table 1), this result is substantial.

In columns (6)-(8), we additionally include firm fixed effects to further control for

unobserved heterogeneity. The home bias overall and on the extensive margin remain virtually unchanged. The home bias is now positive and significant on the intensive margin as well, implying that unobserved heterogeneity across firms matter for the trade volume of existing trade relationships. For example, if (many) small firms tend to trade nationally and in small amounts, and (fewer) large firms engage in both national and international trades involving large volumes, then a failure to control for firm size will lead to a smaller home bias on the intensive margin. This explanation is consistent with the descriptive statistics of trade: The total trade volume—aggregated over our sample period—of the average firm that only trades at home is about 425,000 allowances, whereas the total trade volume of the average firm that also buys allowances from abroad is more than ten times larger.

For completeness, Table A1 in the Appendix reports estimates for the home bias after aggregating the data to the country-pair-year level. The overall home bias is similar to that in Table 2, but, at the aggregated level, the intensive margin becomes the dominant factor behind the home bias.[18] This contrasts with the regressions on the firm level, where the extensive margin dominates, and highlights the fact that we cannot draw conclusions on firm behavior from aggregate data. Disaggregation is particularly important in our context, because we are explicitly interested in firm-specific heterogeneities that allow us to draw conclusion about the equalization of marginal abatement costs across firms.

Our results document a substantial home bias in international allowance trade. In the absence of transportation costs and other forms of explicit trade costs, and considering that allowances are perfectly homogenous, one possible interpretation for the results in Table 2 is the existence of informational frictions associated with the participation in international allowance trade.

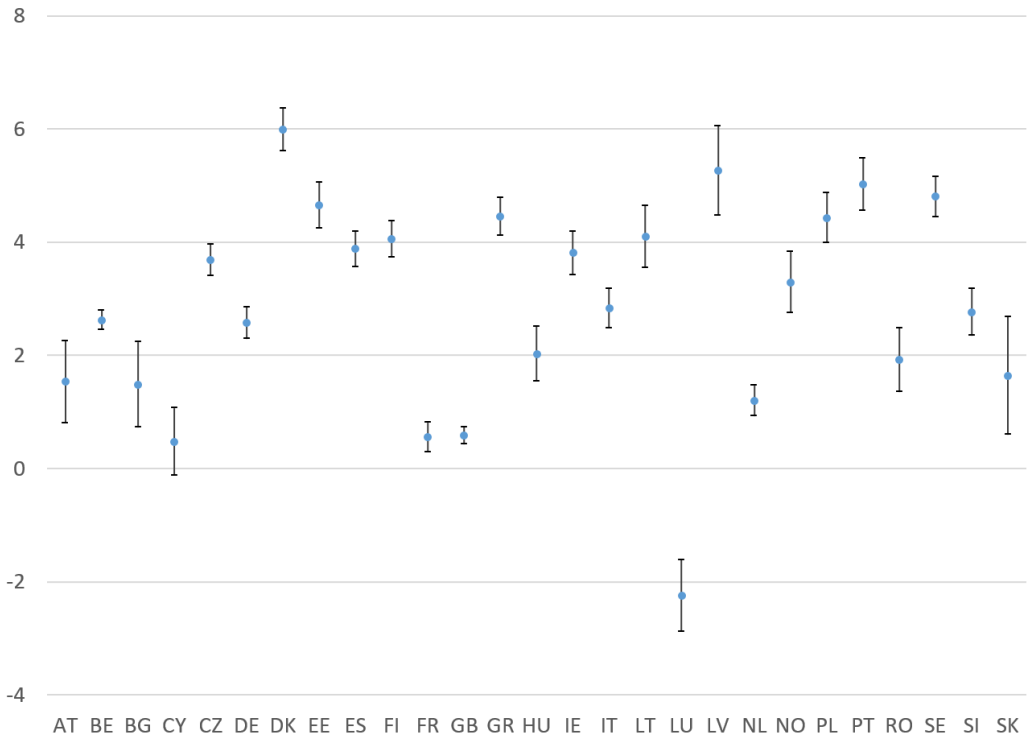
It is important to note that the presence of trade costs (and thus of a home bias) per se does not lead to a distortion as long as these costs are the same for all polluters. In this case, marginal abatement costs will still be equated because all firms face the same total permit costs (which consist of the permit price plus trading costs), such that market

[18]The reason being that the number of zero allowance imports between country-pairs is very low.

efficiency is achieved. However, if trading costs differ between market participants, then marginal abatement costs are no longer equalized, and, as a consequence, the market is not efficient. In the following, we present evidence for heterogeneous transactions costs along two dimensions: (i) Across firm location (countries), and (ii) across firm size.

To investigate whether the home bias is also heterogeneous across EU ETS countries, we estimate separate country-specific coefficients by interacting country-dummies with the INTRA-dummy. Figure 2 shows the country-specific point estimates and confidence intervals. The home bias is positive and statistically significant for all countries that participate in the EU ETS, with the exception of Cyprus and Luxembourg. The results imply that substantial differences exist in the severity of cross-border friction across firms, depending on their location. Since transactions costs in international allowance trade differ across countries, total permit costs (and thus marginal abatement costs) are not equalized across firms within the EU ETS.

Figure 2: Country-specific home bias (dots) and 95% confidence intervals



Note: The dots show the point estimate of the coefficient on the INTRA-dummy interacted with the respective country dummy, and the bars represent 95% confidence intervals. The null hypothesis of equal home bias is rejected at $p<0.001$.

To investigate potential differences in the home bias depending on trading activity, we compute the total purchase volume of a firm during our sample period, and interact this variable with the INTRA-dummy. The results are shown in Table 3 and indicate that the home bias decreases in the total trade volume, suggesting that larger firms (which tend to trade more) face smaller international trade frictions. This effect is driven by the extensive margin, whereas the coefficient on the interaction term is not statistically significant for the intensive margin. These results are qualitatively consistent with the results reported by Jaraitė-Kažukauskė and Kažukauskas (2014), who find that larger firms face smaller overall transactions costs.

Table 3: Home bias by total purchase volume

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	6.105***	-0.463	0.243***
	(0.995)	(1.109)	(0.030)
INTRA×Log total purchase volume	-0.238***	0.068	-0.0013***
	(0.059)	(0.063)	(0.0003)
BC-year FE	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Observations	1,629,730	30,746	1,629,730

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered on the buyer-seller country pair level. Overall: All allowance purchases within the full sample. Intensive: Observations with a positive transaction volume only. Extensive: Indicator function that is 1 in case of positive trade connections, and 0 otherwise. For Probit estimations, the average marginal effects are reported. Log total purchase volume is the logged value of the account-specific total allowance purchases over the sample period, 2005-2013.

3.2 Underlying mechanisms

Our results indicate the presence of a strong home bias, which furthermore differs across firm location and firm size. In this subsection, we focus on two potential mechanisms that can explain this result: Existing trade networks in goods and services, and fixed vs. variable costs of allowance trade.

If allowances could only be bought and sold on exchanges (all of which have the same allowance price), our results would imply differential transactions costs in accessing exchanges, which is of course possible. In this case, all firms face the same permit price

but still differ concerning their transactions costs, hence marginal abatement costs will not be equalized. However, the presence of a home bias, even in countries that do not have exchanges where EUAs are traded—(the majority of the countries in our sample), suggests that many allowance transfers occur via brokers or bilaterally between the two involved parties ("over the counter"). Although there is no official information as to what proportion of allowances are traded on vs. off exchanges, (broker-supplied) evidence exists suggesting that many transactions in our sample period take place outside an organized market (e.g., Ellerman et al. (2016) or World Bank (2012, p. 33).[19] Market participants most likely engage in bilateral trade in order to avoid the fees and implicit costs associated with international exchanges. It is not clear how the transactions costs in bilateral trade are divided between seller and buyer, as this depends on relative bargaining power (Stavins, 1995). However, for cost-minimizing firms, the wedges between bilateral total allowance costs and exchange prices cannot differ by more than the costs associated with accessing international exchanges (see section 2.1).

Bilateral exchange is characterized by information asymmetries, e.g. due to search frictions or contract uncertainty (Chaney, 2014). This suggests that personal trade networks may be important in allowance trade. Potential buyers and sellers of EU allowances may learn about each other through existing trade relationships in the goods and service markets. Since firms have, on average, a more extensive domestic trade network, informational transactions costs are lower within countries than across borders, i.e., the probability to find a trade partner domestically is higher. Given the well-documented home bias in the latter (McCallum, 1995), it is thus possible that the trade pattern in goods and services can explain the home bias in the EU ETS.

To test this hypothesis, we re-run our regression specifications of Table 2, but add the total yearly bilateral trade volume in goods and services between countries as a control variable. Table 4 shows the results for the specification including the most restrictive set of fixed effects. Focusing on the overall purchase volume in column (1), we find that the

[19]The EUTL data only contain the transfer amounts and details about the involved parties, but no information about the price or whether the trade took place on an exchange. Note also that it is not possible to infer the number of off-exchange trades by subtracting the exchange-traded volume from total transactions, since some exchanges settled forward contracts financially rather than physically.

Table 4: Home bias when controlling for trade in goods and services

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	0.727*	0.760***	0.014**
	(0.442)	(0.241)	(0.006)
Log imports in goods & services	0.236**	0.005	0.0079***
	(0.094)	(0.051)	(0.0007)
BC-year FE	yes	yes	yes
SC-year FE	yes	yes	yes
Firm FE	yes	yes	yes
Obs.	1,629,730	30,746	1,629,730

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered on the buyer-seller country pair level. Imports in goods and service are total imports of goods and services at the country-pair-year level (see Section 2 for more details). Overall: All allowance purchases within the full sample. Intensive: Observations with a positive transaction volume only. Extensive: Indicator function that is 1 in case of positive trade connections, and 0 otherwise. For Probit estimations, the average marginal effects are reported.

magnitude of the home bias is reduced by about two thirds.[20] This suggests that existing trade networks for goods and services can explain an important part of the home bias in the EU ETS. Table 4 further implies that this mechanism works mostly via the extensive margin, since the home bias on the intensive margin remains about the same as without controlling for trade in goods and services.

An alternative, or complementary, mechanism that could lead to a home bias in allowance trade are foreign market entry costs (Chaney, 2014; Rauch, 1999; Melitz, 2003), which would be fixed in nature. To investigate this possibility, we construct a binary variable, $EST_{bf,bc,sc,y}$, that is one if buying firm bf has already established a trade connection with seller country sc in any year prior to y, and zero otherwise:

$$EST_{bf,bc,sc,y} = \mathbb{1}\{\sum_{t=2005}^{t=y-1} X_{bf,bc,sc,y} > 0\} \tag{5}$$

Table 5 shows the results of including this dummy variable in the regression. We find that having previously traded with a counterparty in a given country significantly increases a firm's probability for further trades along both margins. Furthermore, the coefficient on the interaction term implies that the overall home bias is significantly smaller

[20] This is derived by $\frac{e^{1.832}-e^{0.727}}{e^{1.832}} = 0.669$.

for firm(buyer)-country(seller) pairs that have already traded before, due to a reduction along the extensive margin. Having a previously established trade connection increases the probability of a trade by 9 percentage points.

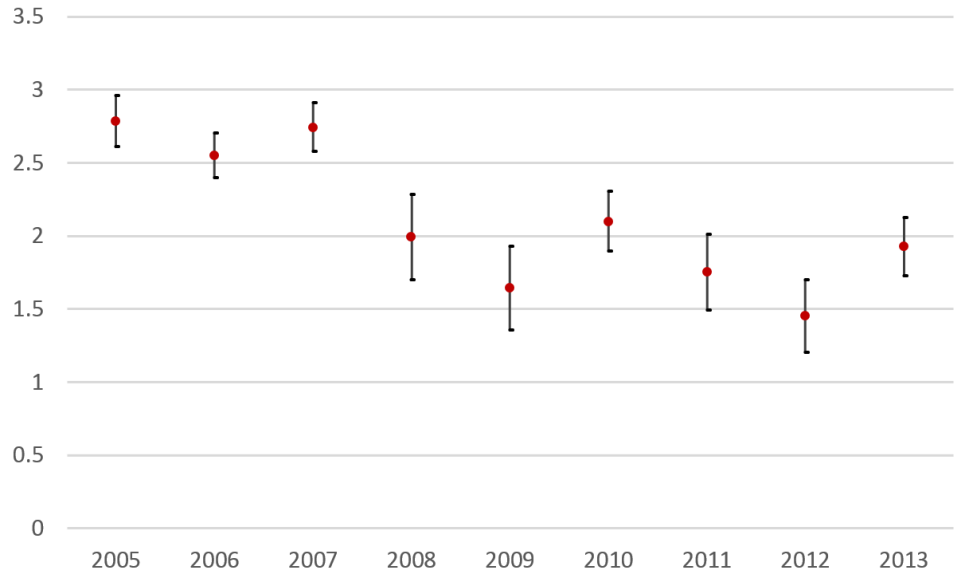
Table 5: Allowance purchases 2005-2013, conditional on established trade connections

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	2.444***	0.659***	0.115***
	(0.241)	(0.239)	(0.009)
EST	2.527***	0.520***	0.092***
	(0.132)	(0.097)	(0.005)
INTRA*EST	-1.419***	0.078	-0.014***
	(0.259)	(0.251)	(0.001)
BC-year FE	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Observations	1,629,730	30,746	1,629,730

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered on the buyer-seller country pair level. Overall: All allowance purchases within the full sample. Intensive: Observations with a positive transaction volume only. Extensive: Indicator function that is 1 in case of positive trade connections, and 0 otherwise. For Probit estimations, the average marginal effects are reported.

If cross-border transactions costs occur predominantly when establishing a new trade relationship, the home bias could be an initial phenomenon that diminishes over time as more trade connections have been formed. To test this hypothesis, we create year-dummies and interact them with the INTRA-dummy. Figure 3 shows the point estimate and confidence intervals for the overall home bias; the full results are shown in Table A3 in the Appendix. The home bias indeed decreased over time, although it has not disappeared in 2013, the ninth year of the EU ETS. The null hypothesis of a time-invariant home bias is rejected at p<0.001.The decrease is consistent with an increasing number of firms having incurred the fixed cost of foreign market entry. However, it is important to keep in mind that other—non-exclusive—possible explanations exist for the results in Figure 3. For example, a decrease in the home bias over time might alternatively be explained by an ongoing process of market integration across the EU (Bergstrand et al., 2015).

Figure 3: Home bias (dots) over time and 95% confidence intervals.



Note: Results are based on the estimates presented in column (1), Table A3 in the Appendix.

4 Robustness tests

To assess the robustness of our results, we conduct a series of tests using different subsamples of the data. In this section, we discuss the qualitative findings of these tests. The corresponding tables can be found in the Appendix.

In our baseline specification, we have aggregated all trades to the firm level. However, it is possible that firms belonging to the same owner pool allowances among themselves just like a firm can use a PHA to pool the allowances from its various OHAs. To control for this possibility, we aggregate the data to the level of the Global Ultimate Owner (GUO) as defined by the Orbis database. Table A4 presents the estimates. The results are qualitatively similar to the regressions involving the firm-level sample, suggesting that trade within firms owned by the same owner are not responsible for the home bias.

We were not able to associate all accounts in EUTL within the Orbis database, especially not PHAs. To ensure that the home bias is not driven by "invisible" intra-firm trade between accounts that in fact belong to the same firm, but for which we cannot establish a connection via Orbis, we have re-estimated our model using only accounts for which we do find information in Orbis. Table A5 presents the results aggregated to the firm level (colums 1-3) and the GUO level (colums 4-6). The resulting home bias remains

statistically significant and quite similar to the regressions based on the full sample.

The EU ETS covers large installations in energy-intensive sectors (which are assigned an OHA), but anyone can open a PHA and trade allowances and in fact a large share of the allowance trade occurs via PHAs. As discussed above, some of the trades involving PHAs are carried out by firms owning installations covered by the EU ETS that find it convenient to centrally collect and manage the free allocation of their OHAs. However, other allowance trades involving PHAs are unrelated to emissions compliance. Since the beginning of the market, many financial institutions have included allowances into their portfolio as an additional asset. The existence of a home bias for trade that is primarily motivated by hedging or speculation does not necessarily imply an inefficiency in terms of emissions abatement, if compliance trade is not subject to this friction.

Furthermore, there is evidence that some allowance trade took place with the purpose of perpetrating a value added tax (VAT) fraud (Efstratios, 2012; Nield and Pereira, 2016). These tax fraud schemes exploited the fact that the EU levies a VAT on the sale of emission allowances if it they are traded within a country, but that sales across borders are exempt from VAT.[21] For the tax fraud scheme to work, the trader that owes the VAT payment to the respective national government has to disappear (this firm is referred to as the "missing trader"). Since OHAs represent physical installations owned by firms that can easily be located, VAT fraud necessarily involves a PHA on at least one side of the trade.

In order ensure that our results are not driven by transactions that are either legitimate trades unrelated to compliance, or artificial trades in the context of VAT fraud, we restrict our analysis to transactions where both sides of the trade are OHAs. Table A6 shows the corresponding regression results. Again, we find strong evidence for a home bias. For this sub-sample, the coefficient on the intensive margin is positive even without including

[21] A typical mechanism for VAT fraud involves a carousel of firms located in different countries, as in the following example: Firm 1 located in country A sells allowances to firm 2 located in country B. Because this is an international (but intra-community) sale, it is exempt from the VAT. Next, firm 2 sells the allowances to firm 3, which is also located in country B. Firm 2 charges the VAT to firm 3, but never forwards it to the tax agency in B. Firm 3 then sells the allowances back to firm 1, and because this is again an international transaction, the tax authorities in B reimburse it for the VAT. If all three firms belong to the same criminal organization, the allowances can be sent around in a circle many times. The financial gains accrue because firm 3 receives the VAT reimbursed from the tax authority in B, but the tax authority never receives this tax from firm 2, which disappears (a "missing trader"). The system has since been reformed such that this type of fraud is no longer possible.

firm fixed effects, which is likely due to the absence of the firms with the largest trading activity, which tend to be PHAs.

Since the VAT fraud was particularly widespread in France, and it occurred mostly during Phase II of the system (Nield and Pereira, 2016), we re-run the analysis (a) after excluding all trades where either the buying or selling account holder is located in France, and (b) after restricting the sample to the first period (2005-2007). The results are shown in Tables A7 and A8, respectively. The qualitative nature of the results remains unchanged. Finally, note that since VAT fraud necessarily involves international transactions (in addition to domestic ones), widespread VAT fraud will likely decrease the extent of the home bias, not exacerbate it.

Last, we re-run our regression analysis for the sales of allowances by aggregating our transaction data to the firm(sf)-country(bc)-year(y) level. Even though the underlying transaction data is the same, differences in the results could arise due to differences in aggregation. The results are shown in Table A9, and they are again very similar to those from the base model.

5 Conclusions

In this paper, we provide evidence for a home bias in allowance trading in the EU ETS during the years 2005-2013. The home bias occurs along both margins of trade, persists even in the ninth year of the market and is robust to the use of different sub-samples. Since allowances are perfectly homogenous and not associated with transportation costs, these trading frictions point to the presence of informational transactions costs that increase across borders. Interestingly, the home bias becomes smaller if we control for trade patterns in goods and services, for which a well-established home bias exists. This suggests that firms use their existing trade networks to overcome informational costs in allowance trading.

We find that the home bias differs across countries and decreases with firm (trade) size. In the presence of heterogeneous transactions costs, marginal abatement costs will not be equated across polluters, and thus compliance costs will not be minimized.

Although the econometric results are clear and robust to a series of alternative specifications, the economic consequences are less obvious. The welfare loss is an increasing function of the difference in (total) allowance costs between participating firms. However, the presence of a home bias *per se* does not allow us to judge the magnitude of the cost differential. One the one hand, even small differences in trade costs for a homogenous good can lead to an almost complete home bias; on the other hand, the underlying reason for a home bias could be significant cost differences due to search costs and exchange fees. Since the latter are significant, especially for smaller firms, the welfare cost could potentially be large in the EU ETS. However, to quantify the welfare consequences with a sufficient degree of certainty, it would be necessary to estimate marginal abatement costs or transactions costs across firms and countries. This is beyond the scope of the current paper, and we leave this for future research.

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Appendix

Table A1: Country-level Estimates

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	1.983***	1.976***	0.487***
	(0.184)	(0.172)	(0.011)
BC-year FE	yes	yes	yes
SC-year FE	yes	yes	yes
Obs.	6,804	6,804	3,287

Note: The unit of analysis is the buying country rather than the buying account holder. For additional notes, see Tables 2-5 in the main text.

Table A2: Descriptive statistics for the OHA subsample

Variable	**Sample**	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Obs.**	**Units**
	Dependent Variable						
Purchases CO2 allowances	Overall	1,055	43,891	0	8,008,642	350,028	tCO2
	Intensive	93,110	401,812	1	8,008,642	3,967	tCO2
	Extensive	0.011	0.106	0	1	350,028	-
	Explanatory Variables						
INTRA	Overall	0.042	0.20	0	1	350,028	-
	Intensive	0.612	0.487	0	1	3,967	-

Table A3: Variation of home bias over time (full sample)

	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA · 2005	2.783***	1.389***	0.073***
	(0.175)	(0.122)	(0.007)
INTRA · 2006	2.549***	1.203***	0.122***
	(0.154)	(0.117)	(0.009)
INTRA · 2007	2.741***	1.249***	0.141***
	(0.165)	(0.100)	(0.010)
INTRA · 2008	1.989***	0.718***	0.155***
	(0.292)	(0.187)	(0.115)
INTRA · 2009	1.641***	0.809***	0.096***
	(0.287)	(0.197)	(0.013)
INTRA · 2010	2.098***	0.940***	0.108***
	(0.203)	(0.105)	(0.015)
INTRA · 2011	1.750***	0.564***	0.130***
	(0.258)	(0.130)	(0.017)
INTRA · 2012	1.452***	0.580***	0.159***
	(0.248)	(0.158)	(0.018)
INTRA · 2013	1.924***	0.820***	0.234***
	(0.197)	(0.094)	(0.016)
BC-year FE×Year FE	Yes	Yes	Yes
SC-year FE×Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Observations	1,629,730	30,746	1,629,730

For notes, see Tables 2-5 in the main text.

Table A4: Home bias after aggregating to the level of global ultimate owner (GUO)

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	1.624***	0.724**	0.143***
	(0.201)	(0.110)	(0.013)
BC-year FE	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes
GUO FE	Yes	Yes	Yes
Observations	1,334,415	26,027	1,334,415

Note: This sample is aggregated to the level of the global ultimate owner in the Orbis database. Accounts for which we found no match in Orbis, or for which Orbis supplied no GUO, are retained and treated as an individual GUO. For additional notes, see Tables 2-5 in the main text.

Table A5: Home bias after removing intra-firm trades

Dependent Variable:	Allowance purchases					
	Orbis firms only			Orbis GUO only		
	Poisson PML		Probit	Poisson PML		Probit
	Overall	Intensive	Extensive	Overall	Intensive	Extensive
	(1)	(2)	(3)	(4)	(5)	(6)
INTRA	1.832***	0.792***	0.141***	1.421***	0.623***	0.134***
	(0.196)	(0.096)	(0.013)	(0.238)	(0.124)	(0.013)
BC-year FE	Yes	Yes	Yes	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm / GUO FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,515,489	29,087	1,515,489	532,564	10,324	532,564

Note: In the subsample "Orbis firm only", we have restricted the analysis to firms that we can identify in the Orbis database (i.e., firms with a BvD ID). In the subsample "Orbis GUO only", we have further restricted the sample to firms for which Orbis lists a global ultimate owner and aggregated the data to that level; if none is listed, the firm is excluded. For additional notes, see Tables 2-5 in the main text.

Table A6: Home bias for the OHA subsample

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	3.521***	0.425**	0.120***
	(0.162)	(0.130)	(0.009)
BC-year FE	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes
Account holder FE	Yes	Yes	Yes
Observations	350,028	3,967	350,028

Note: This sample is restricted to include only transactions of OHA accounts on the buyer as well as the seller side. Standard errors are clustered on the buyer-seller country pair level. For additional notes, see Tables 2-5 in the main text.

Table A7: Excluding France

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	2.086***	0.995***	0.147***
	(0.187)	(0.070)	(0.013)
BC-year FE	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Observations	1,414,020	26,211	1,414,020

Note: This sample is restricted to transactions where neither the buying nor the selling account is located in France. For additional notes, see Tables 2-5 in the main text.

Table A8: Home bias during Phase I only

Dependent Variable:	Allowance purchases		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	2.658***	1.261***	0.298***
	(0.148)	(0.114)	(0.018)
BC-year FE	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Observations	120,224	3,567	120,224

Note: This sample is restricted to transactions taking place during Phase I of the EU ETS (2005-2007). For additional notes, see Tables 2-5 in the main text.

Table A9: Home bias based on allowance sales, 2005-2013 (full sample)

Dependent Variable:	Allowance sales		
	Poisson PML		Probit
	Overall	Intensive	Extensive
	(1)	(2)	(3)
INTRA	1.870***	0.925***	0.170***
	(0.192)	(0.115)	(0.015)
BC-year FE	Yes	Yes	Yes
SC-year FE	Yes	Yes	Yes
Account holder (Seller) FE	Yes	Yes	Yes
Observations	1,566,378	30,875	1,566,378

Note: In this regression, we aggregate the transaction data to the account holder (seller)-country (buyer)-year level (see the main text for details). For additional notes, see Tables 2-5 in the main text.