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Demand for offsetting and insetting in the EU Emissions Trading System

Misato Sato*, Marta Ciszewska** and Timothy Laing***[1]

Abstract

International carbon offsetting can help reduce compliance costs in emissions trading schemes and at the same time support carbon mitigation projects in developing countries. A surprising observation from the European Union Emissions Trading System's experience with offsetting is that companies do not fully utilise offsetting for compliance despite the cost advantage in doing so. However, so far there has been limited research evaluating what factors influence companies' decisions to utilise offsets. This paper fills this gap by investigating the demand for carbon offsets in tradable permit emissions markets. To do so, we use detailed firm-level data on 279 companies regulated under the EU ETS during 2008-2012. Our findings suggest that there are clear sectoral differences and that, contrary to expectations, transaction costs and over-allocation of free allowances are not the key determining factors. We find some evidence to support the existence of 'insetting', that is, companies with subsidiaries in key offset countries are more likely to use a larger share of their offset allowance for compliance. Semi-structured interviews with companies supported these findings.

1. Introduction

Carbon trading mechanisms have emerged as the most favoured policy instrument for the control of greenhouse gas emissions. Globally, one regional (EU), 4 national (Kazakstan, South Korea, New Zealand and Switzerland) and 12 subnational schemes are currently in place, covering around 9% of global emissions in 2015 (World Bank and Ecofys 2014). The European Union Emissions Trading System (EU ETS) is by far the largest and has been in operation since 2005. A decade of its operation offers valuable lessons for all, including some 15 more schemes that are currently scheduled or under consideration.

An important, but under-studied, area of carbon trading is the use of international carbon offsetting mechanisms[2] which allow installations to invest in international carbon reduction projects for compliance. Under the EU ETS, in accordance with the Kyoto Protocol, two additional flexible mechanisms have been adopted to improve the effectiveness of the scheme: the Clean Development Mechanism (CDM) and Joint Implementation (JI).[3] The underlying rationale for linking the EU ETS to the mechanisms has been clearly stated in the European Commissions' Linking Directive (2004):

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[2] For the purpose of this study, the terms "offsetting" "project-based " and "flexible" mechanisms are used interchangeably.

[3] The Clean Development Mechanism is defined in Article 12 of the Kyoto Protocol. It allows a country with an emission reduction limitation (Annex B) to implement emission reduction projects in developing countries. Joint Implementation is defined in Article 6 of the Kyoto Protocol. It allows an Annex B country to earn Emission Reduction Units (ERUs) from a project in another Annex B Party.

"Linking the Kyoto project-based mechanisms to the Community scheme [...] will increase the diversity of low-cost compliance options … leading to a reduction of the overall costs of compliance … while improving the liquidity of the Community market in greenhouse gas emission allowances."

As a result of these mechanisms, emissions reductions in projects are exchanged for credits that could be used by companies covered by the EU ETS to meet a set share of their compliance requirement, a process commonly referred to as offsetting. More specifically, companies can acquire Certified Emission Reductions (CERs) from CDM projects or Emission Reduction Units (ERUs) from JI projects. These can be purchased directly from the original party or by directly investing in CDM or JI projects (primary CERs or ERUs) or from the marketplace (secondary CERs and ERUs).

Curiously, however, the uptake of low-cost compliance options has varied considerably across operators. Despite the clear economic incentives to maximise the use of offsets (because the prices in offset markets have been low relative to the EU ETS) not all firms chose to do so. This suggests the existence of factors other than regulatory cost minimisation that drives the uptake of offsetting. According to one survey which asked companies regulated under the EU ETS about their compliance strategies, around 20% of respondents used trading as the primary compliance strategy, 30% reduced their own emissions, 5% used CDM/JI projects and over 50% used a combination of the three (Point Carbon 2008).

While much attention has been paid to the supply side of offset markets, surprisingly, there has been little research undertaken to date to understand the demand for international credits. This paper aims to fill this gap and to this end, we adopt two approaches. First, we conduct a quantitative assessment of the factors driving the observed variation in the use of offsetting across companies regulated under the EU ETS, and examine how this varies between sectors and credit types: CDM and JI. To do so, we exploit the large variation in firms regulated under the EU ETS and use detailed firm level data, Second, we use a series of semi-structured interviews to obtain qualitative evidence to support our findings.

By better understanding the corporate decision-making processes and market realities of offsetting, this paper aims to contribute to discussion on the assessment and design of flexible mechanisms in emissions trading schemes globally. Indeed, many of the intended nationally determined contributions (INDCs) pledged leading up to the Paris Conference of the Parties (COP) in 2015 also included the use of international credits for compliance.

We find new and interesting evidence how variation in offset usage across firms relate to observable characteristics including firm size, sector, and ownership structure. For example, our data reveals that contrary to expectations and all else being equal, smaller firms use relatively more offsets, and that firms that receive excess free allocation (relative to their emissions) are more likely to undertake more offsetting. In terms of sectors, firms in steel and cement are most likely to use offsetting for compliance. Our results also finds new evidence to support the phenomena of 'insetting' within the EU ETS (Tipper et al 2009). This describes the behaviour of firms to take actions to reduce carbon emissions within the sphere of influence or interest of a company, but beyond its day-to-day activities. For example, actions taken to reduce carbon emissions in suppliers or subsidiaries would fall within this definition. Our results indicate that some amount of insetting has occurred but the role of subsidiaries on firms' offsetting behaviour is mixed across industry and country – with greater impact of subsidiaries in JI countries than CDM, reflecting the greater institutional requirements and need for local expertise in this mechanism. These findings are broadly supported by the interviews conducted.

The paper is structured as follows. Section 2 gives the context by outlining the structures of the EU ETS and the use of offsets in the scheme. Section 3 discusses factors influencing corporate strategy in relation to project-based mechanisms, drawing on insights from the existing literature. Section 4 presents the quantitative analysis including data, methods and results. Section 5 presents the qualitative assessment and the additional insights gained from interviews with company representatives. Section 6 offers some discussion of our findings, policy implications and concludes.

2. Offsetting in EU ETS Phase 2 (2008-2012)

The EU ETS provides an excellent case study to explore the role of offsetting in emissions trading due to its maturity and the extensive use of offsetting. The EU ETS's operation has been split into three distinct phases each with varying regulations relating to the use of offsets. Phase I between 2005 and 2007 was designed as a self-contained pilot phase. There were no provisions for the use of offsets, however the regulatory mechanisms for the use of offsets in Phase II had already been put in place through the so-called 'Linking Directive'. The Directive allowed Member States to grant operators the right to use international credits up to a defined percentage through their National Allocation Plans (NAPs), with CERs from the CDM and ERUs from JI becoming fully fungible with the EU ETS's EU Allowance Unit (EUAs). Each member state had the right to define for itself the limit of the use of CERs and ERUs – having regard for the provisions of the Kyoto Protocol and the Marrakesh Accords and the requirement that credits must be supplemental to domestic action.

Figure 1. Offset usage during EU ETS Phase 2 by type Source: EUTL

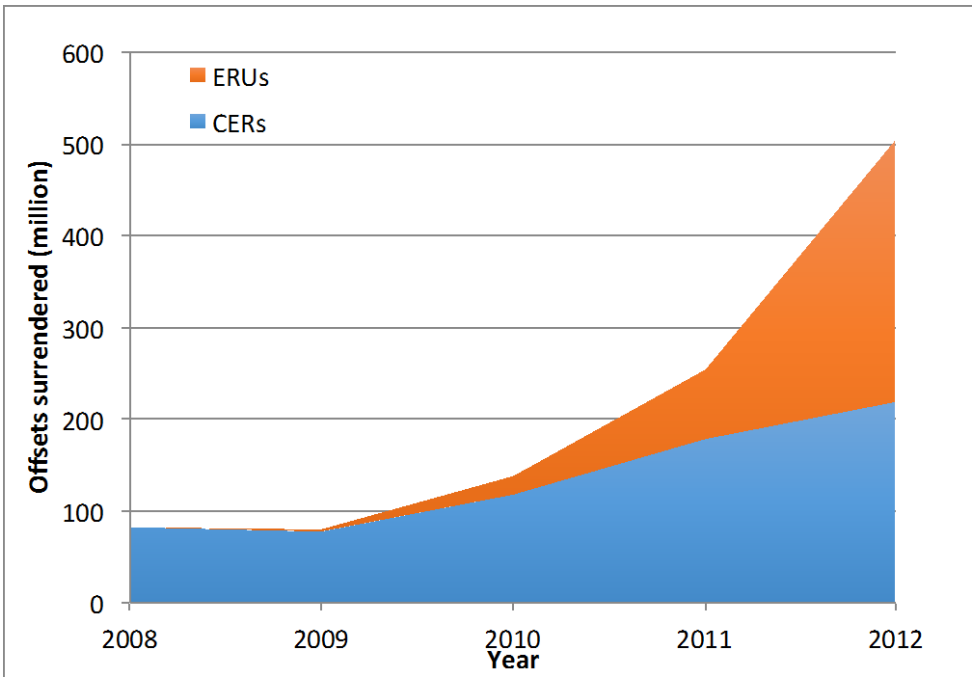

Table 1: Usage of CER and ERU credits by companies with the largest entitlements in Phase 2

	Type	Total	%Total	SUM	Limit	Usage
RWE Group	CER	15236226	53.3%	28582435	74,323,236	38.5%
	ERU	13346209	46.7%			
E.ON AG	CER	41271785	77.7%	53140146	65629103	81%
	ERU	11868361	22.3%			
Vattenfall AB	CER	19991555	93%	21493540	63812329	33.7%
	ERU	1501985	7%			
ArcelorMittal	CER	33049118	73%	45270852	52724453	86%
	ERU	12221734	27%			
Endesa S.A.	CER	25966307	96.6%	26891586	52556175	51.2%
	ERU	925279	3.4%			
ENEL SpA	CER	19155239	99.1%	19333536	36372226	53.2%
	ERU	178297	0.9%			
PGE S.A.	CER	25692493	95.1%	27009121	27010450	100%
	ERU	1316628	4.9%			
EDF Group	CER	5126868	56.4%	9086558	24757525	36.7%
	ERU	3959690	43.6%			
ThyssenKrupp AG	CER	6388908	31.3%	20432367	22854947	89.4%
	ERU	14043459	68.7%			
ČEZ Group	CER	5134137	27.4%	18760787	22570774	83.1%
	ERU	13626650	72.6%			
GdF Suez	CER	13310660	71.1%	18724123	21796754	85.9%
	ERU	5413463	28.9%			
PPC S.A.	CER	9651426	48.4%	19935392	19935392	100%
	ERU	10283966	51.6%			
Iberdrola S.A.	CER	9853244	75.7%	13017247	19102500	68.1%
	ERU	3164003	24.3%			
Gas Natural Fenosa	CER	7557673	72.8%	10385214	19021283	54.6%
	ERU	2827541	27.2%			
Eni S.p.A.	CER	714778	38.3%	1864778	17938817	10.4%
	ERU	1150000	61.7%			
EDP S.A.	CER	11836542	80.3%	14746252	16182689	91.1%
	ERU	2909710	19.7%			
Lafarge SA	CER	14271118	100%	14271234	15453485	92.3%
	ERU	116	0			
Tata Steel	CER	10976027	82.5%	13307735	15179820	87.7%
	ERU	2331708	17.5%			
Total S.A.	CER	4628156	33.6%	13782070	14772445	93.3%
	ERU	9153914	66.4%			
STEAG GmbH	CER	7587429	59.4%	12782846	14715297	87%
	ERU	5195417	40.6%			
Heidelberg Cement	CER	1661910	12.1%	13738082	13953079	93.3%
	ERU	12076172	87.9%			

This method of allocation meant that there was in effect an overall cap of the total amount of credits allowed into the EU ETS. The total sum of the flexible space allowed across member state came to 1.4 billion tonnes over Phase 2 (2008-2012)[4] of which around 76% was used. As shown in Figure 1, the use of offset credits, both CERs and ERUs grew rapidly, throughout Phase II of the scheme, with annual usage substantially higher in 2011 and 2012 than in 2008.[5]

Within this overall flexible space, there was a high range of variability across member states and industries and over time in how much credits could be used for compliance. Some countries such as Estonia disallowed any offset use, while Germany and UK allowed companies to use offsets up to 22% and 8% of compliance respectively (Trotignon 2012).

Along with such quantitative restrictions, quality restrictions were also applied on the use of credits, mostly at the European level. For example, credits originating from nuclear facilities or relating to Land Use, Land Use Change and Forestry (LULUCF) were excluded. Further, from the beginning of Phase III (2013), CERs and ERUs were no longer compliance units – and could not be surrendered directly. Instead they were required to be exchanged with EUAs. Credits from industrial gas destruction projects and those from non-Least Developed Countries (in particular, CERSs from China and India) were disallowed from April 2013.

How did companies respond to these flexibility mechanism rules under the EU ETS? Table 1 shows the usage of CER and ERU credits by 21 companies with the largest offset entitlements in Phase 2. What is striking is the variability of uptake of offsetting across companies. Particularly in the energy sector, some notable actors have been inactive in their use of offset credits, regardless of existing deficits of allowances. For instance, RWE, Vattenfall or EDF or Eni used less than 50% of their entitlements. At the same time, there are companies that have used the whole of their available limit, such as both Polish PGE and Greek PPC. Uptake by companies in the iron and steel (ArcelorMittal, ThyssenKrupp) and cement (Lafarge, HeidelberCement) sectors tend to be consistently high, nearing or exceeding 90% in most cases.

3. Factors influencing corporate strategy in relation to project-based mechanisms – insights from the related literature

The existing literature on project-based flexible mechanisms has focused on the supply side, and there is little written on the nature of the demand for CDM or JI credits. In particular, existing studies tend to assess effective design of flexible mechanisms (Paulsson 2009), the issue of additionality (Wara and Victor 2008, Schneider 2009, Grubb et al 2011, Hayashi and Michaelowa 2013) as well as its contribution to sustainable development (Sutter and Parreno 2007, Schneider 2007, Olsen 2007).

There is limited academic literature on the demand for carbon offsets and to our knowledge, no papers have yet explicitly examined the drivers of investment in CDM and JI empirically. However, discussions in the related literature point to a number of potential factors that may drive differences in offsetting behaviour across firms.

Sandbag (2010a, 2010b, 2012) highlights **sectoral differences in offsetting behaviour**, by offering a descriptive analysis of the CER and JI markets focusing on the largest companies

[4] See http://ec.europa.eu/clima/policies/ets/pre2013/index_en.htm

[5] A large amount of this influx came from industrial gas destruction projects – which raised doubts over their additionality and lead to revised plans for Phase III.

using offsets. They show that the power sector (which has the most stringent cap) is the most active in the pursuit of cheaper offsets as expected. This suggests that the difference between allocation and verified emissions (i.e. **overallocation** of free allowances) may play a role, such that companies that receive significant surplus free allowances relative to verified emissions may be less likely to maximise offset use. Indeed, Lutken and Michaelowa (2008) argues that overallocation could change the motivation of companies that have already fulfilled obligations of the EU ETS, from emissions reductions cheaply to extracting financial arbitrage. However, the evidence to support this is not found in the Sandbag reports – they find that companies that received significant surpluses of allowances, mainly steel and cement sectors, have also pursued additional profits through trading offsets. Interestingly, an increasing number of credits used by steel and cement sectors have originated from projects in competing companies (Sandbag 2012).

Some studies suggest that **firm size** may affect offsetting behaviour, primarily due to the existence of **transaction costs**. Transaction costs pose a barrier to exercise the opportunity to use offsets for compliance, suggesting the importance of internal capacity at the company level. This also suggests that smaller companies maybe more constrained in terms of managerial availability and manpower, reducing their ability to collect the necessary information and make an informed decision (Buckley 1989). Trotingnon (2012) looks at offseting in EU ETS in 2008 and 2009 and finds that factors such as transaction costs particularly affect small installations. Braun et al (2015) find, using a stylised model and annual compliance data from the EU ETS, that offset usage quotas coupled with firm-level heterogeneity in transaction costs explains variation in compliance options used across firms.

On the other hand, transaction costs also suggests that barriers may be lower for companies with **international linkages** in offset countries. Indeed, a number of studies point to the importance of having **international subsidiaries**. Michaelowa and Jotzo (2005) argue that transaction costs (e.g. search costs and negotiation costs) in CDM projects can account for a significant share of the total cost of the investment but can be eliminated in the case of investment in their own subsidiary. Thus, companies with an international presence have better opportunity to invest in projects. Lutken and Michaelowa (2008) suggest that offsetting behaviour is linked to companies' existing international operations, explaining that the prime driver of companies' decisions lay in their core business activity. They argue that companies in Annex B countries are less likely to divert from their core business, technology and investment destination and invest in unfamiliar sectors or countries. These argument links to the concept of insetting, introduced formally by Tipper et al (2009) as: *'a partnership/investment in an emission reducing activity within the sphere of influence or interest of a company (outside WBCSD Scopes 1 and 2), whereby the GHG reductions are acknowledged to be created through partnership and where mutual benefit is derived.'* (p.3) Despite coverage in the grey literature and the international press (Guardian 2015), insetting has not yet been studied academically to our knowledge.

Trotingnon (2012) argues that small installations are more affected by the lack of capacity to deal with **uncertainty** regarding the nature of the CERs on offer. Nazifi (2013)'s investigation into the price spread between EUAs and CERs finds that the spread is in part driven by the uncertainty associated with offsets, mostly concerning financial institutions delivering them, as well as the uncertainty around the long-term future of the overall market. One of the implications is that the usage of the CDM credits would be affected by the capacity and willingness of the company to take on the risk. This is in line with Lutken and Michaelowa (2008)'s assessment that **corporate personality and culture** also play a role in investment decisions choices around risk-taking and compliance behaviour.

Relatedly, a number of papers have examined the motivations of actors in the voluntary carbon market focusing on markets in the US (Erickson et al 2013) and international air passengers (Mair 2011). Peters-Stanley and Yin (2013) find that purchases are generally motivated by **Corporate Social Responsibility** (CSR), rather than the need to meet regulatory requirements. The demand in the voluntary sector differs significantly in both size and type from the compliance market, such as the EU ETS, that dominates purchases of CDM and JI credits (Peters-Stanley and Yin 2013, World Bank and Ecofys 2014).

In sum, the literature points to a number of firm level characteristics that may influence offset usage including main economic activity, firm size, capacity to undertake trading, risk preferences, CSR policy, ratio between allocation and emissions, and international subsidiaries. Section 4 and 5 will go on to assess quantitatively and qualitatively whether there is evidence of these factors in the behaviour of firms under the EU ETS.

4. Quantitative analysis

4.1 Data sources

The European Union Transaction Log (EUTL) provides data for each EU ETS installation, the level of verified emissions, accredited allowances and surrendered units. The data on surrendered units are available by type of units EUAs, CERs and ERUs until 2012. From 2013, only data on the total surrendered units is available and the use of CDM or JI credits used for compliance could no longer be tracked. For this reason, this analysis uses data for EU ETS Phase 2 (2008-2012).

The unit of analysis here is the company (or operator), hence if one company has several installations covered under the EU ETS, we aggregate them up to the company level. This analysis covers 279 operators. Under this aggregation method, installations are assigned to the company that owned them prior to Phase 2, even if ownership changed during the Phase 2 period. This is because often, the strategic response and especially the choice of project financing, has been made prior to or in the early years. In the raw EUTL data, information on the firm or sector to which the installation belongs is not always provided. For this reason, we use a cleaned and enriched version of the EUTL data which has addressed these shortcomings.[6]

The sample represents offset entitlement greater than 500,000 credits, accounting for nearly 85% of all offset entitlements. It covers mainly large and medium-sized parent companies and as such, has limited explanatory power for smaller companies.

A number of factors that explain the differences in offset usage for compliance have been discussed in the literature (Section 3) including firm characteristics. We obtained information on several observable variables including firm size, annual turnover, main activity and international subsidiaries by country from the Orbis database (Bureau van Dijk). In particular, we are interested in the number of subsidiaries companies have in key CDM and JI countries (China, India, Brazil, Mexico, Russia and Poland). The firm level data was matched with the EUTL data on offset use.

4.2 Descriptive data

As shown in Table 2, during Phase 2 (2008-2012), companies did not fully use the opportunity to comply with the EU ETS obligation using offset credits, despite their cheaper

[6] This data was provided by the Global Carbon team at Statkraft.

price. Out of the total entitlement of 1.4 billion credits available from the NAPs, nearly 1.06 billion CERs and ERUs were surrendered during Phase 2 which results in close to 76 per cent usage rate within the scheme.

What we can also observe is that the use of both CERs and ERUs increased over time. The share of CDM emissions reductions has been almost twice that of JI for the entirety of Phase 2. This can be explained by the earlier development of the CDM, which was established in 2000, and accepted within the EU ETS in 2006, while JI was established later. Finally, the pattern was undoubtedly influenced by the awaited political decisions banning the use of credits from industrial gases announced in 2011, to take effect from 2013. This resulted in the increased offsets usage for compliance in 2011 and 2012 (e.g. an increase by 103% of HFC23 CERs surrendered in 2011– Sandbag 2012), indicating that the ability to tolerate risk was relevant for companies' compliance decisions.

Table 2. Summary of the aggregate compliance in Phase 2 (in 1,000)

	2008	2009	2010	2011	2012	**Total**
Verified emissions	2,119,673	1,879,607	1,938,881	1,904,532	1,951,197	**9,793,890**
Distributed allowances	1,957,937	1,972,033	1,994,366	2,016,726	2,228,584	**10,169,646**
Total offsets surrendered	83,585	80,836	137,153	253,625	503,722	**1,058,921**
CERs	83,536	77,605	117,037	177,832	219,572	**675,581**
%	99.94%	96.00%	85.33%	70.12%	43.59%	**63.80%**
ERUs	49	3,231	20,116	75,794	284,150	**383,340**
%	0.06%	4.00%	14.67%	29.88%	56.41%	**36.20%**

Table 3 summarizes the descriptive data for different sectors.[7] The combustion sector has been the largest in each year, bearing the majority of verified emissions as well as the highest restrictions. Two other carbon intensive industries – iron and steel production as well as cement production – have been viewed as threatened by competitive loss due to carbon limits, but have been generously issued free allocations.

From Table 3, it is evident that two sectors - energy and oil refining - submitted offsets totalling about 20% of their verified emissions, and had the lowest usage rates of all the sectors, with combustion of fuels being the only sector in the sample with a negative balance. At the same time, some energy intensive companies had a surplus of allowances which did not prevent them from investing in the flexible mechanisms, and treating it as an opportunity for profit beyond their mandatory obligation for mitigation.

This result is somewhat counter-intuitive, especially in the case of combustion plants, and can partially be explained by the use of installation-level data for this table, which classifies installations based on their activity while disregarding the owner's general business area. To illustrate this, out of 113 installations operated by ArcelorMittal, only 46 have a main activity related to the production of iron and steel, with 38 allocated to the combustion of fuels. This example shows that an analysis at the installation-level can be misleading, and should be carefully interpreted. For this reason, our quantitative analysis below is performed using company-level data.

7 The categorization has been made using the NACE Rev 2 classification.

Table 3: Surrendered offsets per sector in Phase 2 (in 1,000)

Main Activity	Credit entitlement	CERs	ERUs	**Usage**	Verified Emissions	Surplus	Allocation
Combustion of fuels	970,840	466,228	227,156	**71%**	7,138,754	-550,723	6,588,031
Refining of mineral oil	95,884	31,295	33,030	**67%**	703,652	52,749	756,401
Production of pig iron or steel	120,947	57,169	51,635	**90%**	501.910	347,419	849,329
Production of cement clinker and lime	116,275	70,966	39,663	**95%**	570,226	195,698	765,924
Remaining	94,082	49,923	31,855	**87%**	869,157	340,803	1,209,960
Grand Total	1,398,028	675,581	383,340	**76%**	9,783,700	385,946	10,169,646

Table 4: Descriptive Statistics for variable

Variable	**Average**	**Standard Deviation**	**Units**	**Description**	**Source**
Usage	0.863	0.232	Percentage	Usage of allowable offsets	EUTL
Average revenue	18,712,965	49,978,175	€	Average annual revenue from the company 2008-2012	Orbis
Number of subsidiaries per revenue	9.05	16.64	Number /€ of revenue (ln)	Number of subsidiaries per unit of revenue (ln)	Orbis
Phase 3 allocation	365,162	709,695	EUAs	Numbers of EUAs freely allocated in Phase 3	EUTL
Phase 2 over-allocation	-123,180	22,701,930	EUAs	Number of EUAs allocated compared to verified emissions	EUTL
Subsidiary in China	1.83	6.60	Number of subsidiaries	Number of subsidiaries in China	Orbis
Subsidiary in Brazil	1.31	4.83	Number of subsidiaries	Number of subsidiaries in Brazil	Orbis
Subsidiary in Mexico	1.23	3.77	Number of subsidiaries	Number of subsidiaries in Mexico	Orbis
Subsidiary in India	0.75	3.02	Number of subsidiaries	Number of subsidiaries in India	Orbis
Subsidiary in Russia	1.29	7.94	Number of subsidiaries	Number of subsidiaries in Russia	Orbis
Subsidiary in	2.04	6.29	Number of	Number of subsidiaries	Orbis

Poland			subsidiaries	in Poland	
Subsidiary in CDM countries	5.11	13.01	Number of subsidiaries	Number of subsidiaries in Brazil, China, Mexico and India	Orbis
Subsidiary in JI countries	3.62	10.83	Number of subsidiaries	Number of subsidiaries in Russia and Poland	Orbis

4.3 Empirical Strategy

The aim here is not to develop a full or complete explanation of cross-company variation in offset usage. Instead, it is to assess the impact of observable company characteristics on their use of offsets for EU ETS compliance. The analysis consists of cross-sectional ordinary least squares (OLS) regression of firm-level offset usage (CDM and JI) in EU ETS Phase 2 (aggregating 2008-2012) on a number of variables:

$$USAGE_i = \alpha_0 + \alpha_1(OVERALLOCATION) + \alpha_2(REVENUE) + \alpha_3(SECTOR) + \alpha_4(PHASE3) + \alpha_5(SUBSIDIARIES)$$

Here, *USAGE* is the outcome and dependent variable (the number of CERs and ERUs surrendered as a percentage of the allowable level) at the company level. We regress this on the free allocation volume as a percentage of verified emissions (*OVERALLOCATION*), average yearly revenue of the parent company in logs (*REVENUE*) which proxies for company size, a sector dummy defined as the parent company's core business activity (*SECTOR*), aggregate offset entitlements for a company in Phase 3 (*PHASE3*) to control for the effect of future allocation decisions upon current behaviour and the number of registered subsidiaries of the parent company per unit of revenue (*SUBSIDIARIES*) to represent the internal capacity for offsetting. A full description of the variables and their sources are provided in Table 4.

In order to test the role of subsidiaries in offsetting (or insetting) behaviour, we account only for those subsidiaries in relevant countries participating in offset mechanisms. Under the CDM, Annex I countries could invest in developing countries. By the end of 2012, only 63 of them issued any credits with China, India, South Korea, Brazil and Mexico accounting for over 90% of them (UNEP DTU). The scale of Joint Implementation was even smaller, the projects took place in only 15 countries with Poland and Russia accounting for a majority of ERUs issued in that period (UNEP DTU). We therefore limited our analysis of subsidiaries in CDM countries to China, India, Mexico and Brazil and Russia and Poland for JI.

As the analysis uses company-level data, sectoral classification was based on the main business activity of the company regardless of the classification of each individual installation, with companies split into five categories: Energy, Oil, Cement, Steel and other. A set of four dummy variables was used to capture this categorisation. As discussed above, the reason for the choice is varying exposure in terms of stringency of allocation, vertical and horizontal coverage of the sector, and international presence. Variables were tested for multicollinearity with no serious problems identified.

4.4 Results

Table 5 column 1 shows the results for the whole sample of data but without country-level subsidiary effects. Column 2 includes variables for the number of subsidiaries in key CDM and JI countries. Column 3 includes the total number of subsidiaries in these countries.

A number of key results emerge from examining the sample as a whole. The results indicate that, all else equal, smaller companies (in terms of turnover) tend to use a greater percentage of their offset allowance. If company size is assumed to be inversely related to transaction costs, this finding then contradicts the analytical and theoretical arguments presented above that smaller companies offset less due to high transaction costs. In addition, overallocation in Phase 2 is positively linked with offset usage. This is again contrary to theoretical predictions discussed in Section 3, that offset use increases with exposure to carbon prices. These two surprising results indicate the complex nature of determinants of offseting behaviour, and the existence of other confounding factors. For example, there may be unobserved characteristics of firms with over-allocation (e.g. higher capacity to lobby for more free allocation and/or higher trading capacity to undertake arbitrage).

The results in Table 5 also indicate that there are sectoral differences in the offset usage with steel and cement sectors being more likely to use a greater share of their offset allowance relative to the baseline sector (energy). This result is interesting because it again contradicts expectations based on transaction costs-linked arguments. That is, energy companies are expected to fully utilise offset allowance because they are more likely to benefit from existing capacity and expertise in commodities trading. Several explanations may be possible for the result that steel and cement companies use a larger share of offset allowances. They may have been more likely to be tied into CDM or JI projects for insetting purposes and, given the upfront investment, it makes economic sense to realise and utilise the flow of credits. Also, cement and steel companies may have increasingly turned to profit-making through trading international credits, as they faced greater financial difficulty during Phase 2 from the economic downturn in Europe relative to the energy sector. The energy sector may also have faced higher restrictions, both internal and external, to participate in such trading, stemming from their historical background as predominantly state-owned entities. Higher allocation in Phase 3 is linked to higher use of offset allowances, but the effect is not significant in all specifications. The number of subsidiaries per unit of revenue had no significant effect.

In terms of international linkages, a number of interesting findings emerge. As shown in column 2, the existence of subsidiaries in CDM countries (China, India, Brazil or Mexico) do not influence usage, whereas having more subsidiaries in JI countries (Russia and Poland) is linked with using more offsets. The difference between CDM and JI countries is highlighted in column 3, when we include totals for the number of subsidiaries in key CDM and JI countries – only the JI variable is positive and significant.

Table 5: Regression results using the full sample of firms

	(1)	(2)	(3)
Average revenue (Ln)	-0.0255**	-0.0275***	-0.0276***
	(0.0101)	(0.0104)	(0.0104)
Number of subsidiaries per revenue	-0.000574	-0.000921	-0.000843
	(0.000992)	(0.00101)	(0.00107)
Oil	-0.0328	-0.0291	-0.0368
	(0.0571)	(0.0579)	(0.0575)
Steel	0.0876**	0.0993**	0.0954**

	(0.0385)	(0.0409)	(0.0391)
Cement	0.0863***	0.0957***	0.0886***
	(0.0299)	(0.0316)	(0.0302)
Other	0.122***	0.130***	0.123***
	(0.0326)	(0.0344)	(0.0325)
Phase 3 allocation	3.08e-08*	1.88e-08	2.64e-08*
	(1.63e-08)	(1.66e-08)	(1.59e-08)
Phase 2 overallocation	1.44e-09***	1.56e-09***	1.53e-09***
	(4.60e-10)	(5.00e-10)	(4.70e-10)
Subsidiary in China		-0.00162	
		(0.00245)	
Subsidiary in Brazil		-0.00164	
		(0.00271)	
Subsidiary in Mexico		0.00496	
		(0.00418)	
Subsidiary in India		0.000475	
		(0.00358)	
Subsidiary in Russia		0.00240***	
		(0.000560)	
Subsidiary in Poland		0.00512***	
		(0.00117)	
Subsidiary in CDM countries			-4.90e-05
			(0.00115)
Subsidiary in JI countries			0.00290***
			(0.000662)
Constant	1.198***	1.216***	1.223***
	(0.139)	(0.143)	(0.143)
Observations	265	265	265
R-squared	0.155	0.181	0.172

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We now examine if we split the sample by key industrial groups (Table 6) resulting with smalller sample size hence less explanatory power. Of most interest here is the differential effect of specific country subsidiaries across industrial groups. Having subsidiaries in Brazil increases the use of offsets in the Oil and Steel sectors, as well as the Other sector. Having subsidiaries in China is associated with reduced offset use for energy firms. Subsidiaries in Mexico reduced offset use for oil and steel firms, while increasing use in other firms. Energy firms with more subsidiaries in India used more offsets. For key JI countries having subsidiaries in Russia increased offset use for oil firms, while Polish subsidiaries increased offset use in Energy and Oil firms. Due to the small sample size, we take caution in the interpretation of these coefficients, as well as those on other variables. Average revenue has a negative, significant effect only for energy companies. Oil companies with more subsidiaries per revenue use less of their offset allowance. We find results for Phase 3 allocation and Phase 2 overallocation that are consistent with the whole sample only for energy companies.

Table 6: Regression results by industry

	Energy	Oil	Steel	Cement	Other
Average revenue (Ln)	-0.0352**	-0.0113	-0.0234	-0.00577	-0.0194
	(0.0174)	(0.0392)	(0.0396)	(0.0157)	(0.0157)
Number of subsidiaries per revenue	0.000222	-0.0246***	-0.00282	0.000107	-0.00245
	(0.00182)	(0.00700)	(0.00389)	(0.000794)	(0.00236)
Phase 3 allocation	5.25e-08**	2.41e-07	6.09e-08	1.88e-08	2.40e-07*
	(2.44e-08)	(2.25e-07)	(3.65e-08)	(1.12e-08)	(1.36e-07)
Phase 2 overallocation	1.96e-09***	4.89e-09	3.54e-09	1.37e-10	-4.25e-10
	(5.71e-10)	(4.35e-09)	(3.68e-09)	(1.10e-09)	(6.91e-09)
Subsidiary in China	-0.0450*	-0.0356	0.0222	0.00776	-0.000834
	(0.0229)	(0.0284)	(0.0499)	(0.00952)	(0.00230)
Subsidiary in Brazil	-0.00246	0.418***	0.0995**	-4.87e-05	0.0116**
	(0.00359)	(0.0678)	(0.0330)	(0.00729)	(0.00519)
Subsidiary in Mexico	0.00420	-0.198***	-0.122**	0.00400	0.0204*
	(0.00590)	(0.0556)	(0.0526)	(0.00395)	(0.0114)
Subsidiary in India	0.0184***	-0.193	-0.00877	-0.00695	-0.0244*
	(0.00622)	(0.140)	(0.00912)	(0.0205)	(0.0143)
Subsidiary in Russia	-0.00307	0.00455***	0.152	-0.0263	0.00440
	(0.00490)	(0.00109)	(0.0931)	(0.0231)	(0.00617)
Subsidiary in Poland	0.00439***	0.00826**	0.0269	0.00420	-0.00298
	(0.00128)	(0.00304)	(0.0206)	(0.00309)	(0.00318)
Constant	1.317***	0.972*	1.233*	1.018***	1.200***
	(0.240)	(0.570)	(0.577)	(0.203)	(0.209)
Observations	109	40	19	37	60
R-squared	0.184	0.349	0.359	0.081	0.168

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Overall, this analysis represents first steps towards quantitatively understanding how observable characteristics of firms explain company behaviour in terms of offsetting and insetting activity. Our results support some of the explanations discussed in previous literature, whilst contradicting others. In particular, we find some support to the arguments that offset uptake is differentiated across sectors, that international linkages matters and insetting is occurring in some sectors - having subsidiary companies in host countries of JI and CDM projects can increase likelihood of using offsets for compliance.

5. Qualitative analysis

5.1 Methodology

To supplement the quantitative analysis, we also sought to understand offsetting behaviour through semi-structured telephone interviews with company representatives. Specifically, interviews were conducted in 2014 with representatives of 7 companies covered by the EU ETS from two sectors (Energy and cement). The interview discussions were formulated around questions (presented the in Appendix) about company structure, overall compliance strategy and the offset purchasing approach. The exact wording of questions and the order in which the topics were covered varied by interview. Each interview lasted between 30 and 90 minutes. The general profile of an interviewee in the sample is a person responsible for

the management of the company's account of carbon credits, who was involved in the EU ETS compliance throughout the entire Phase 2.

5.2 Results

The interviews conducted with market participants have indicated several patterns in strategic response to offsetting that relate closely to the variables identified in the literature in Section 3 and from the quantitative analysis in Section 4. All interviewees brought up multiple factors influencing these decisions, with the **price of offsets** identified as the leading determinant in their decision making process.

The role of **international linkages** and subsidiaries was identified in the interviews with large cement companies, who represented the only companies in the sample that practiced insetting in JI and CDM projects within their own subsidiaries. In both cases, the decisions were made prior to Phase 2. Although the political uncertainty at the time was considered, it did not impede investment suggesting that operating in subsidiaries helped to mitigate some of the uncertainty that these firms may otherwise have faced. This evidence is consistent with our results in Section 4, that having subsidiaries can affect offset usage, in certain sectors and countries.

The interviews also revealed the importance of variables that are harder to observe and quantify, such as corporate personality, culture and strategy. For example, when asked about motivations for offset use, some interviewees explained that where credits were traded, this was done only to meet the needs of the installations. In other words, the established trading desks were used only to serve the internal needs of the company, and not for further profit making, speculation and trading beyond required volumes.

Interviews with energy companies revealed that none had invested in JI or CDM projects in their subsidiaries – again highlighting the importance of sectoral differences. The indicated impediments were a combination of lack of market knowledge and relationships with necessary parties, uncertainty within the CDM and JI schemes, and lack of knowledge of the technologies which dominated the project market. Barriers to trade have also been indicated by an Eastern European utility, who managed carbon portfolios of smaller companies, for which the operational and analytical costs were too high to set up their own desks – highlighting the crucial role of transaction costs in some types of firms (though not necessarily fully correlated to firm size).

Other factors that play a role in offsetting behaviours surfaced through the interviews. For example, one European energy company (an active buyer of primary credits), stated that their participation in offset projects was motivated by the strategic need to learn about new technologies and markets. The importance of parallel environmental policies as also mentioned, in particular the EU Renewable Energy Directive. Specifically, a Southern European utility decided to significantly diversify its fuel mix and invested in new, renewable sources both internal and external to the company. Finally, the same companies indicated that the possibility to bank allowances within Phase 2 and from Phase 2 to Phase 3 has played a significant role in their compliance strategy and has been greatly utilised to limit the costs of compliance.

6. Discussion

The EU ETS provides useful experience and insights into drivers of demand for international carbon credits. While globally, the focus shifted towards domestic action in the lead up to the Paris COP in 2015, to meet ambitious global CO2 mitigation goals, it is likely that international carbon trading will be an important part of post 2020 climate actions, hence it is important to incorporate lessons learnt to improve the efficiency of future offsetting mechanisms.

This paper aims to further the understanding on the demand side of the offsets market. Why do some firms buy international credits for compliance while others don't? We survey the existing literature and conduct both quantitative and qualitative analysis to examine these issues. We find that companies' behaviour with regards to offsetting are influenced by a number of factors, both observable and non-observable.

Using firm level data for the EU ETS Phase 2 period, our regression analysis findings contradict two expected relationships: that larger firms and those more exposed to carbon costs (those with less free allocation relative to emissions) are more likely to use higher share of offset for compliance. These results indicate that the corporate strategies on offset decisions are complex and there are many confounding factors. For example our findings do not support arguments that larger companies are more likely to engage in offsetting because they benefit from larger internal capacity to engage in carbon trading. One reason for our findings may be that the importance of carbon costs to the balance sheets may be less for large firms than for smaller industrial firms with high emissions and low turnover. The companies in the sample with the largest average turnover over the period are mostly from the oil industry (Exxon Mobil, Shell, BP), the largest utilities in Europe (E.ON, Eni, GDF Suez) or their core business has a low carbon nature, as in case of Volkswagen or Daimer. In addition, larger companies may have much greater scope for internal emissions reductions, allowing them to be compliant without having to explore external options. In contrast smaller installations may have less 'low-hanging fruit' and thus meeting their compliance needs via external options may be more attractive. Testing this hypothesis is an interesting avenue for future research.

While over-allocation is expected to reduce the exposure of these firms to carbon costs, an alternative explanation is that over-allocation creates new opportunities and demand for engagement in offsets by increasing the internal capacity to undertake offsetting. Despite these firms holding sufficient allowances to cover their own emissions an incentive remained to engage in offset activity due to the prevailing price differential between offsets and allowances.

Interviews also gave insights into the nature of the relationships between firm size, allocation, banking and investment into offsetting. Some overallocated companies made strategic decisions prior to the launch of Phase 2, especially regarding project investment and designation of a devoted trading desk, creating the internal capacity to offset. As allowances in Phase 2 were grandfathered, companies with a surplus of credits were motivated by extracting profit and if their banked allowances exceeded their yearly emissions and financial transactions, the risk of non-compliance was eliminated. Thus, commitment to pre-established offsetting strategy and a mix of lower risks and access to investment possibilities also influence the uptake of offsetting in Phase 2.

That offset use cannot be easily explained by simple firm and allocation characteristics suggests that the role of unobserved factors is likely to be important. The existing literature highlights the role of corporate culture and personalities as well as risk preference, for example, and their importance was confirmed through semi-structured interviews conducted in this analysis.

Key phenomenon such as how companies have conceptually treated the EU ETS may also be key determinants of offset activity. Other studies (Laing et al 2015) have found that some companies have viewed emissions trading as a regulatory activity to be led by the environmental management department, whilst others have treated it as just another form of cost to be minimised and led by the finance department. In the case of the former a budget is allocated and regulatory targets are met, in the case of the latter assets are traded in order to minimise costs and maximise profits. In the former there is little incentive to engage in offsetting for cost minimisation purposes (although some of the 'softer' reasons for offsetting such as technology testing could still be applicable), in the latter however there are strong incentives to find the cheapest long-term option to meet companies regulatory requirements. Understanding whether there are sectoral, geographical or temporal differences in whether firms adopted the first or second approach is a key research task to understand not only offsetting behaviour, but the response to emissions trading more generally.

This paper finds some initial evidence to support the phenomena of 'insetting' within the EU ETS. Although this phenomenon has been discussed in the literature there has been no previous study of how and where it has happened in practice. We find that some amount of insetting has occurred especially through the JI mechanism within the steel sector in firms with subsidiaries in Russia and Poland.

This selective use of insetting also links to the importance of internal trading and offsetting capacity. We find that having subsidiaries in JI countries is generally more important than having subsidiaries in CDM countries in determining the use of offsets. JI was a different mechanism to the CDM with less central institutional support and a less well-developed secondary market. Therefore, to engage in offset activity with the mechanism greater understanding of, and capacity to operate in, countries where JI was located is required than for CDM projects. Firms with subsidiaries in these countries therefore are likely to have much greater capacity to engage in these projects than those without.

The data that we use is limited to use of any type of CDM or JI credit by companies. It does not allow us to examine the important distinction between the motivations of those engaged in directly investing in primary CERs or ERUs and purchasing on the secondary market. There is a clear distinction between these two types of products, and thus we would expect different characteristics between the two types of investors. Investing in primary offsets represents a potentially greater, more long-term commitment by firms in the projects generating those credits. This potentially allows the companies greater control over the quality of the offsets, or at least greater information on this quality, and also offers the potential to reap non-monetary, non-emission rewards from the offset projects, such as corporate social responsibility benefits. Secondary purchasers on the other hand may find it more difficult to procure information on quality and cannot reap these 'soft' benefits from offsetting. The EU ETS's drive towards higher quality offsets has meant a sharp-drop off in the secondary market (World Bank 2014). Our interview evidence also highlights that a number of firms have had non-monetary, non-emission reasons for investing in the amount and type of offset projects, highlighting their demand for primary CERs rather than through the secondary market.

Overall, this paper highlights the importance of understanding the determinants and motivations behind offsetting, to improve the efficiency of the design of carbon markets that aims to maximise the uptake of international credits for compliance. The EU ETS experience showed clearly that cheap prices of CERs and ERUs were insufficient to attract demand, and that demand was driven by a multitude of factors and involved a large element of risk given high levels of uncertainty in the market. Indeed, this research presents evidence that

some companies are more cautious with involvement in new projects outside of their core business activity, preferring to undertake 'insetting' than 'offsetting'. Understanding and anticipating these risk or regulatory preferences can help improve the efficiency of offsetting – e.g. in predicting demand in California's cap-and-trade programme where offsets are currently being used (IETA 2015).

The existence of the insetting phenomenon is interesting for a number of reasons. Such engagement of firms in primary credits generation can have positive effects for stimulating international technology transfers, which may be one of the aims of the flexible mechanisms. It may also have a positive effect on greening supply chains. To pursue such aims and engage such sectors in the offset market, a strong and long-term price signal and certain political messages are likely to be important, to help companies develop strategies to commit to international offsetting projects. However, it is also important to evaluate the efficiency of using insetting as a strategy to optimise international technology diffusion vis-a-vis other policy instruments. Re-evaluating the objectives and performance of offsetting (e.g. to what extend did it reduce abatement costs or help technology transfer?) is another important area for future research.

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APPENDIX – INTERVIEW OUTLINE

1. Could you explain the structure of your company; in which countries does it operate globally and within Europe? What is the level of integration of different installations/subsidiaries?
2. At what level was the decision about mitigation strategy made for each single installation compliant within the EU ETS?
3. Has your company created a special department to trade and manage the portfolio of credits? Was the service outsourced to another company?
4. Did your company invest in the primary CDM projects or JI projects or purchase credits directly from the sources? What was the motivation behind this decision?
5. When obtaining credits, did you use exchanges, brokers, OTC transactions to obtain your credits? Did your company buy credits from your competitors in Europe or invest in CDM projects in installations from your sector?
6. Was your company motivated mainly by financial benefits of using offsets and looked for cheapest available projects or ways to obtain credits? Were there any other benefits that were taken into account?
7. How was such potential investment in a project assessed? Which risks were accounted for?
8. Did the financial crisis and overallocation of allowances affect your company's strategy?
9. How would you evaluate the significance of transaction costs and the economy of scale from obtaining many credits from one source?
10. How would you assess the role of banking and borrowing of credits within Phase II? Has it influenced your compliance strategy?