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The Effects of EU ETS Indirect Cost Compensation on Firms Outcomes

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Contents

Abstract

This report evaluates the impact of the EU Emission Trading System (EU ETS) indirect cost compensation on firms economic performance and competitiveness, seeking to assess potential competition distortions and carbon leakage risks produced by the policy. The analysis is run on the sample of businesses operating in any of the sectors eligible to compensation and on the aluminium sector alone. The data employed in the evaluation is at the firm level and comes from the records on the beneficiaries of indirect cost compensation provided by DG COMP and from the Orbis Bureau Van Dijk database.

Competition distortion is measured in terms of the effects of the intervention on per worker measures of turnover and value of total assets. The risk of carbon leakage is evaluated on the basis of firm-level indicators of turnover, value of total assets and number of employees.

The results suggest that receiving compensation for indirect costs does not have a statistically significant impact on labour productivity of firms in comparison to those that do not receive funding. Conversely, the evidence points to a negative effect on performance measured in terms of turnover, value of total assets and employment. This might be due to a multitude of factors that affect firms' economic performance, for instance differences in energy costs across countries that do not provide compensation compared to MS that foresee this type of aid.

As far as the analysis on aid intensity is concerned, which only contemplates a more homogeneous pool of firms operating in aiding countries, higher compensation amounts do not seem to generate competition distortion. At the same time, a higher level of subsidies appears to marginally reduce the risk of carbon leakage, as performance measured in terms of turnover, value of total assets and number of employees improves. Estimated coefficients suggest that, for each 1% increase in the amount of the subsidy received (i.e. around 1,000 EUR), firms expand their turnover and their assets value by 0.01%, and their workforce by 0.07%.

The report also provides some suggestions on future data collection and reporting provisions, aimed at reducing cost, facilitating data management and increasing the quality and level of accuracy of future evaluations.

1 Introduction

The European Commission has set to achieve by 2050 ambitious environmental goals through a package of measures, known as the European Green Deal, ranging from cutting-edge Research & Innovation to environmental policies, including a severe emissions cut (European Commission (COM(2019) 640 final)). The aim is to put the EU on a path of more sustainable growth, thereby improving citizens' health conditions and well-being and limiting environment-related risks.

EU actions in preserving environmental quality are not recent. One of the primary tools of the EU policy to contrast climate change and reduce Greenhouse Gas (GHG) emissions is the EU Emission Trading System (EU ETS), approved in 2003. The ETS operates so as to create a carbon price signal that induces firms and businesses to reduce their emission in two ways. On the one hand, businesses must buy CO_2 certificates equivalent to their industrial emissions (direct costs). On the other hand, firms incur in an additional cost for the electricity they consume (indirect costs) because also their energy suppliers (power generators) are subject to direct costs.

The EU foresees compensation for both types of costs, with the primary aim of avoiding that CO_2 intensive industries move their businesses outside the EU. This phenomenon, which is commonly known as "carbon leakage" is detrimental for two reasons. First, firms moving to countries that have less stringent regulation on emissions would continue to contribute to high levels of worldwide emissions. Second, their relocation could translate into closing or downsizing of businesses operating in the EU, with a subsequent loss of jobs. Furthermore, carbon leakage in the medium-long term might discourage firms' investment in new production facilities or reinvestment in those that are at the end of their lifetime (Matthes, 2008a). In contrast, overcompensation might determine market distortions by subsidizing the activities of firms which could otherwise be not profitable (Matthes, 2008b).

The EU mandates compensation of direct costs via the granting of free allowances by Member States (MS) directly under the ETS Directive (European Commission (2003/87/EC)). Similarly, indirect costs can be compensated by Member States under approved State Aid measures and in compliance with the corresponding Guidelines (European Commission (2012/C 158/04)). Compensation of indirect costs, however, is optional for MS and, as such, it might give rise to distortions within the internal market.

This study originates from a number of exchanges between the JRC and DG COMP in relation to the foreseen revision of the Guidelines on State Aid measures in the context of the GHG allowance trading system.[1] Its aim consists in evaluating the effects of indirect costs compensation in terms of competition distortion and risk of carbon leakage on firms.

The assessment of carbon leakage risk is not straightforward, as leakage might arise from different channels and could be affected by a number of factors (carbon price level and its worldwide evolution, policy responses, market characteristics and other firm level factors). Nevertheless, understanding firms response to the EU ETS could help designing more effective policy interventions. Ideally, plant level data could provide a more detailed picture of firms' productive choices due to direct and indirect costs and to their compensation; unfortunately, data at this level of granularity is rarely available and often hard to match with other firm-level information.

A sizable part of the existing economic literature has focused on the direct effect of the EU ETS on emissions abatement, that is considered the main goal of the regulation. Notwithstanding, there is a large number of studies looking at firms' economic performance, measured mainly by profits, revenues, output and employment. A detailed review of the studies on the first ten years of the ETS guidelines is illustrated by Martin et al. (2016), which focuses especially on contributions seeking to establish a causal link and providing quantitative evidence. In response to the ETS regulation, firms could resort to costly abatement or buy permits. In both cases this might generate lower profits and market share loss, especially for businesses competing in international markets and unable to pass-through the higher carbon cost (Martin et al., 2016).

This evaluation study adds to the body of literature analysing the impact of the EU ETS on firms economic performance and competitiveness. In line with other papers (Abrell et al., 2011; Anger and Oberndorfer, 2008), it gathers firm-level data from the Orbis database but providing fresh evidence both for the period under analysis and for its main goals. Indeed, the vast majority of the literature looks at the impact of the direct ETS cost and only a few papers cover the period after 2013, while none of them exploits the subsidy intensity.

The aim of the analysis is to assess whether the indirect cost compensation under State Aid measures in the period 2013–2017 has had an impact on the internal market, using firm-level data. In particular, this study evaluates the impact of the aid on firms' economic outcomes and the potential existence of competition distortions. The latter is assessed by resorting to per employee measures in terms of either turnover or value of total assets. Furthermore, it investigates on changes in operating revenues (turnover) and number of employees to assess the impacts on carbon leakage risk in the short run. The analysis is complemented by looking at the impact on the value of the firms' total assets, which might be representative of the investment decisions and therefore signal the existence of leakage in the medium-long term in so far as higher carbon costs bring about

[1] The interactions between the JRC and DG COMP commenced from the participation to an upstream meeting with the Regulatory Scrutiny Board (RSB) in April 2019, where the revision of the Guidelines was discussed.

closure of the undertakings or redirect new investments in non-regulated areas.

The evaluation exercise presented in this report exploits the information in the records on the beneficiaries of indirect cost compensation that were provided to DG COMP by the MS with an approved State Aid under the EU ETS framework. The data was then linked to the Orbis Bureau Van Dijk database, which contains balance sheet information of firms. The analysis covers the period 2009–2017 and comprises firms operating across different sectors in 12 MS, 6 of which provide funding for indirect cost compensation. The data allows to compare the average change in performance for a group of firms receiving compensation with the one of a similar group of firms that operate in the absence of aid, following a *Difference-in-differences* (DiD) approach. The evaluation looks at firms operating in all eligible sectors, as well as on the subgroup from the aluminium sector.

Although in the empirical literature there is widespread consensus in recognising the effectiveness of the ETS provisions in terms of emissions abatement, findings on firms' economic performance are not unambiguous, suggesting that the desired effects on emission and innovation are costly in terms of economic performance, but still not confirming the existence of a marked detrimental effect (Martin et al., 2016).

The results of the analysis illustrated in this report suggest that the indirect cost compensation supplied by MS with an approved State Aid scheme had little or negligible impact on the measures of competitiveness considered, namely turnover per worker and value of total assets per employee. However, when outcomes are considered in absolute terms (i.e. turnover, total assets and number of employees), beneficiaries seem to perform worse than non-aided firms. These findings are partially in line with some existing works that investigate on the effects of energy-related interventions (energy tax) in Finland (Laukkanen et al., 2019) and in the United Kingdom (Martin et al., 2014). The former find a negative effect on revenues and gross output, the latter observes evidence pointing to the absence of an effect of the energy tax on productivity, production and employment.

When considering studies on the ETS interventions, a negative impact on employment is confirmed also in Abrell et al. (2011) and Wagner et al. (2013), the latter using plant-level data in France. In contrast, a positive link on value added and labour productivity at plant level is found by Klemetsen et al. (2020) in Norway. A positive effect on turnover is identified by Chan et al. (2013). Other studies using firm-level data also found a non-statistically significant effect on turnover (Abrell et al., 2011), employment (Flues and Lutz, 2015), total factor productivity and investment (Commins et al., 2011). The heterogeneity characterising the empirical evidence on firms' economic performance might be grounded in several aspects, ranging from data granularity, timeline of the analysis and the identification of treated and control groups. It is also important to highlight that it is difficult to quantify indirect ETS costs for firms as they depend on pass-trough electricity costs and on the features of the industrial sectors. Moreover, electricity prices are sometimes the results of bilateral negotiations and might consistently differ between firms and be subject to diversified levels of tax and levies in each MS.

Results from the analysis on the intensive margins point out that firms receiving a higher subsidy tend to experience a better performance in terms of turnover, investments and job retention in comparison to firms receiving subsidy of lower amounts. Here, the focus is only on the beneficiaries of indirect compensation for which it was possible to retrieve aid intensity data, thus implying a more homogeneous sample of firms that have comparable characteristics in all, but for the treatment intensity.

Finally, this report provides some recommendations on the potential improvement in relation to reporting obligations and data collection, striving to ease data handling and increase the quality and accurateness of future evaluation exercises.

The remainder of the report is organised as follows. The next section provides a brief overview of the institutional context and a description of the EU ETS. Section 3 illustrates the data used in the analysis: the two data sources (the records on the beneficiaries provided by the MS and the Orbis database), the matching procedure applied to link the information at the firm level and a set of descriptive statistics that characterize the final sample. Section 4 outlines the methodology used to evaluate the effects of the indirect cost compensation on firm financial outcomes and section 5 presents the results. Section 6 contains critical remarks and provides a list of suggestions for future improvements. Finally, section 7 concludes.

2 Institutional Setting

The EU ETS is the largest trading system of emission allowances worldwide (Bocklet et al., 2019). It is in place since 2005 as a tool to meet the goals of the Kyoto Protocol (UN Convention for Climate Change, 1997).

The ETS is based on a "cap and trade" mechanism, which sets a threshold for the total GHG emission volumes produced by energy-intensive installations and aircraft operators and allows trading those limited allowances. The emission allowances are rights to produce GHG emissions (measured as tonnes of CO_2 equivalent). The cap is fixed in terms of number of allowances available in the whole system and it has been subject to yearly reductions from 2013 to 2020.

Participants to the ETS receive a certain number of emission rights for free and can exchange the allowances in an auction-based market. The installations that do not have sufficient allowances to cover their GHG emissions are subject to significant penalties. The limited supply of allowances in the market gives them value and fosters an efficient allocations of the emission rights where there is either a higher demand or a lower capacity to switch towards less pollutant productive system. Analogously, this system encourages companies to adopt solutions which cut GHG emissions to meet the ETS target, thus allowing to efficiently fulfill environmental goals.

The ETS directive was formally adopted in 2003 (European Commission (2003/87/EC)) but several changes have been applied over time, identifying four trading periods, or phases. The first pilot phase covered the period 2005–2007, which tested the functioning of the carbon market and prepared Member States for the first commitment period of the Kyoto Protocol, that started in 2008. The second phase (2008–2012) reduced the number of allowances by 6.5% to trigger a more effective emissions reduction by increasing allowances price, which fell to zero at the end of the previous period. In the third phase (2013–2020) a major reform took place, introducing an EU-wide cap on emissions with a reduction of the free allowances of about 1.74% by year and the replacement of the cost-free allocation with the auctioning of the allowances. The fourth trading period is expected to run from 2021 to 2030. To date, the EU ETS covers about 11,000 power stations and plants in the EU 28 plus Iceland, Norway and Liechtenstein and the aviation sector since 2012.

An important potential drawback of the EU ETS system is the risk that EU companies affected by the climate policy restrictions are in a competitive disadvantage with respect to companies operating outside of the EU, which are not subject to the policy. In fact, the EU ETS actually generates two categories of additional costs due to the emissions restrictions for the firms targeted by the policy: direct and indirect costs. The direct emission costs are those associated with a firm own emissions and the need to purchase CO_2 certificates; conversely, indirect costs are generated by the firm suppliers and transferred throughout other direct costs, i.e. the electricity prices. Indeed, power generator providers have to use allowances to cover their emissions and they could repay the higher production costs by increasing the electricity prices of their customers. Therefore, businesses might decide to relocate their production in countries with less strict provisions in terms of GHG emissions cut, thus generating a global increase of GHG emissions. To address this risk, which is known as carbon leakage, the EU ETS foresees direct and indirect cost compensation.

To this end, the Directive identifies the sectors which are exposed to a significant risk of carbon leakage (European Commission (2012/C 158/04), Annex II) and establishes some mitigating measures for the higher costs of electricity due to ETS. In terms of direct emission costs, sectors exposed to carbon leakage are exempted from the phasing out of the free allocation of emission allowances. In relation to the indirect emission costs, the EU ETS allows MS to provide by State Aid a financial aid to electricity-intensive undertakings. The value of the compensations, as well as the sectors eligible and the definition of electricity-intensive are specified in the State Aid decision of the MS, as long as it complies with the EU ETS Guidelines (European Commission (2012/C 158/04)). The carbon leakage list of sectors is updated every five years and sectors remain in the list until renewal.

Table 1: State Aid decisions on EU ETS indirect compensation

Member State	Duration of the scheme	Budget of the scheme	Commission decision
Belgium (Flanders)	2013 - 2020	EUR 7-113 mln†	SA.37017
Belgium (Wallonia)	2017 - 2020	EUR 17,5 mln (2017-2020)	SA.49630
Finland	2016 - 2020	EUR 149 mln (2016-2020)	SA.44378
France	2015 - 2020	EUR 364 mln (2015-2018)	SA.43389 / SA.49875
Germany	2013 - 2020	EUR 576 mln (2013-2015)	SA.36103
Greece	2013 - 2020	EUR 14-20 mln†	SA.38630
Lithuania	2014 - 2020	EUR 13,1 mln (2014-2020)	SA.41981
Luxembourg	2017 - 2020	EUR 48-60 mln (2017-2020)	SA.51097
Slovakia	2014 - 2020	EUR 250 mln (2014-2020)	SA.43506
Spain	2013 - 2020	EUR 695 mln (2013-2020)	SA.36650 / SA.45164 / SA.49751 / SA.53427
The Netherlands	2013 - 2020	EUR 156 mln (2014-2015)	SA.37084
United Kingdom	2013 - 2020	GBP 113 mln (2013-2015)	SA.35543

Note: † annual budget based on CO_2 price. Poland recently had a State Aid approved for the period 2019-2020 (SA.53850).

The compensation for indirect costs is applied on a voluntary basis by each MS following a standard State Aid procedure (Table 1). Over the 28 EU Members, only 11 decided to introduce compensation for indirect costs (Belgium, Finland, France, Germany, Greece, Lithuania, Luxembourg, the Netherlands, Slovakia, Spain and the United Kingdom). This exposes firms operating in the same sector to a different cost of the regulation according to the country's decision to compensate or not, thereby creating an interesting scenario to set a quasi-experimental framework for the evaluation of this provision of the EU ETS. The aid is delivered as a direct grant, with the exception of Spain which has foreseen also an interest rate subsidy and a tax rate deduction.

3 Data

This section describes in detail the data used in the analysis, which come from two main sources: the records on the beneficiaries of the ETS indirect cost compensation granted under State Aid measures and the information on balance sheets of firms. The former were provided by MS to DG COMP, the latter is contained in the Orbis Bureau Van Dijk database. Then, the procedure that was used to match the data from the two sources is outlined. Finally, the resulting sample is thoroughly described.

3.1 Data on beneficiaries of ETS indirect cost compensation

To date, eleven MS have applied State Aid measures for the compensation of the EU ETS indirect costs. Overall, the JRC received records of beneficiaries on six MS: Belgium, Finland, Germany, the Netherlands, Spain, the United Kingdom.[2]

The records on the beneficiaries of the compensation for indirect EU ETS costs were provided by DG COMP to the JRC in their original format, as they were transmitted from each MS to DG COMP. The format in which these records are presented varies across MS and years. Thus, putting together these records required a considerable harmonisation exercise.

Data on Belgium is differentiated by region. In fact, there exist two State Aid cases for Belgium: one for Flanders (SA.37017) which started in 2013 and one for Wallonia (SA.49630) which started in 2017. In the first case, firm-level records cover the years 2013–2016. Here, the available information includes the name of the firm, the NACE in which the firm operates, the reference year, the year of payment and the amount subsidised in EUR. In the second case, a list of names and their associated identifier used by the public administration of Wallonia was provided, along with the corresponding NACE, the compensation foreseen under the guidelines and the one that was actually paid after some adjustments and weighting. The records for Wallonia refer to the year 2017 only.

The records transmitted by Germany (SA.36103) cover the years 2013–2016. Data are at activity/plant level and include a unique firm and plant identifier which does not change over time, the name of the firm and of the plant/activity, the corresponding NACE, and the necessary information to compute the amount of compensation that each firm receives (correction factor, yearly and benchmark consumption and production, whether it refers to a primary or a fall back calculation). In fact, the German records do not provide the amount of compensation explicitly. Thus, the JRC retrieved all the missing information from official documentation and applied the formula to compute the compensation as from the Guidelines (European Commission (2012/C 158/04)).[3]

Data from Spain (SA.36650) is at plant level and covers the year 2016 only, despite the Aid scheme being in place since 2013.[4] The available data is quite detailed and includes names of the firms and of the single installations, information on the sector of activity (NACE and PRODCOM), yearly baseline output and baseline electricity benchmark and the amount of the aid received (including adjustments applied to the aid amounts, the total requested grant amount and the total amount actually paid). Differently from other MS, Spain also provides details on the VAT number of firms, which constitutes an important piece of information when linking different databases.

Records from Finland (SA.44378) cover 2016 only, that is the first year of the compensation scheme. Data are at plant level and include the name of the firm and of the aided installations, the NACE in which they operate, information on electricity consumption and production and the amount of the aid received.

Records from the Netherlands (SA.37084) cover the years 2014–2017, although the scheme was first implemented in 2013. Data are at activity level and include the name of the firms, the NACE in which they operate, information on primary and fall back electricity consumption and production and the amount of the aid received (including adjustments applied to the aid amounts, the total requested grant amount and the total amount actually paid).

Finally, records from UK (SA.35543) are available for the years 2013–2016. The records referred to 2013 are very detailed and include activity-level information on NACE, 8-digit PRODCOM, benchmark and yearly production and consumption and the aid paid out in 2013. Records referred to the following years only contain the name of the business, the name of the installation, 8-digit PRODCOM information and the aid amounts obtained under ETS and CPS.[5]

Given the differences existing in the records, the harmonisation exercise considered only the pieces of information that were available for all beneficiaries from all MS: name of firm, 4-digit NACE and aid amount.

[2] Records for France, Greece, Luxembourg and Slovakia were not available. Lithuania also has an approved State Aid but it is not considered because only one beneficiary has been compensated over the years.

[3] A check was made in collaboration with DG COMP to ensure the formula was computed correctly.

[4] Records referred to SA.45164, SA.49751 and SA.53427 were not provided.

[5] The Carbon Price Support (CPS) was introduced by the UK government in addition to the European scheme.

This is briefly summarised in Table 2.[6]

At the end of the harmonisation process, a total of 753 unique records, divided across the six countries mentioned, were gathered. Figure 1 reports the number of firms that were identified by country and year across all sectors (left) and in the aluminium sector alone (right). Germany is the country with the largest group of

Table 2: Descriptive statistics on beneficiaries

Information	BE (F)	BE (W)	FI	DE	NL	ES	UK	All MS
Name of firm	Y	Y	Y	Y	Y	Y	Y	✓
Name of installation/plant			Y	Y	Y	Y	Y	
Time-invariant record id				Y				
VAT number						Y		
4-digit NACE	Y	Y	Y	Y	Y	Y	P	✓
8-digit PRODCOM						Y	Y	
Elements to compute formula	P		Y	Y	Y	Y	P	
Aid computed/requested		Y			Y	Y		
Adjustments to aid					Y	Y		
Aid paid out	Y	Y	Y	C	Y	Y	Y	✓
Other non-ETS aid compensated							P	
Missing years	2017		2017	2017	2013	2013, 2014, 2015, 2017	2017	

Note: BE(F) and BE(W) refer to Flanders and Wallonia, respectively; Y = available in all records; P = partially available (only in some records); C = computed by the JRC. Elements to compute formula include baseline/benchmark and yearly consumption and production.

Figure 1: Number of beneficiaries in the original records

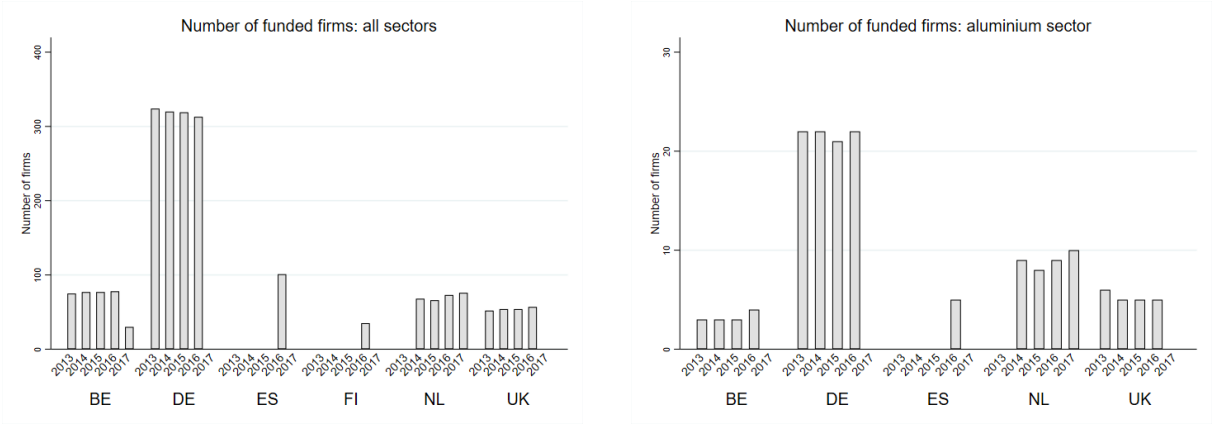


Table 3: Descriptive statistics on aid paid to beneficiaries

Country	Year	N	Mean	Std. Dev.	Min	Max
BE	2013	75	657.342	1313.425	5.261	6850.670
	2014	77	389.103	748.620	2.316	4097.465
	2015	77	511.476	985.072	1.132	5383.989
	2016	78	599.364	1156.559	1.150	6352.736
	2017	30	250.000	325.074	6.097	1170.421
DE	2013	324	1009.256	2580.008	6.845	25745.660
	2014	320	605.364	1582.049	5.746	15175.500
	2015	319	996.288	2613.815	0.000	25290.570
	2016	313	677.319	1736.169	7.020	16491.550
FI	2016	35	1083.028	1971.585	19.850	11204.670
ES	2016	101	59.279	118.824	0.483	823.666
NL	2014	68	786.110	1763.323	0.000	8735.586
	2015	66	474.730	1030.872	6.058	5155.428
	2016	73	732.559	1586.668	9.503	8086.945
	2017	76	485.566	1082.863	6.579	5598.655
UK	2013	52	609.754	1419.539	8.627	8888.148
	2014	54	362.304	872.818	0.000	5564.604
	2015	54	394.771	795.618	18.857	4031.508
	2016	57	295.580	579.005	5.068	3141.160
Total	2013	451	904.671	2306.084	5.261	25745.660
	2014	519	571.671	1456.005	0.000	15175.500
	2015	516	794.282	2151.311	0.000	25290.570
	2016	657	567.685	1472.570	0.483	16491.550
	2017	106	418.896	937.080	6.097	5598.655

Note: Aid is expressed in thousands of EUR. BE 2013-3016 refers to Flanders only; BE 2017 refers to Wallonia only.

[6] Section 6 highlights difficulties and limitations that these differences have caused for the execution of this evaluation. Thus, a list of suggestions aiming at facilitating future evaluation exercises is provided.

funded firms (320 per year circa), while the number of aided entities in the other countries is relatively balanced, at around 50-70 businesses per year. This pattern is resembled when focusing only on the aluminium sector, as the plot to the right shows. The only exception is found in Finland, where there are no firms operating in this sector.

Details on the number of firms identified and statistics on the aid amounts paid to them are shown in Table 3, by country and year. Finland and Germany pay relatively higher amounts, on average, while Spain is the country with smaller subsidies per firm.

3.2 Financial data on firms

Firms financials are extracted from the Orbis Bureau Van Dijk database, which provides balance sheet information at firm level. The panel is constructed following the methodology proposed by Kalemli-Ozcan et al. (2015) and all values are harmonised according to the Eurostat Consumer Price Index (HCPI).

The dataset includes all firms operating in one of the sectors covered by the EU ETS and listed in Table A.2. Sectors are identified using NACE Rev.2 codes at 4 digits (core, primary and secondary activities are considered). Companies registered with consolidated accounts when there is also an unconsolidated record and firms with no financial information are excluded.

For the purpose of the analysis, the Orbis database is mainly used to gather variables representing firms' performance. However, the data suffer from a number of issues, especially related to the presence of many missing values due to heterogeneous reporting obligations across countries. To avoid a consistent data loss determined by missing financials, the choice of the variables has been based also on their completeness.

Firms regulated by the ETS might indirectly pay the emissions reduction with lower profits due to costly abatement or permits purchase. Moreover, competition with rivals companies not affected by the ETS could yield to lower market share. All these elements might discourage firms' new investments or even facilitate their relocation in non-treated areas. Balance sheet data included in the Orbis dataset allows assessing the potential competition distortion and carbon leakage risk at the firm level, by considering some standard indicators of economic performance.[7]

In particular, the effect on competitiveness is assessed by looking at per employee measures, namely: labour productivity (turnover/employees) and assets per employee (total assets/employees). Both indicators offer a relative measure of firm performance, in terms of output value (turnover) or investments (total assets) scaled over firms size (number of employees).

In order to provide a more complete picture of the effects that might occur in the short term, the analysis considers also changes in operating revenues (turnover) and number of employees which should mirror production choices directly. Turnover is a standard indicator of firm performance expressed as the value of the services and goods sold. It is widely considered as one of the main factors to assess the economic growth of a company, i.e. firm's profitability. Furthermore, while a pure measure of profit might suffer from potential profit shifting practices, turnover is unlikely to be affected by these operations. The number of employees accounts for firm size and helps identifying the potential risk of carbon leakage in terms of jobs loss. In the same vein, changes in the investment decisions, which are likely to happen in the medium-long term, are here proxied by the value of total assets that allows detecting expansions or shrinkages of the firms' assets endowments.

3.3 Matching data

Once the records on beneficiaries were harmonised and the data extracted from Orbis were appropriately cleaned, the two databases were matched. Given the poor quality of the data at hand, the matching procedure proved to be quite demanding and required a substantial amount of manual recoding.

To start with, firms registered in Spain were matched on the basis of the VAT number, which was available in the original files on beneficiaries transmitted by the Spanish authorities. This eased up substantially the matching of these firms. Unfortunately, information on the VAT number was only accessible on the Spanish records. In all other cases, a probabilistic matching on company names by country was carried out. This consists in an algorithm that assigns a score to each entry on the basis of how well it matches to any of the records existing in the data. The score goes from zero (no match) to one (perfect match) and considers the position of each letter in a given name. In total, 398 exact matches were found between the entries in Orbis and those in the beneficiaries records. The remaining ones were checked manually one-by-one. Eventually, 603 beneficiaries were correctly matched to the Orbis database, i.e. 80% of the original pool of beneficiaries. The entries from the records on the beneficiaries that were discarded either have missing financial information or do not appear at all in the Orbis database.

Orbis reports three different variables that refer to the activity of each firm: a NACE code referred to the core activity, a NACE code for the primary activity and a NACE code associated to the secondary activity. Sometimes

[7] For a survey of other studies using this type of data see Martin et al. (2016).

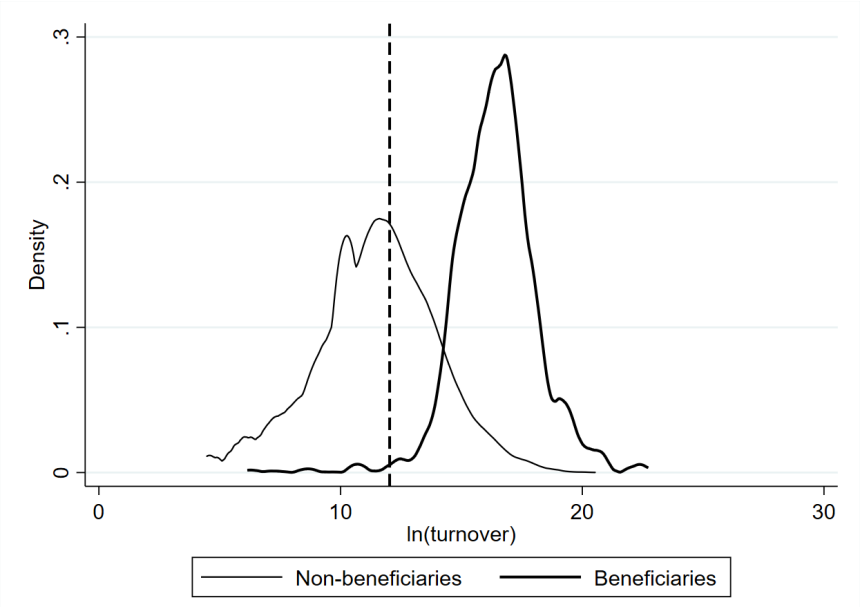
these are all equal to each other, but in most cases different codes are reported. In some instances, the NACE code that appears in the records of the beneficiaries does not coincide with the core activity as stored in the Orbis database. For firms that are funded under the ETS indirect cost compensation measures, the NACE code is the one reported in the original records of the beneficiaries. For those that are not funded, priority is given to the NACE code associated to the core activity carried out by the firm, if this appears in the list of activities eligible for the ETS indirect cost compensation (Table A.2). If this is not the case, the NACE code that is considered is the one associated to the primary activity, as long as this appears in the list of eligible activities. Any firm that does not satisfy this criteria is dropped from the sample. Therefore, all entities that report an eligible NACE code as secondary activity only are not considered.

Moreover, the Orbis database contains information on firms that do operate in the eligible activities in the countries that have adopted indirect cost compensation schemes but do not appear in the original records transmitted by MS to DG COMP. The reason might lie in the existence of the "de minimis" rule, which provides that subsidies of less than 200,000 EUR granted to an undertaking over a period of 3 years do not constitute State Aid within the meaning of the EC Treaty's ban on aid liable to distort competition (European Commission (Regulation (EU) No 1407/2013)). Thus, it might be that the records provided by MS to DG COMP do not account for these funds and therefore firms do not appear as beneficiaries, whilst, de facto, receiving some funding. As it is impossible to determine whether firms in the Orbis database belong to such group, all entities operating in an eligible sector of activity in a country with an approved State Aid measure for ETS indirect cost compensation are excluded from the final sample if they do not appear in the beneficiary list.

A quick visual inspection of the data revealed an over-representation of larger firms among the group of the beneficiaries. In fact, the average turnover of those firms belonging to the group of the non-beneficiaries was sensibly lower than the turnover of the beneficiaries. This might be explained by the exclusion from the sample of those firms that appear as non-funded while being potential beneficiaries in the six aiding countries just described above. Figure 2 shows the distribution of the turnover across the two groups. The thick curve, which refers to the group of the beneficiaries, lays much further to the right (i.e. towards higher values) in comparison to the thin curve, which represents the group of the non-beneficiaries. Thus, in order to ensure comparability between the two samples and retain only firms that have similar size and economic potential, the sample was trimmed at a threshold that corresponds to the value of the first percentile of the distribution of the beneficiaries (i.e. the vertical dashed line in the figure). This implies that firms with a turnover lower than 16,762 EUR, namely 15 beneficiaries and 11,554 non-funded firms, were excluded from the final sample.

Finally, the sample was further refined by removing businesses that do not appear in the Orbis database continuously over the period 2013–2017. This procedure was implemented in order to avoid potential distortions that may arise because some firms disappear from the sample and it is not possible to determine whether this

Figure 2: Sample selection on turnover



Note: The figure shows the distribution of ln(turnover) for non-beneficiaries and for beneficiaries (thin and thick lines, respectively). The vertical dashed line refers to the 1st percentile of the distribution for beneficiaries. This corresponds to 12.029 in logarithmic form, which is equivalent to the actual value of 16,762 EUR.

occurs because they exit from the market or if this is due to reporting issues. In the first case, in fact, a selection bias may arise, as only the most virtuous businesses would survive. Thus, only firms that appear continuously in the years 2013–2017 are retained.[8]

3.4 Descriptive statistics

The final sample consists of an unbalanced panel of 3,706 firms, of which 319 are funded under State Aid measures for ETS indirect cost compensation. The sample covers the period 2009–2017, for a total of 27,290 observations.

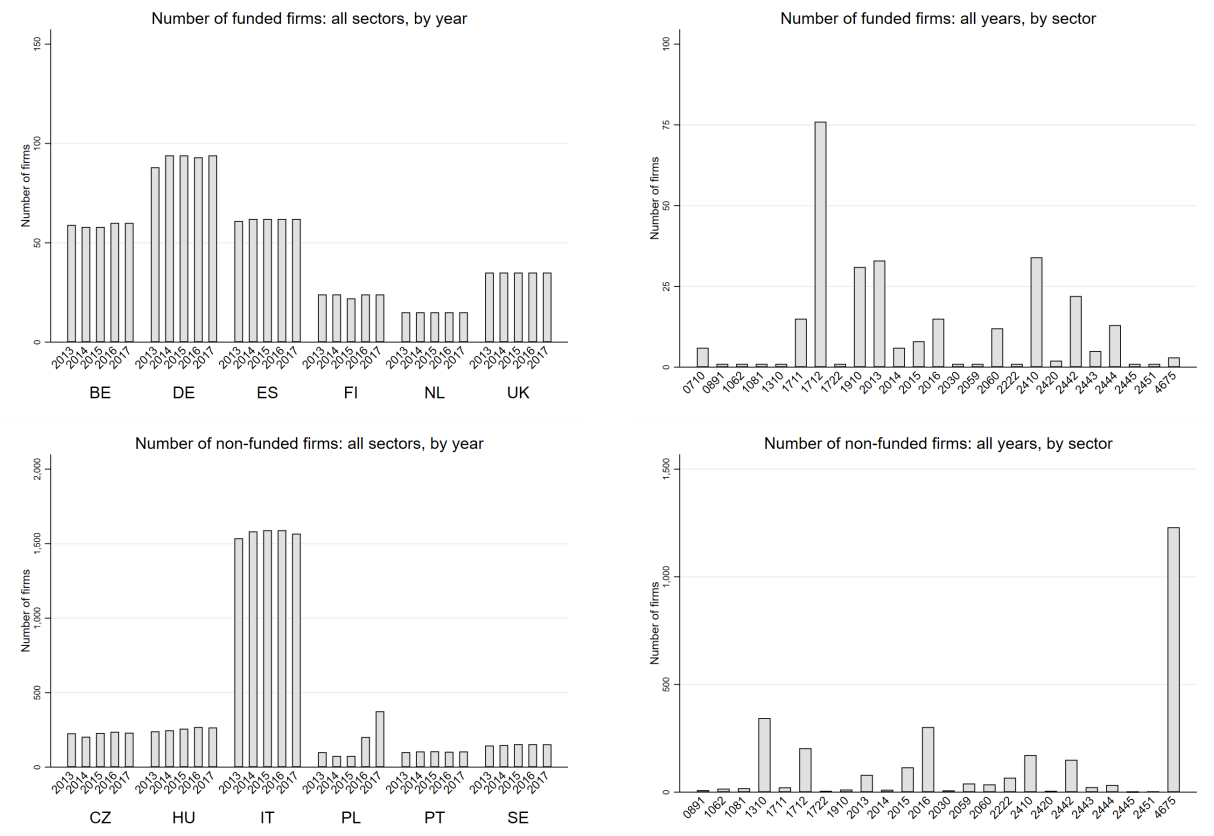
All firms in the sample operate activities in one of the 13 4-digit NACE-coded sectors or 7 subsectors that are eligible for indirect cost compensation, either in a country with an approved State Aid scheme or in a country that does not provide funding. These firms however may have several activities, which explains why they are reported under 26 NACE-code, the main NACE-code reflecting their principal activity. These are listed in Table A.2. Throughout the report, all analyses are run both on the total sample which includes all 26 sectors and on a smaller sub-sample of firms operating in the aluminium sector (NACE 24.42) alone.

Figure 3 shows the total number of firms in the sample, by country and by year (left) and by sector of activity (right). The plots at the top refer to the beneficiaries of indirect cost compensation, those at the bottom to the comparison group (non-funded firms).

The sample of the beneficiaries amounts to around 300 firms per year, while non-funded firms are about 2,500 every year. The two samples are not homogeneous in the type of activity carried out. In fact, funded firms are quite represented in many sectors, with the manufacture of paper and paperboard (NACE 17.12) being the largest group. In the case of firms that operate in countries that do not provide ETS indirect cost compensation, 45% of them belong to NACE 46.75 ("Wholesale of chemical products").[9]

Figure 5 shows the distribution of the firm performance indicators in the final sample. The information provided by the two plots at the top clearly shows a difference in size, measured both as the value of the total assets and the number of employees, between beneficiaries and non-beneficiaries. However, when the two

Figure 3: Number of funded and non-funded firms, all sectors



[8] See Table A.1 for a summary of the firms that are dropped from the sample with this procedure.

[9] These differences are accounted for in the estimation of the effects of the indirect compensation on firm outcomes with the use of NACE fixed effects (see section 4 for details). The robustness of the results is also tested by excluding each sector at a time from the sample (section 5).

Table 4: Descriptive statistics on aid paid to beneficiaries, final sample

Country	Year	All sectors					Aluminium				
		N	Mean	Std. Dev.	Min	Max	N	Mean	Std. Dev.	Min	Max
BE	2013	38	94.882	161.160	1.068	677.531	3	37.188	50.716	7.864	95.750
	2014	37	58.171	92.902	0.633	407.206	3	22.818	31.692	4.253	59.412
	2015	38	74.782	121.908	0.840	538.399	3	29.903	41.407	5.760	77.716
	2016	41	84.219	141.873	1.017	646.518	4	27.168	44.036	2.904	93.149
	2017	24	30.556	36.164	0.634	121.759					
DE	2013	114	143.997	283.932	1.191	1819.966	10	148.563	340.967	1.191	1095.468
	2014	114	87.437	179.535	0.723	1116.502	9	110.203	254.205	0.723	777.062
	2015	113	144.367	298.268	2.150	1857.033	10	166.539	405.932	2.748	1303.060
	2016	114	96.449	198.022	1.492	1225.922	10	111.895	270.811	1.798	870.791
ES	2016	62	6.513	13.895	0.160	82.087	2	45.366	51.931	8.644	82.087
FI	2016	25	138.517	226.953	3.720	1124.837					
NL	2014	11	93.704	149.647	2.782	487.243	2	4.227	2.043	2.782	5.671
	2015	13	48.238	82.796	1.646	289.021	2	2.500	1.208	1.646	3.354
	2016	12	80.391	134.969	2.584	453.865	2	3.926	1.897	2.584	5.267
	2017	14	49.362	88.865	1.812	318.263	2	2.753	1.330	1.812	3.693
UK	2013	28	62.634	165.008	2.245	875.483	4	10.278	12.566	2.245	28.833
	2014	30	36.042	101.617	0.683	556.460	4	8.344	10.509	1.408	23.983
	2015	33	30.713	69.055	1.886	379.705	4	10.223	10.276	1.886	24.866
	2016	33	23.837	48.770	0.510	261.070	3	4.063	2.876	1.479	7.162
Total	2013	180	120.972	247.755	1.068	1819.966	17	96.371	264.497	1.191	1095.468
	2014	192	74.126	154.408	0.633	1116.502	18	61.228	181.983	0.723	777.062
	2015	197	105.563	238.858	0.840	1857.033	19	94.789	297.819	1.646	1303.060
	2016	287	69.917	159.627	0.160	1225.922	21	63.733	189.161	1.479	870.791
	2017	38	37.484	60.598	0.634	318.263	2	2.753	1.330	1.812	3.693

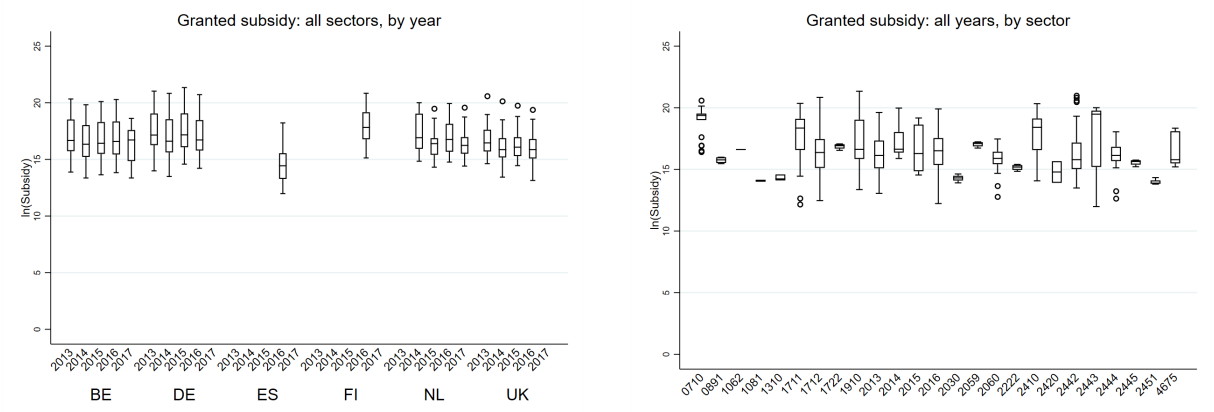
Note: Aid is expressed in thousands of EUR. BE 2013-3016 refers to Flanders only; BE 2017 refers to Wallonia only.

proxies for labour productivity are considered (namely, turnover per employee and total assets per employee), this difference fades, as the two distribution are almost overlapping. In other words, while the two samples appear to be systematically different in terms of size and capacity, when performance is standardized on the basis of the workforce employed, beneficiaries and non-beneficiaries appear to be relatively similar to each other.

Figure 4 displays the distribution of the subsidies received by the funded firms by country and year (left plot) and by sector (right plot).[10] The distribution of the subsidies appears to be relatively similar from one country to the other (with the exception of Spain, which lies in a lower position with respect to the others) but very heterogeneous across sectors. Table 4 reports the main descriptive statistics of the amounts by country and year. Germany and Finland are the most generous countries with aid amounts above 100,000 EUR on average, while Spain grants the smallest amounts (6,573 EUR on average).

The aluminium sector accounts for almost 8% of the sample of the beneficiaries. It is covered by around 5% of non-funded firms. This sector is represented in all MS considered, except Finland, proportionally to the total number of firms operating in each country (Figure 6). As previously shown in Figure 4 with reference to all types of activities, the distribution of subsidy amounts over time is fairly homogeneous also in the case of the aluminium sector (Figure 7).

Figure 4: Granted subsidy, all sectors



[10] Boxplots convey the following information: boxes range from the first (25%) to the third (75%) quartile of the distribution, with a line in the center of the box which flags the median value; whiskers show the largest value between the minimum and the maximum of the distributions, or 1.5 times the interquartile range; in the latter case, outliers are also marked with a circle.

Figure 5: Distribution of performance indicators by group

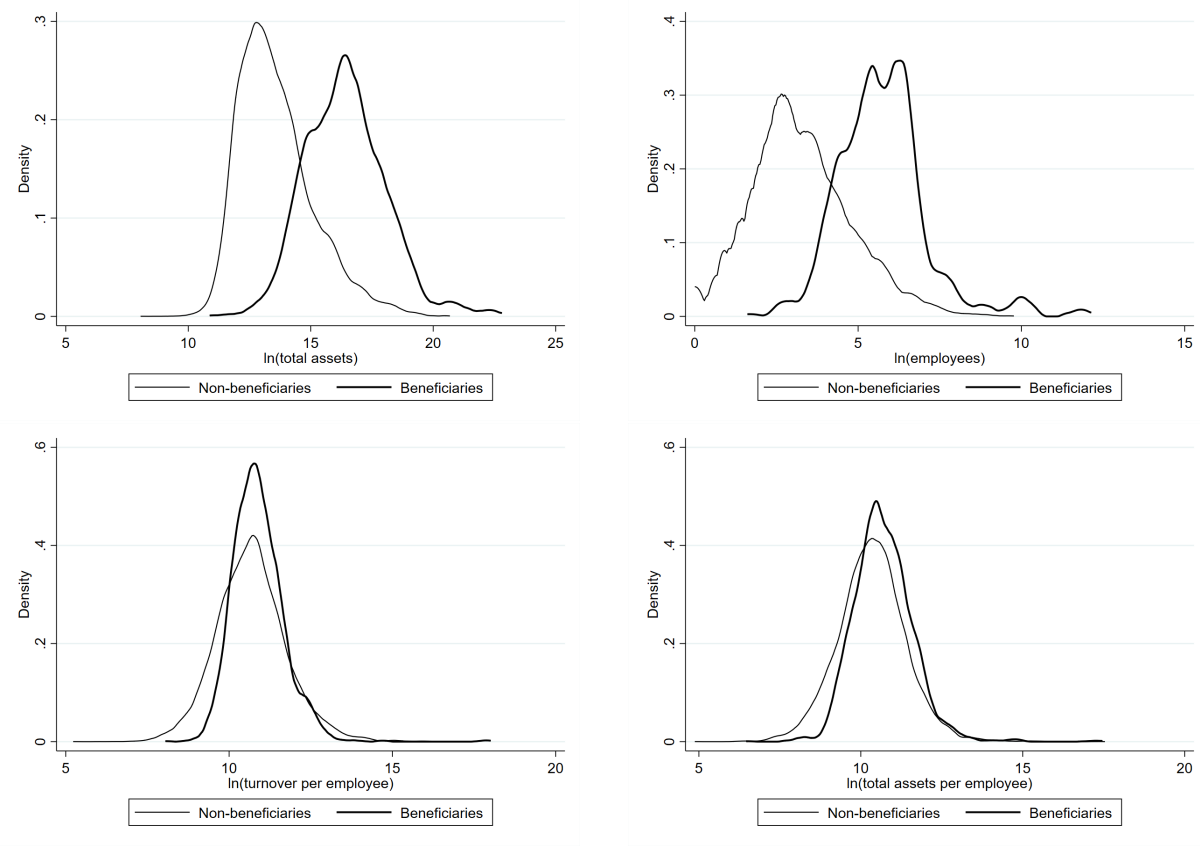


Figure 6: Number of funded and non-funded firms, aluminium sector

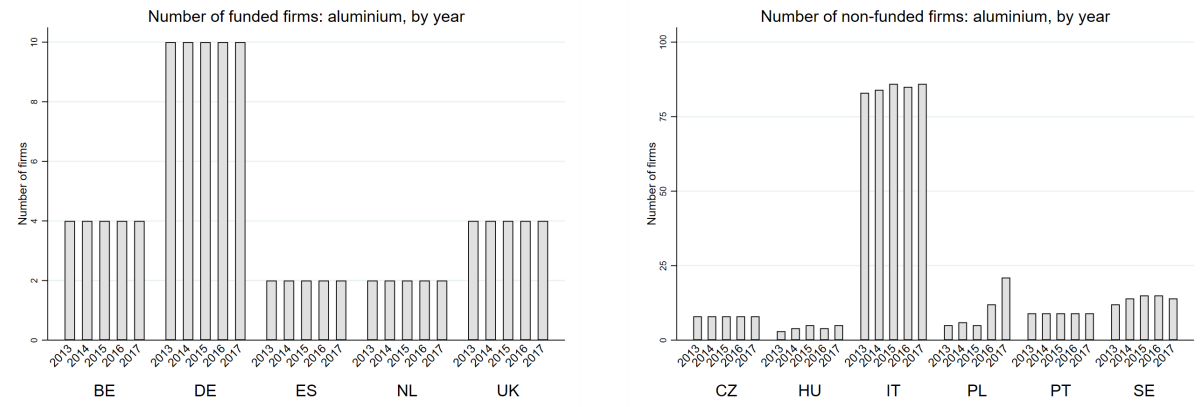
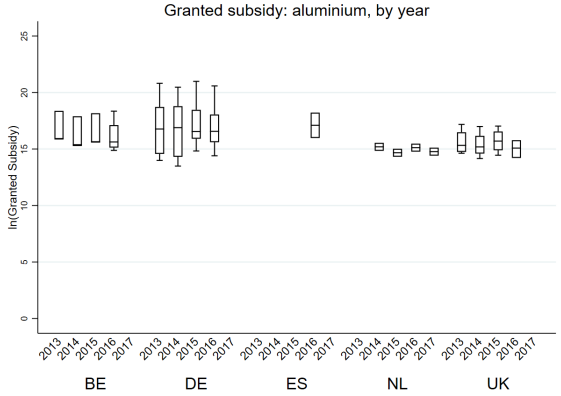


Figure 7: Granted subsidy, aluminium sector



4 Methodology

The aim of the analysis is to assess whether the EU ETS compensation for indirect costs has contributed to reducing the risk of carbon leakage for firms operating in the exposed sectors, whilst not generating competition distortions within the internal market.

The intervention concerns firms operating in selected sectors in a given group of countries. The treated group is composed of firms operating in eligible sectors in aided countries: Belgium, Germany, Spain, Finland, the Netherlands and the United Kingdom. For most MS the treatment starts in 2013, while in Finland it starts in 2016 and in Belgium-Wallonia in 2017.

The control group is defined on the basis of the firms that operate in the same sectors as those in the treatment group but in countries that do not provide indirect cost compensation. These are: Bulgaria, Czech Republic, Hungary, Ireland, Italy, Latvia, Malta, Poland, Portugal, Romania and Sweden. However, Bulgaria and Romania entered the EU only in 2007, hence, firms in these countries might be on a different growth path compared to those operating in other MS. Moreover, Ireland, Latvia and Malta have a very small sample size and hence they are not considered. The final sample of firms in the control group comprises the following six MS: Czech Republic, Hungary, Italy, Poland, Portugal and Sweden.

Data is available for a period that spans from before to after the start of the compensation, i.e. from 2009 to 2017.

A simple comparison between the performance of firms receiving the intervention and those not receiving it after the inception of the indirect cost compensation would not appropriately capture its effects because it would not account for differences in the pre-intervention period. These might, for instance, arise from the fact that some sectors were already subject to the direct cost compensation under Phase I (2005–2007) and Phase II (2008–2012) of the ETS.

Thus, a Difference-in-Differences model can account for these aspects. It consists in taking the difference of the outcome before and after the treatment for firms in the control group and subtracting it from the same difference observed among firms in the treated group. This allows accounting for unobserved differences between the two groups which are fixed over time as well as differences that vary through time but affect both control and treatment groups equally (such as economy-wide factors).

The estimation of the effects is based on the following regression framework:

$$Y_{isct} = \beta T_{sct} + \gamma_i + \delta_t + \sigma X_{ct} + \theta_{st} + \epsilon_{isct} \tag{1}$$

where Y_{isct} is the outcome for firm i, operating in sector s in country c in year t. In the analysis, five firm outcomes are considered: turnover per employee, total assets per employee, turnover, total assets and the number of employees. These are all expressed in logarithm to ease the interpretation of the results, as explained below.

The effect of the EU ETS indirect cost compensation is captured by the coefficient β, which is the one associated to T_{sct}.

The variable T_{sct} takes two forms. In one case, it is an indicator that takes value one if the firm is deemed to receive indirect cost compensation, because it operates in a country where the sector is eligible to funding in that year, and value zero otherwise (i.e. either it operates in an aiding country in a period prior to the enactment of the State Aid scheme or it operates in a country were indirect cost compensation is not contemplated). Here, the indicator is referred to as 'Aid' and is used in the analysis described in section 5.1. The estimation of the coefficient β associated to this indicator allows answering to the following question: by what percentage does the firm's performance change when it receives compensation, regardless of the amount of the aid?

In the second case, which applies to the results presented in section 5.2, T_{sct} is (the logarithm of) the amount of the subsidy received by each firm and is named 'Subsidy'. Here, the β expresses an elasticity, thus it addresses the question: by what percentage does the firm's performance change for every one per cent increase in the amount of the aid?[11]

In addition, the model allows for a number of fixed effects, which are meant to capture time-invariant differences that might exist across firms (γ_i) and years (δ_t), or shocks that might occur in specific time periods in given sectors (θ_{st}).

Adding these sets of fixed effects in the model is vital to eliminate or attenuate any potential confounding factor that might arise, especially given the lack of observable characteristics to use as controls. The inclusion of firm fixed effects (γ_i) clears the estimation of β from all firm-specific factors that are not observable and do not (or are unlikely to) change over time. This is the case, for instance, of firm size or market power of the group. The year fixed effects (δ_t) pick up the potential effect of events that are common to all firms in the sample, e.g. global financial shocks or EU-level changes in regulation. Sector-year fixed effects (θ_{st}) consider any circumstances that affect single sectors in a given year at the EU-level such as changes in regulations or market competition. This also includes all EU-wide sector-specific changes to the EU ETS and to other directives such as the Industrial

[11] This is evaluated only for the observation where the amount of the subsidy is non-zero.

Emission Directive (IED). As the treatment varies at the level of country and year, some control variables are included in the model in order to account for time-varying factors that are country-specific. These are included in the set X_{ct}, which contains GDP per capita, the debit-to-GDP ratio, the average gross electricity price for the consumption band 70k-150k MWh and the yearly amount of greenhouse gases emitted.[12] Thus, the effect of the funding on firm outcomes captured by β is to be intended net of all the above potential confounding factors. Finally, ϵ_{isct} represents the error.[13]

[12] All these country-level indicators are gathered from Eurostat.

[13] Standard errors are clustered at the firm level. Clustering at country or sector level yields identical results.

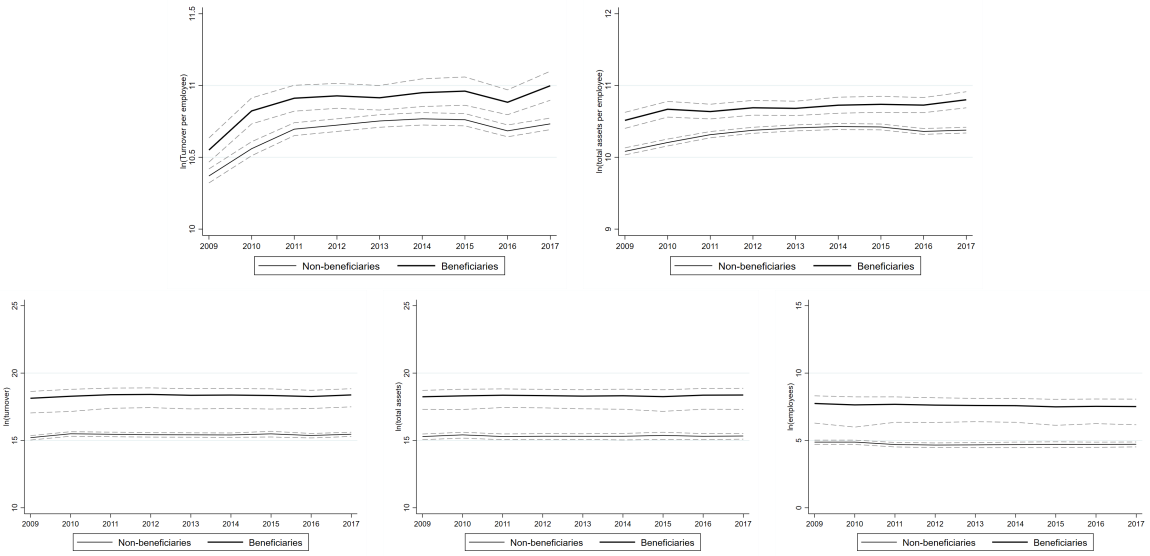
5 Results

A first naïve investigation on the performance of beneficiaries and non-beneficiaries over time is carried out by observing their average trending. Figure 8 displays some descriptive evidence on the average level of measures of turnover per employee and total assets per employee (above) and of turnover, total assets and number of employees (below) of firms belonging to the two groups. The thick solid lines refer to the average values for the beneficiaries and the thin solid lines to the group of control firms (i.e. those not receiving funding at all). The dashed lines represent the 95% confidence intervals. The plots clearly show, first, that on average beneficiaries are larger, as they have higher levels of turnover, total assets and employees. Moreover, beneficiaries exhibit higher levels of labour productivity and assets per employee. Second, and most importantly, the two groups seem to behave in a similar way (or, to have a common trend), as the two curves are parallel throughout the whole period considered in all cases.

This first inspection suggests that the behaviour of the two groups might have not changed over time, and especially from before to after the start of the EU ETS indirect cost compensation schemes (in 2013 for most MS, in 2016 in Finland and in 2017 in Belgium-Wallonia). However, the raw averages might hide the effect of some of the potential confounding factors described in the previous section, or their combination. Therefore, a more structured approach in the form of a Difference-in-Differences model, as outlined in section 4, is required.

The remainder of this section presents the results of the estimation of the effect of receiving EU ETS indirect cost compensation on the extensive margin (that is, whether funding is received or not) and on the intensive margin (namely, the effect of each EUR of aid received), both for all firms in the sample and for the aluminium sector alone.

Figure 8: Trends in performance by group, raw data



Note: Raw averages. The thick solid lines represent the average values for the beneficiaries; the thin solid lines refer to the group of non-beneficiaries firms. The dashed lines represent the 95% confidence intervals.

5.1 EU-ETS indirect cost compensation on the extensive margin

Table 5 shows the effect of receiving compensation for ETS indirect costs on a proxy of labour productivity, namely turnover per employee (columns 1–3) and on the average value of total assets per worker (columns 4–6). These are meant to account for the effect of the aid on competitiveness, thus giving insights on the existence of potential competition distortions. Moreover, given that firms receiving compensation are substantially larger than non-beneficiaries (Figure 5), expressing the outcomes in relative terms on the basis of the firms' number of employees increases the comparability across the two groups.

A first simple estimation of the effect of receiving compensation on turnover per employee, presented in column 1, includes only basic controls: firm and year fixed effects. These account for all differences across firms that do not vary over time and for common shocks that occur across all firms in a given time period. The estimated coefficient is not statistically different from zero. This estimate, however, does not include those unobserved factors which are specific for each sector in a certain year (i.e. NACE–year fixed effects) nor country characteristics that may vary over time. As mentioned in section 4, including these elements in the model is crucial to control for these potential confounders. They are added to the model in column 2 and 3, respectively.

As a result, the coefficient changes sign but is, again, imprecisely estimated and cannot be distinguished from zero. Column 3 reports the full specification that is presented in equation 1. Columns 4 to 6 of Table 5 reproduce the same estimates when total assets per employee is considered and yield identical findings.

This first set of results suggests that the EU ETS indirect cost compensation on average did not have an impact on per worker measures, thus pointing to the absence of market distortions due to the compensation.

Considering measures of profitability in absolute terms would capture changes in the production levels that firms overtake in the short run (turnover and employment) and in the medium run (total assets), hence approximating for the risk of carbon leakage, together with firm size (number of employees).

Table 6 shows the estimated effect of the compensation on turnover (columns 1–3), total assets (columns 4–6) and employment (columns 7–9). These measures represent the economic profitability and the size of the firm in absolute terms. As in the previous case, the preferred specifications are the ones that include all fixed effects and control variables (namely, columns 3, 6 and 9). The estimated coefficients are always negative and statistically significant and suggest that receiving compensation yields lower levels of turnover by 5.6%, of total assets by 6.3% and reduces employment by 4.4.%. These findings are in line with existing studies (Cox et al., 2014; Marin and Vona, 2017) mainly focusing on the substitution effect of energy to labour triggered by those policies that foster the transition to renewable energy.

These results might appear as counter-intuitive, as they suggests that firms receiving compensation experience a worse performance compared to firms in the control group who do not receive funding. According to the analysis, this occurs in particular in terms of absolute values of turnover, total assets and employment levels. There exists different potential reasons behind these estimated effects.

A partial explanation may come from the differences in size of treated and control firms highlighted in Figure 5. Considering normalised outcomes as in Table 5 attenuates potential systematic differences in market structure between the two groups.

In addition, it is clear there exist some elements that enter the production function of firms which are not observed in their balance sheet data, such as the cost of the inputs. In the examined case, which focuses on firms that operate in energy-intensive sectors, the cost of energy is a non-negligible part of production costs. It is widely accepted in the literature that climate policies in support of renewable energies imply an increase of the electricity cost and this, in turn, induces firms to optimize their production function by using a different combination of inputs. Thus, as energy becomes more expensive it is substituted to labour (Cox et al., 2014; Marin and Vona, 2017). This interrelation between electricity prices and labour is deeply investigated in Cox et al. (2014) who focus on German manufacturing. In this study, as in the evaluation illustrated here, more accurate estimates would benefit of firm level data on electricity prices, which is still lacking.

Yet, in principle, such mechanisms alone would only affect the number of employees and it would not allow for the compensation of indirect costs to have a negative impact on the performance of aided businesses in comparison to those that do not receive any funding, unless the cost of energy for beneficiaries, net of the subsidy, was higher than that for firms in the comparison group. Unfortunately, the data at hand does not allow

Table 5: Effect of receiving aid on turnover per employee and total assets per employee, all sectors

Dependent variable	(1) Turnover per employee	(2) Turnover per employee	(3) Turnover per employee	(4) Total assets per employee	(5) Total assets per employee	(6) Total assets per employee
Aid	0.020	-0.013	-0.012	0.004	-0.008	-0.020
	(0.020)	(0.024)	(0.024)	(0.025)	(0.029)	(0.030)
Observations	23,277	23,277	23,277	23,277	23,277	23,277
R-squared	0.922	0.924	0.924	0.917	0.918	0.919
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
NACE-Year Fixed Effects		Yes	Yes		Yes	Yes
Country-specific controls			Yes			Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. Standard errors in parentheses. 'Aid' is equal to one if the firm is a beneficiary of compensation and equal to zero otherwise. The dependent variable is expressed in logarithm. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

Table 6: Effect of receiving aid on turnover, total assets and employment, all sectors

Dependent variable	(1) Turnover	(2) Turnover	(3) Turnover	(4) Total assets	(5) Total assets	(6) Total assets	(7) Employees	(8) Employees	(9) Employees
Aid	-0.063***	-0.044*	-0.056**	-0.079***	-0.039	-0.063**	-0.083***	-0.031	-0.044**
	(0.023)	(0.026)	(0.025)	(0.024)	(0.026)	(0.027)	(0.017)	(0.020)	(0.020)
Observations	23,277	23,277	23,277	23,277	23,277	23,277	23,277	23,277	23,277
R-squared	0.975	0.975	0.975	0.980	0.981	0.981	0.974	0.974	0.974
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NACE-Year Fixed Effects		Yes	Yes		Yes	Yes		Yes	Yes
Country-specific controls			Yes			Yes			Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. Standard errors in parentheses. 'Aid' is equal to one if the firm is a beneficiary of compensation and equal to zero otherwise. The dependent variable is expressed in logarithm. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

Table 7: Effect of receiving aid on turnover per employee and total assets per employee, aluminium sector

Dependent variable	(1) Turnover per employee	(2) Turnover per employee	(3) Turnover per employee	(4) Total assets per employee
Aid	0.090	0.108*	0.136	0.142
	(0.058)	(0.065)	(0.104)	(0.111)
Observations	1,249	1,249	1,249	1,249
R-squared	0.860	0.860	0.864	0.866
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Country-specific controls		Yes		Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. Standard errors in parentheses. 'Aid' is equal to one if the firm is a beneficiary of compensation and equal to zero otherwise. The dependent variable is expressed in logarithm. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

Table 8: Effect of receiving aid on turnover, total assets and employment, aluminium sector

Dependent variable	(1) Turnover	(2) Turnover	(3) Total assets	(4) Total assets	(5) Employees	(6) Employees
Aid	-0.024	-0.055	0.021	-0.020	-0.114	-0.162**
	(0.097)	(0.097)	(0.091)	(0.094)	(0.077)	(0.075)
Observations	1,249	1,249	1,249	1,249	1,249	1,249
R-squared	0.967	0.968	0.980	0.980	0.960	0.961
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific controls		Yes		Yes		Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. Standard errors in parentheses. 'Aid' is equal to one if the firm is a beneficiary of compensation and equal to zero otherwise. The dependent variable is expressed in logarithm. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

to causally test this hypothesis, as input costs (and especially energy costs) at the firm level are not observable.

A way to understand whether differentials in energy costs could represent a decisive determinant of this result is to look at the trends of energy prices in countries that compensate indirect costs and countries that do not. Figure A.3 depicts the average gross energy prices for non-household consumers in the consumption bands 20k–70k MWh and 70k-150k MWh (top) and the average share of energy produced from renewable sources (bottom), split by group, i.e. compensating versus non compensating countries.[14]

The trends in the average energy prices suggest that energy costs were relatively similar in the period up until 2013 but substantially diverge in the following years. Specifically, in MS belonging to the control group the average prices fell steeply, while in the countries that provide compensation for indirect costs they start declining only after a few years. Moreover, the plot at the bottom of Figure A.3 shows that non-aided countries are characterised by a higher share of energy production coming from renewable sources throughout the whole period considered.[15] This is coherent with energy having a lower price on average in countries that belong to the control group, and the more so given that in these areas firms could access extra benefits reserved to the use of renewable sources. This evidence, albeit suggestive, would be consistent with the co-existence of a premium in energy costs for firms receiving compensation compared to non-funded businesses, which could possibly offset the effects of the compensation.[16]

Tables 7 and 8 show the estimates of the previous models considering the aluminium sector alone.[17] In terms of labour productivity and assets per employee the coefficient is positive in all the specifications, but, again, not statistically significant.[18] When looking at the variables in absolute terms, the effect is always negative, albeit precisely estimated only when employment is taken as outcome. In the aluminium sector, firms receiving compensation experience a reduction in the number of employees of about 16% (column 6, Table 8).

5.1.1 Robustness checks

The Difference-in-Differences model relies upon the validity of some strong identifying hypotheses. Among these, the validation of the so-called "common trend" assumption is crucial. The existence of a common trend between treated firms and controls in the period before the implementation of the policy means that the two groups are comparable in terms of performance they had before receiving the aid. If this condition is verified, it

[14] In the sample, the median amount of energy consumed by firms over the years 2005 to 2017, as reported in the beneficiaries records, is typically around 65k MWh.

[15] Here, no data is available for Finland and Hungary.

[16] The data on energy prices presented in Figure A.3 do not account for different taxation and deduction rates applied by the single MS to various price subcomponents. Thus, this reasoning might be less powerful if countries in the treated group applied systematically lower taxation and/or higher deduction rates in the post-2013 period with respect to MS in the control group. Furthermore, firms' energy costs might derive from bilateral negotiations with power generators which are not identified in balance sheet data.

[17] Since the focus is on a single sector, the NACE-year fixed effects are dropped from the model due to their collinearity with the year fixed effects.

[18] Except the coefficient in column 2, although its significance is weak.

is meaningful to apply the double difference to estimate the impact of the subsidy in the post-implementation period.

In order to assess its validity and to test whether there has been any anticipation of the intervention before its formal entry into force, an event study in the spirit of Autor (2003) is carried out, by considering three years before the implementation and five years after. The choice is driven by the fact that the bulk of the treated firms in the sample started receiving compensation in 2013. For this group of firms, the selected range allows for t-3 being the year 2009 and t+5 being the year 2017, which are the first and the last year observed in the data. However, the treatment does not start in the same year for all firms: compensation is available since 2016 in Finland and since 2017 in Belgium-Wallonia. Hence, the event study analysis is centered around the year of implementation, in order to make firms operating in different countries comparable on the basis of how long they have been exposed to the treatment (i.e. the compensation).

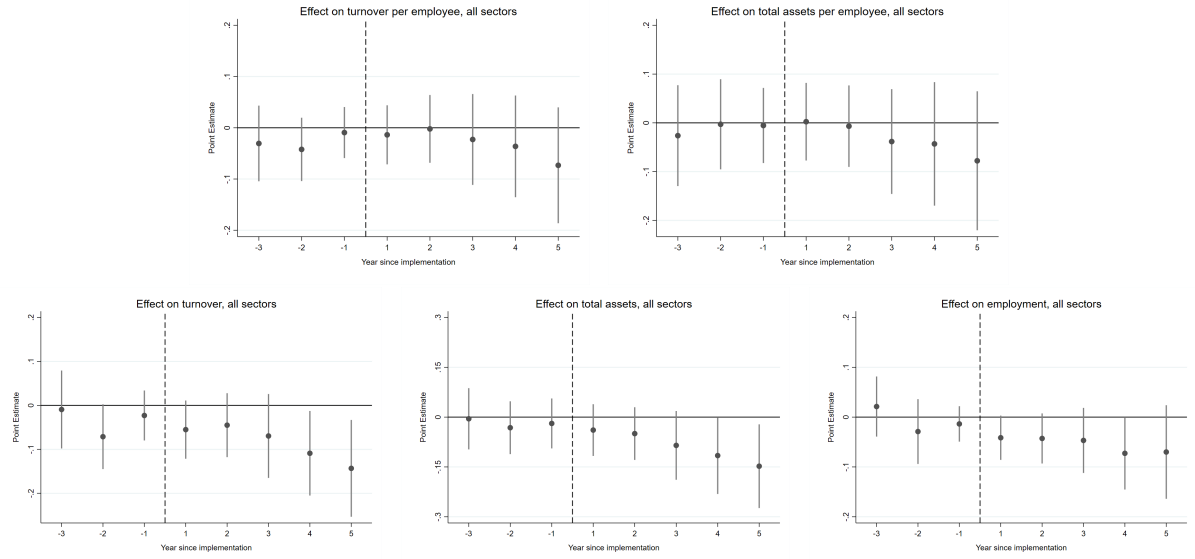
The event study analysis is plotted in Figure 9 for all five outcomes considered. Here, all sectors are included in the sample. The horizontal axis counts the years to the implementation and the vertical dashed line separates the pre-implementation period from the years when firms are exposed to the compensation. In all cases, the estimated yearly coefficients in the pre-implementation period are never statistically different from zero, as confidence interval crosses the zero line in all cases. This proves the absence of any anticipatory effect and that the behaviour of firms before the approval of the ETS indirect cost compensation was following a similar trend with respect to firms operating in countries without aid.[19]

The event study analysis also provides some insights on the dynamics of the policy effects, showing how the impact changes over time. When considering the years after the implementation, the plots reflect the results presented in Tables 5 and 6 are confirmed. In fact, the evidence points to a non statistically significant impact of the indirect cost compensation on per worker outcomes both in the short (at $t+1$) and in the longer run ($t+2$ to $t+5$). Notwithstanding, a negative effect is found on turnover, total assets and employment, especially four and five years after the compensation being in place.

The plots in Figure 10 show the event study analysis for the five outcomes with a focus on the aluminium sector. Coefficients are never statistically significant, but it is worth highlighting that the point estimates on labour productivity are slightly positive, and possibly determined by a reduction in employment (the denominator of the ratio) which is not coupled with variations in terms of turnover (the numerator).

As a further robustness test, all estimates are re-run excluding each country or sector, one at a time, to ensure that the results discussed above are not driven by a single group of observations. These are presented in Figures A.1 and A.2. The graphs plot the estimated coefficients and their respective confidence intervals obtained by repeating the fully-specified model for all outcomes over a sample which excludes either countries (Figure A.1) or sectors (Figure A.2) one by one. The flat patterns confirm that results are not markedly driven by

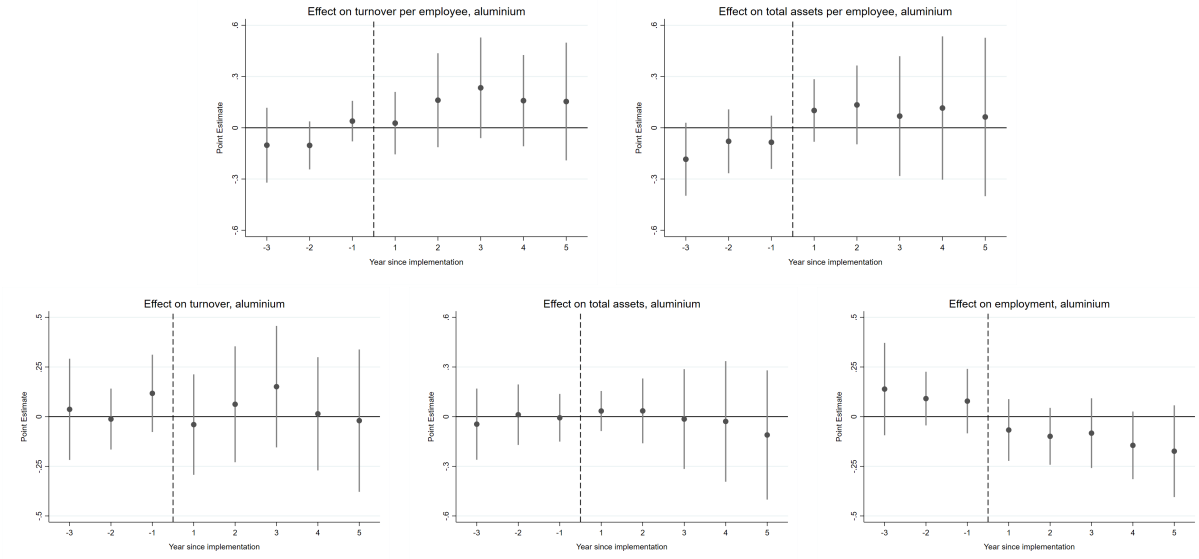
Figure 9: Event studies: effect of receiving aid on firm performance, all sectors



Note: The vertical dashed line identifies the year of implementation (2012, 2015 or 2016, depending on the country considered). Black dots are the points estimates of the effect of the aid in each year; the vertical lines represent the respective 90% confidence intervals. Regressions include fixed effects and controls as from Equation 1.

[19] In other words, given that the coefficients associated to the pre-intervention time periods -3, -2 and -1 are never distinguishable from zero, the conditional outcome trends between firms in the treatment and the control groups are the same.

Figure 10: Event studies: effect of receiving aid on firm performance, aluminium sector



Note: The vertical dashed line identifies the year of implementation (2012, 2015 or 2016, depending on the country considered). Black dots are the points estimates of the effect of the aid in each year; the vertical lines represent the respective 90% confidence intervals. Regressions include firm, group and year fixed effects.

a single country or sector, as their exclusion does not considerably affect the overall estimates. This evidence is reassuring, also in view of the country differences in relative size and the sectoral heterogeneity across treated and control firms revealed by the descriptive statistics in Figure 3.

5.1.2 Heterogeneous effects

Being part of a large group of companies could allow firms exploiting some comparative advantages with respect to other firms facing market challenges alone. In the case of the EU ETS this could translate in economies of scale on productivity and electricity prices which, in turn, would affect firms' performance. Hence, it is worth investigating whether the intervention has had an heterogeneous effect on those companies which are part of a group or an international group. To this end, two additional variables are defined: 'Firm in group' takes value one if the firm belongs to a group counting at least two firms and is equal to zero otherwise; 'Firm in international group' which is equal to one if the firm belongs to a group operating in at least two different countries and zero otherwise. In the main sample, around 8% of businesses belongs to a group and 5% to an international group of firms. For the aluminium sector these figures are 6% and 4%, respectively.

The interpretation of the results is slightly different compared to those discussed above and less straightforward. Here, the effect is still given by the derivative of the equation with respect to the treatment, although this is now computed as the linear combination of the terms 'Aid' and 'Aid * Firm in (international) group'. For the sake of an easier reading of the results, the linear combination and its respective p-value are reported in Table 9, which refers to the whole sample, and in Table 10, which contains estimates run on the sub-sample of firms operating in the aluminium sector only.

The estimates presented in both Tables 9 and 10 show that, in general, there is no heterogeneous effect of the ETS compensation for indirect costs for businesses belonging to a group of at least two firms (columns 1–5), as the p-values associated to the linear combination always exceed the conventional 5% level of significance.

Furthermore, in the sample that includes all the sectors, accounting for some heterogeneous characteristics in terms of firms' organisational structure, still confirms the negative differential effect on turnover, total assets and employees of firms receiving compensation with respect to controls ('Aid' in columns 3–5 and columns 8–10, Table 9). Interestingly, it appears that firms belonging to a group and receiving compensation experience an increase in the value of total assets by around 13-14% compared to firms that are not aided or are not part of a group. This applies regardless of how groups are defined (columns 4 and 9, Table 9). However, the linear combination of these effects is never statistically different from zero, meaning that there is no difference in performance between aided firms that belong to a group and stand-alone businesses that receive compensation.

Similar results are obtained on the aluminium sector, with the exception of a slightly significant increase in labour productivity for aided firms in international groups in comparison to firms that are funded but do not belong to international groups.

Table 9: Effect of receiving aid on firms belonging to groups, all sectors

Dependent variable	(1) Turnover per employee	(2) Total assets per employee	(3) Turnover	(4) Total assets	(5) Employees	(6) Turnover per employee	(7) Total assets per employee	(8) Turnover	(9) Total assets	(10) Employees
Aid	-0.023	-0.034	-0.074***	-0.085***	-0.051***	-0.023	-0.034	-0.075***	-0.086***	-0.052***
	(0.021)	(0.028)	(0.024)	(0.026)	(0.019)	(0.021)	(0.028)	(0.024)	(0.026)	(0.019)
Firm in group	0.061	0.045	0.004	-0.012	-0.057*					
	(0.045)	(0.042)	(0.041)	(0.035)	(0.034)					
Aid * Firm in group	0.064	0.082	0.109	0.127*	0.045					
	(0.081)	(0.085)	(0.083)	(0.076)	(0.067)					
Firm in int'l group						0.041	0.079	-0.035	0.003	-0.076
						(0.056)	(0.063)	(0.076)	(0.052)	(0.058)
Aid * Firm in int'l group						0.071	0.088	0.120	0.138*	0.050
						(0.085)	(0.087)	(0.086)	(0.079)	(0.069)
Linear combination	0.041	0.048	0.035	0.042	-0.006	0.047	0.054	0.045	0.052	-0.002
p-value	0.612	0.568	0.671	0.581	0.921	0.580	0.532	0.598	0.503	0.974
Observations	23,277	23,277	23,277	23,277	23,277	23,277	23,277	23,277	23,277	23,277
R-squared	0.924	0.919	0.975	0.981	0.974	0.924	0.919	0.975	0.981	0.974
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NACE-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. All sectors. 'Aid' is equal to one if the firm is a beneficiary of compensation and equal to zero otherwise. 'Firm in group' is equal to one if the firm belongs to a group counting at least two firms and is equal to zero otherwise. 'Firm in int'l group' is equal to one if the firm belongs to a group operating in at least two countries and is equal to zero otherwise. 'Linear combination' is the sum of the coefficients associated to 'Firm in group' and 'Aid * Firm in group' (columns 1–5) and to 'Firm in int'l group' and 'Aid * Firm in int'l group' (columns 6–10). 'p-value' is the corresponding p-value. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

Table 10: Effect of receiving aid on firms belonging to groups, aluminium sector

Dependent variable	(1) Turnover per employee	(2) Total assets per employee	(3) Turnover	(4) Total assets	(5) Employees	(6) Turnover per employee	(7) Total assets per employee	(8) Turnover	(9) Total assets	(10) Employees
Aid	0.122	0.158	-0.056	-0.019	-0.177**	0.117	0.145	-0.057	-0.030	-0.175**
	(0.077)	(0.129)	(0.114)	(0.110)	(0.087)	(0.077)	(0.121)	(0.111)	(0.102)	(0.083)
Firm in group	0.118	-0.118	-0.016	-0.251**	-0.134***					
	(0.208)	(0.125)	(0.201)	(0.124)	(0.035)					
Aid * Firm in group	-0.077	-0.088	0.006	-0.005	0.083					
	(0.101)	(0.135)	(0.161)	(0.121)	(0.102)					
Firm in int'l group						0.967***	0.314***	0.818***	0.165***	-0.149**
						(0.041)	(0.068)	(0.080)	(0.056)	(0.067)
Aid * Firm in int'l group						0.015	0.006	0.125	0.115	0.109
						(0.094)	(0.142)	(0.211)	(0.100)	(0.147)
Linear combination	0.045	0.070	-0.050	-0.024	-0.094	0.133	0.151	0.067	0.085	-0.066
p-value	0.517	0.401	0.683	0.771	0.225	0.050	0.115	0.709	0.116	0.605
Observations	1,249	1,249	1,249	1,249	1,249	1,249	1,249	1,249	1,249	1,249
R-squared	0.860	0.866	0.968	0.981	0.961	0.861	0.866	0.969	0.980	0.961
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. Aluminium sector only. 'Aid' is equal to one if the firm is a beneficiary of compensation and equal to zero otherwise. 'Firm in group' is equal to one if the firm belongs to a group counting at least two firms and is equal to zero otherwise. 'Firm in int'l group' is equal to one if the firm belongs to a group operating in at least two countries and is equal to zero otherwise. 'Linear combination' is the sum of the coefficients associated to 'Firm in group' and 'Aid * Firm in group' (columns 1–5) and to 'Firm in int'l group' and 'Aid * Firm in int'l group' (columns 6–10). 'p-value' is the corresponding p-value. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

5.2 EU-ETS indirect cost compensation on the intensive margin

The previous findings presented the effect of the ETS indirect compensation intended as a binary treatment. However, compensation is funded by each MS with different intensities, as shown in Figure 4. This suggests analysing the impact of the aid on the performance of the treated firms receiving a subsidy, in order to account for the intensity of the transfer. In this section, the sample is reduced to firms operating in aided countries only and for which information on the subsidy is available. This implies that this part of the analysis contemplates a more homogeneous sample and is exempt from the potential systematic differences across countries in the treated and control groups discussed in the previous section.

Results on the intensive margins are presented both for the whole sample (Table 11) and for the aluminium sector alone (Table 12).

When considering all funded businesses operating in any of the eligible sectors, results highlight the absence of any significant impact on per worker productivity (Table 11, columns 1 and 2), while turnover, total assets and the number of employees seem to be higher the larger the amount of aid received by firms. This would suggest that among the aided countries only, for each 1% increase in the amount of the subsidy received (i.e. around 1,000 EUR), firms expand their turnover and their assets value by 0.01%, and their workforce by 0.07%.

Thus, it would appear that within the group of firms that are subsidised, an increase in the amount granted is associated to a better performance, which would reduce the risk of carbon leakage.

The results replicated for the aluminium sector alone yields similar conclusions (Table 12). A positive and marginally significant effect is found on employment, while turnover increases by about 0.23% for every 1% rise in the amount of subsidy. In other words, the existence of a positive effect suggests that firms receiving a higher subsidy tend to experience a better performance in terms of turnover and job retention in comparison to firms receiving grants of lower amounts.

Table 11: Effect of receiving aid on turnover per employee and total assets per employee, intensive margin, all sectors

Dependent variable	(1) Turnover per employee	(2) Total assets per employee	(3) Turnover	(4) Total assets	(5) Employees
Subsidy	0.025	0.026	0.098**	0.098**	0.073**
	(0.048)	(0.049)	(0.047)	(0.048)	(0.036)
Observations	617	617	617	617	617
R-squared	0.959	0.957	0.989	0.985	0.990
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
NACE-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country-specific controls	Yes	Yes	Yes	Yes	Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. Standard errors in parentheses. Sample of beneficiaries of indirect cost compensation only. 'Subsidy' is the logarithm of the amount received by beneficiaries. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

Table 12: Effect of receiving aid on employment, intensive margin, aluminium sector

Dependent variable	(1) Turnover per employee	(2) Total assets per employee	(3) Turnover	(4) Total assets	(5) Employees
ln(subsidy)	0.110	0.168	0.225**	0.283	0.116*
	(0.069)	(0.179)	(0.090)	(0.187)	(0.059)
Observations	65	65	65	65	65
R-squared	0.944	0.814	0.991	0.960	0.995
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country-specific controls	Yes	Yes	Yes	Yes	Yes

Note: *** p<0.01, ** p<0.05, * p<0.10. Standard errors in parentheses. Sample of beneficiaries of indirect cost compensation only. 'Subsidy' is the logarithm of the amount received by beneficiaries. Country-specific controls include GDP per capita, debit-to-GDP ratio, gross electricity price for the consumption band 70k-150k MWh and emissions of greenhouse gases (in CO2 equivalent).

6 Caveats and suggestions to increase the quality of future evaluations

The evaluation contained in this report is the first analysis that employs firm-level data deriving from the records on beneficiaries of indirect cost compensation that MS are obliged to transmit to DG COMP. As such, it offers the opportunity to reflect on the potential for improvement in relation to reporting obligation procedures and data collection. This appears especially relevant given the foreseen revision of the Guidelines on certain State Aid measures in the context of the GHG allowance trading system post-2020.

The harmonisation of the records carried out for the analysis herein presented proved to be demanding in terms of time and effort. In what follows, some suggestions are provided on a possible revision of the reporting requirements and, in particular, on the format in which the information is transmitted to the Commission by MS. The aim is to envisage a standardised reporting practice that will ease the processing of the records in view of future evaluations exercises. At the same time, the proposed changes would be at very low cost for the reporting authorities, as they would not constitute an additional burden for them, given that all the information mentioned below is already in their possession.

First, it would be desirable that reporting authorities are provided with a standardised template designed by the Commission, which would ease the automatised management of the information. To date, the records on beneficiaries provided to the Commission greatly differ in format from one MS to another, and sometimes the same MS uses different templates over time. For this reason, most of the information used in the analysis required a large amount of harmonisation to be done by hand.

Thus, it is suggested that:

- all records are provided in .xls or .csv format;
- each row refers to a single plant/installation/activity;
- any information is provided in wide format (all in the same row);
- all the relevant information is recorded in the same worksheet (one per year, per MS).

Second, the inclusion of the following information in *all* records would sensibly increase data quality and the chances to successfully link the records on the beneficiaries to other sources such as the Orbis database (as in the analysis presented in this report) and the e-PRTR database:

- the official names of the firm and of the plant/installation;
- the VAT number;
- the plant/installation (facility) ID as reported in the e-PRTR database;
- the location (city and country) of the plant;
- the 4-digit NACE code of the activity carried out within the plant/installation;
- all elements necessary to compute the formula as reported in the Guidelines;
- the amount of the aid computed for the given plant/installation/activity;
- any adjustment to the aid amount;
- the final amount received by the firm for the given plant/installation/activity;
- any other transfer received by firm for the given plant/installation/activity under other national schemes.

Most of the above information is already present in the records transmitted by the majority of MS to the Commission. However, it is the case that some of the entries are transmitted only in part, or are not reported at all, despite the fact that they are in the possession of the corresponding national managing authority.

When harmonising records provided by different MS, if any of the entries is not available even for one country or for a single year, then the entry cannot be used in the analysis. As outlined in the section 3.1 and summarised in Table 2, this issue markedly limited the possibility to exploit the available data in the evaluation presented in this report. For instance, it was not possible to account for the consumption of electricity reported in the records on the beneficiaries, nor for the recipiency of other transfers related to the emissions of GHG, because some MS did not transmit this piece of information. Taking these factors into consideration in the analysis, however, would have been important in order to better identify the effect of interest (i.e. the impact of EU ETS indirect cost compensation on firm outcomes). Moreover, a finer definition of the entities receiving the aid, for instance via the provision of records at the plant level with information on their name and location (or, better, the facility ID reported in the e-PRTR), would have enabled linking the records on the beneficiaries to relevant databases such as the e-PRTR. This would have allowed studying also whether the indirect cost compensation brought about a conversion of the technologies and a reduction in emissions by the funded plants.

Third, in the best-case scenario, the database would also include records on firms receiving aid under the “de minimis” rule. As outlined in section 3.3, the absence of such information constituted a major challenge when selecting a proper comparison group and led to the decision to retain only larger firms in the sample. While the selection of the sample in the analysis was made so as to minimise arbitrariness, if complete information were present the sample would have been chosen following an entirely objective procedure.

7 Conclusion

This evaluation exercise investigates the impact of the EU ETS compensation for indirect costs on firm outcomes. The analysis exploits the advantage of a unique panel dataset at firm level, containing detailed information on the beneficiaries of the ETS indirect cost compensation gathered by DG COMP and balance sheet financial variables of firms extracted from the Orbis database.

This is the first study analysing the impact of the ETS indirect cost compensation at firm level with an EU-wide coverage. Moreover, in comparison to the prior literature, it is the first attempt to carry out the evaluation of this policy in a quasi-experimental framework and to estimate the causal impact of the indirect cost compensation.

Findings are in line with the existing literature analysing single country interventions (mainly on tax exemptions and tax refunds). The results presented here suggest that the aid has not had a significant effect on average relative competitiveness, measured in terms of turnover per worker and the value of total assets per employees. However, there is evidence of beneficiaries performing worse than firms operating in non-funded countries when turnover, value of total assets and number of employees are considered as outcomes. This applies to the sample of all firms operating in the sectors eligible to compensation and, to a lesser extent, to businesses active in the aluminium sector alone.

These results point to a reduction in performance of aided firms, which might then be subject to a higher risk of carbon leakage. This could be due to systematic differences across countries that provide funding and those that do not, which might originate, for instance, from different patterns in the evolution of electricity prices.

When focusing only on the beneficiaries for which the value of the subsidy is available, a positive impact of the compensation is identified. Specifically, the estimated coefficients imply that firms receiving a higher subsidy experience a positive and significant impact on the measures of turnover, total assets and employment considered, in comparison to businesses that receive lower aid amounts.

These results offer interesting insights in terms of how firms adapt production decisions to transfers “doses” and to what extent heterogeneous treatment intensities might affect firms’ economic performance and, in turn, market competition and leakage.

Another question which is left unanswered, but that would be relevant to the objectives of the EU ETS as a whole, refers to the impact this policy has had on firms’ behaviour in terms of electricity consumption, for which data is not available, as some firms might have decided to switch to energy generated from more sustainable sources.

As a final remark, the exercise suggests that high-quality data collection should represent a crucial aspect of the policy cycle, so as to allow a more accurate and solid evaluation of the policy impact.

8 Appendix

Table A.1: Number of firms dropped in the balancing procedure

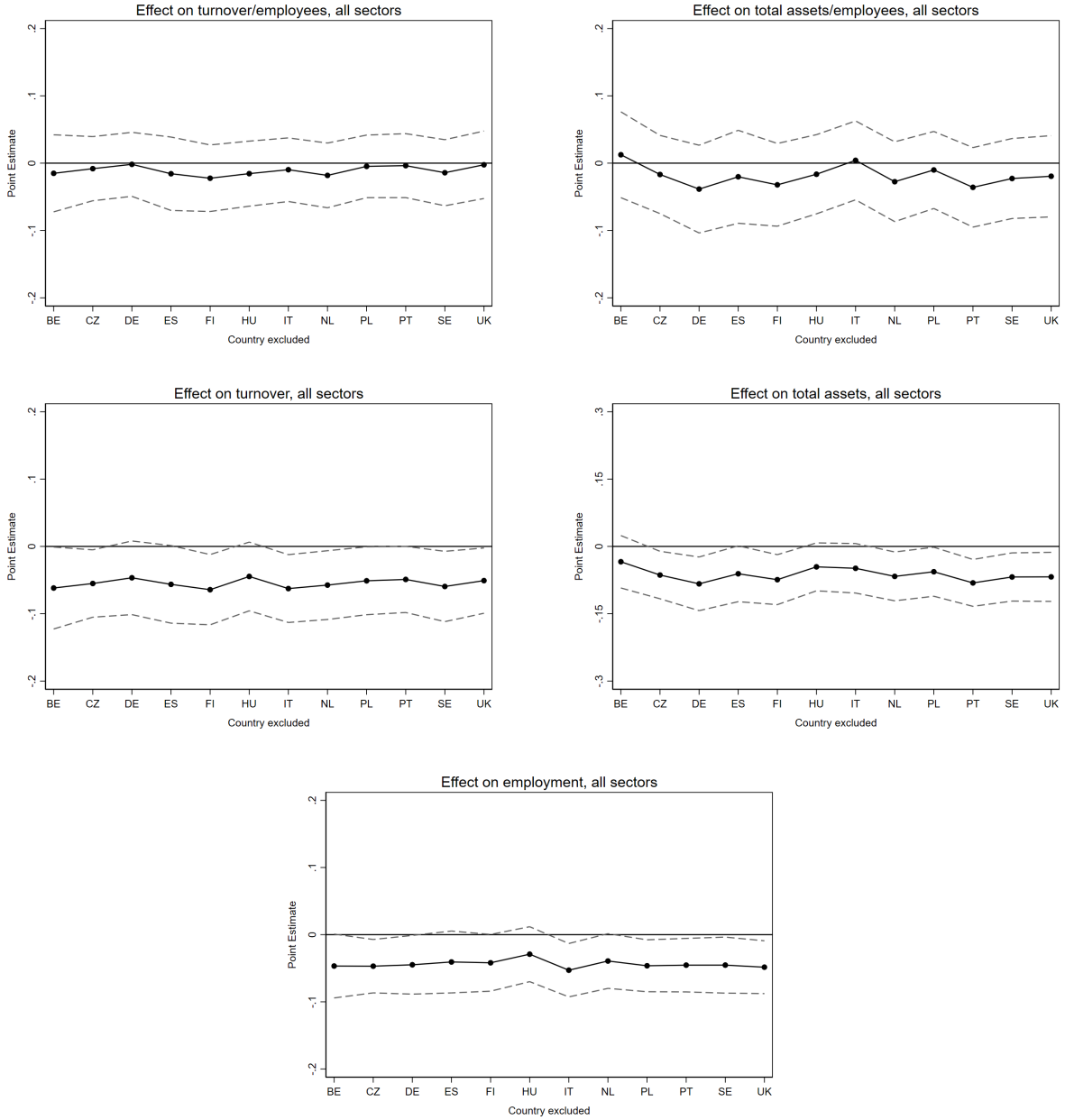
Country	Firms	Country	Firms
BE	8	CZ	208
DE	102	HU	169
ES	13	IT	809
FI	1	PL	460
NL	11	PT	38
UK	9	SE	50
Total	144	Total	1,734

Table A.2: List of aided sectors

NACE Rev. 2 code	Description
7.1	Mining of iron ores
8.91	Mining of chemical and fertiliser minerals
10.62	Manufacture of starches and starch products
10.81	Manufacture of sugar
10.91	Manufacture of prepared feeds for farm animals
13.1	Preparation and spinning of textile fibres
13.2	Weaving of textiles
13.93	Manufacture of carpets and rugs
14.11	Manufacture of leather clothes
17.11	Manufacture of pulp
17.12	Manufacture of paper and paperboard
17.22	Manufacture of household and sanitary goods and of toilet requisites
18.14	Binding and related services
19.1	Manufacture of coke oven products
19.2	Manufacture of refined petroleum products
20.11	Manufacture of industrial gases
20.12	Manufacture of dyes and pigments
20.13	Manufacture of other inorganic basic chemicals
20.14	Manufacture of other organic basic chemicals
20.15	Manufacture of fertilisers and nitrogen compounds
20.16	Manufacture of plastics in primary forms
20.2	Manufacture of pesticides and other agrochemical products
20.3	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
20.59	Manufacture of other chemical products n.e.c.
20.6	Manufacture of man-made fibres
22.22	Manufacture of plastic packing goods
24.1	Manufacture of basic iron and steel and of ferro-alloys
24.2	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
24.42	Aluminium production
24.43	Lead, zinc and tin production
24.44	Copper production
24.45	Other non-ferrous metal production
24.51	Casting of iron
28.94	Manufacture of machinery for textile, apparel and leather production
46.12	Agents involved in the sale of fuels, ores, metals and industrial chemicals
46.75	Wholesale of chemical products

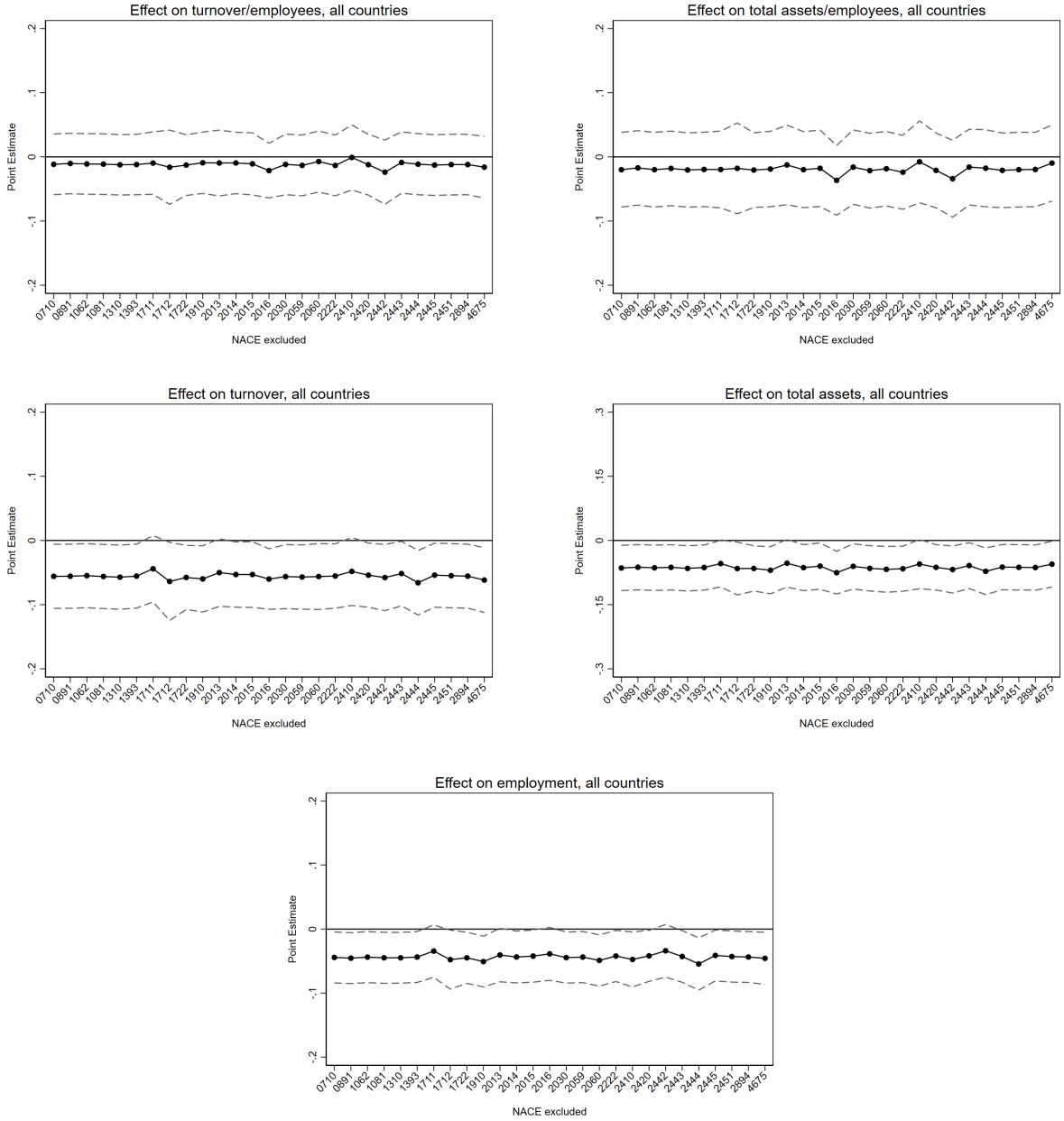
Note: The list of aided sectors is based on the Annex II, of (European Commission, 2012) and on the list of NACE codes derived from the beneficiaries records provided by MS.

Figure A.1: Effect of receiving aid on firm performance, excluding countries one by one



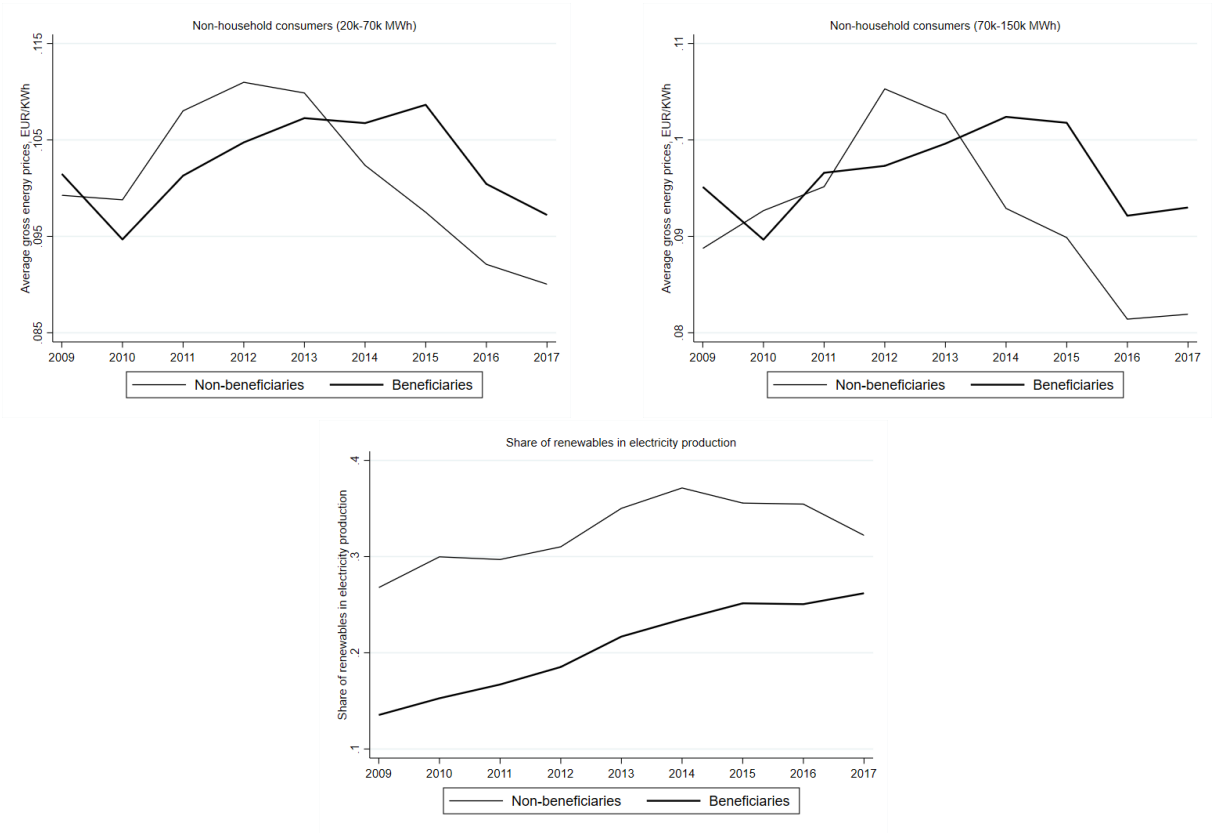
Note: The horizontal axis reports the country excluded from the estimation. Coefficients (black dots) estimated as from Equation 1. Dashed lines represent 95% confidence intervals.

Figure A.2: Effect of receiving aid on firm performance, excluding sectors one by one



Note: The horizontal axis reports the sector excluded from the estimation. Coefficients (black dots) estimated as from Equation 1. Dashed lines represent 95% confidence intervals.

Figure A.3: Average gross energy prices for non-household consumers and share of renewables in electricity production



Note: Raw averages. The thick solid lines represent the average values for the aided countries; the thin solid lines refer to the countries that do not apply compensation Sources: Eurostat (gross electricity prices) and Enerdata (share of renewables).

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