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Climate Policy, Manufacturing Competitiveness and the Decision to Exit: Evidence from Germany

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Climate Policy, Manufacturing Competitiveness and the Decision to Exit: Evidence from Germany*

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Abstract

There are longstanding concerns that the costs of environmental regulations can reduce industry competitiveness, especially in the presence of incomplete regulation. Using detailed administrative data on manufacturing establishments in Germany, we empirically analyze how two prominent climate policies, as well as measures to mitigate their effective compliance costs, affect competitiveness outcomes. We estimate small or no direct effects of compliance costs on wages and employment in regulated establishments. However, we do find evidence of a reduction in the propensity to exit among establishments that were shielded from compliance costs. Our findings highlight that even when operating firms appear largely unaffected, meaningful impacts can still arise when accounting for firms opting to shut down.

JEL Codes: D22, H23, L23, L60, Q52, Q54

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1 Introduction

Policies aimed at tackling environmental problems often raise concerns from firms that compliance costs risk harming industry competitiveness. For instance, emissions taxes and permit trading schemes put a price on firms' polluting activities. Command and control regulation can mandate that firms adopt costly abatement technologies, or even prohibit certain forms of economic activity. Firms can face increased costs from new taxes and fees that raise revenues to directly fund environmental programs. In these various cases it is common for policymakers to combine new environmental policies with additional industry support measures, especially in the presence of incomplete regulation where leakage is a concern. This may include grandfathering establishments into the new regime, providing direct subsidies or exempting particularly at-risk firms from complying in certain areas.

In this paper we use detailed administrative data on the universe of manufacturing establishments in Germany to evaluate the effectiveness of efforts to shield certain firms from environmental policy costs. Germany is an interesting setting to focus on given it is a large industrial economy with a sizeable manufacturing sector. We study two different environmental policies that have had important effects on the industrial and manufacturing sectors in Germany: the European Union Emissions Trading System (EU ETS) and the Renewable Energy Sources Act (EEG) levy. In both cases we examine steps taken by policymakers to reduce the costs these regulations imposed on certain firms. We focus on firm performance metrics using information on the workforce – primarily employment and wages. Furthermore, in an important extension to prior research we study the risk of establishment closures.

The first policy we study is the EU ETS, which is the world's oldest and most stringent carbon emission trading program. In operation since 2005, it covers installations that account for 45% of EU total emissions, the vast majority coming from large facilities in the energy and manufacturing sectors. Complying with the EU ETS places costs on CO_2-emitting firms because they must either invest in abatement technologies or buy permits to cover their emissions. Notwithstanding this, evaluation studies of the early EU ETS find no significant adverse impacts on manufacturing firms (Martin, Muûls and Wagner, 2016), and potentially even some positive impacts via increased revenues, investment (Dechezleprêtre, Nachtigall and Venmans, 2023) or innovation (Calel and Dechezleprêtre, 2016). In the German context, several studies have found positive impacts on firm efficiency and performance, especially during the early compliance periods (Lutz, 2016; Löschel, Lutz and Managi, 2019; Hintermann et al., 2024). This may reflect the knock-on effects of regulation-induced investments and innovation, but it might also be a consequence of generous allocation of free permits intended to support incumbent firms.

The second policy we study is the EEG levy, which raised money to fund subsidies for renewable energy producers through a surcharge on German consumers' electricity prices. When it was introduced in 2000 the levy was 0.19 euro cent per kilowatthour (kWh). Due to rapid growth in the scale of Germany's renewable energy deployment, the levy rose to 6.76 cent per kWh in 2020. This rise was substantial, with the levy at its peak amounting to more than 40% of industrial consumers' electricity prices before it was abolished in the summer of 2022. To mitigate concerns that these additional costs could place electricity-intensive trade-exposed firms at a competitive disadvantage, a levy exemption was introduced in 2003 and further modified in 2013. Establishments that were eligible for this exemption paid a significantly lower surcharge than the smaller and less electricity intensive consumers that faced the full surcharge.

To study the impact of these two policies we start with a difference-in-differences empirical strategy. We look at the change in wages and employment for regulated establishments, and compare them to the changes for unregulated establishments. To overcome concerns about selection of the establishments that end up being subject to these policies we combine our difference-in-differences approach with non-parametric matching. We implement exact matching based on categories of establishments size (number of employees), establishment growth (annual change in number of employees), and sector (2-digit industry code). This helps ensure we find a suitable set of control firms to compare with those that are ultimately subject to the EU ETS and the EEG levy exemption. We also only focus on establishments that become subject to either policy in a single compliance phase. This simplifies the analysis and avoids issues associated with identifying effects in the presence of staggered treatment (Goodman-Bacon, 2021; Callaway and Sant'Anna, 2021).

To study the risk of firms shutting down, we turn to a survival analysis. In general, the firms affected by our two policies have a low baseline risk of exiting, with around 10% exiting over our twenty year sample period. To see if this rate of exit is affected by the EU ETS (and associated free permit allocation) or the EEG levy exemption, we compare the hazard of exiting for treated establishments with a control group of establishments not affected by these policies. As with the difference-in-difference analysis, we employ the same exact matching strategy to ensure our control establishments form a credible counterfactual.

Our results for the EU ETS indicate no significant impact on aggregate employment or average wages. The one exception is that we observe a small increase in average wages in later compliance phases and concentrated at establishments that continue to receive additional support due to being designated at risk of carbon leakage. That these effects are either zero or positive, despite the EU ETS notionally entailing compliance *costs*, may seem counter-intuitive. However, this is in line with previous research that has found positive initial effects of the EU ETS on efficiency and performance of German manufacturing firms (Lutz, 2016; Löschel, Lutz and Managi, 2019; Hintermann et al., 2024). The modest positive wage effects we observe, particularly among leakage-exposed establishments receiving continued policy support, are consistent with recent research documenting that German manufacturing firms pass through rents from reduced energy prices to wages if the associated cost reductions are sufficiently large, which tends to be the case among very energy-intensive firms (Mertens, Mueller and Neuschaeffer, 2026).

We provide new evidence that establishments regulated by the EU ETS were also less likely to shut down and exit. By the end of our sample period, establishments that were regulated by the ETS had exited at about half of the rate for similar non-regulated establishments. These findings are confirmed in a more aggregated approach based on the counts of establishments over time. Using variation in eligibility for free permits across sectors and over time, we find evidence suggesting that free permit allocation prevented regulated establishments from exiting at the same rate as unregulated establishments.

Our results for the EEG levy exemption indicate no significant impact on aggregate employment or average wages. Identification her is imperfect due to limitations in our matching, with a pre-existing relative decrease on both measures for our matched treated establishments. Even so, it does not appear this particular policy resulted in a meaningfully expanded or better-paid workforce relative to establishments that did not receive this subsidy, despite the considerable sums spent on this support for energy-intensive industries.

We do find some limited evidence that the establishments that received the EEG levy exemption were less likely to shut down and exit based on an establishment-level survival analysis. By the end of our sample period, establishments that were exempted from paying the EEG levy exemption had exited at about four fifths of the rate for similar non-exempt establishments. We find similar results when using a more aggregated approach based on the counts of establishments over time. In either case, the effect is less pronounced then the effect we find for the EU ETS.

Our findings contribute to the rich and extensive literature conducting ex post evaluations of environmental policies. With regard to the EU ETS, early evaluations surveyed in Martin, Muûls and Wagner (2016) hardly find evidence that emissions abatement induced significant negative impacts on economic performance of manufacturing firms. Subsequent studies that have sought to empirically evaluate the impact of the EU ETS on regulated firms have largely confirmed this (Jaraite-Kaukauske and Maria, 2016; Borghesi, Franco and Marin, 2016; Lutz, 2016; Löschel, Lutz and Managi, 2019; Koch and Basse Mama, 2019; Naegele and Zaklan, 2019; Klemetsen, Rosendahl and Jakobsen, 2020; Hintermann et al., 2024; Bremer and Sommer, 2025; Colmer et al., 2025; Karlsson, 2025).

While employment, revenues or profitability have been regularly used to measure firm performance in the empirical literature, data limitations have thus far prevented investigations of the restructuring of markets through firm entry and exit. Prior research by Verde, Graf and Jong (2019) highlights the difficulty of reliably measuring entry and exit of regulated installations in the EU ETS. Using the list of ETS regulated entities (known as EUTL) as a proxy measure of active establishments, these authors treat additions as entry and removals as exit. However, doing so might confound an establishment's regulatory status with its extensive-margin production choice. An additional challenge has been to combine this choice with equally reliable information for a suitable group of unregulated plants. We are able to provide new insights on these fronts by exploiting comprehensive data on the universe of German manufacturing establishments. These data, which are comprised of about 200,000 establishments per year, have not been used in prior research on the EU ETS.

The literature evaluating the impact of the EEG levy is more limited. Gerster (2017) and Gerster and Lamp (2024) find that, while the levy exemption caused affected firms to alter their energy consumption patterns, there was no evidence for short-run effects on gross output, exports and employment. We largely confirm these findings in terms of the effects on the workforce. We also leverage our detailed employee data to show how policy impacts on wages and employment vary across skills, age and other worker characteristics. Finally, we find new evidence of a potential reduction in the likelihood of firms exiting when they receive the levy exemption subsidy, although these effects are small. Earlier research on the UK climate change levy, an energy tax differentiated by fuel type, had found no discernable impact of energy taxes on plant exit (Martin, de Preux and Wagner, 2014).

Our paper also contributes to the broader literature on policy leakage and incomplete regulation. Early work in this area focused on the pollution haven hypothesis and the extent to which firms may relocate to jurisdictions where environmental regulations are less stringent (Brunnermeier and Levinson, 2004). More recent work has looked at how to identify industries and firms at risk of leakage, and how to design and target subsidies to mitigate these effects in the presence of incomplete regulation (Martin et al., 2014; Fowlie and Reguant, 2018, 2022). We provide new evidence on the effectiveness of two important policies that were explicitly designed to reduce this kind of leakage; free allocation of ETS allowances and exemptions from EEG levy payments.

The remainder of the paper is structured as follows: Section 2 describes the data used in our analysis; Section 3 sets out our empirical strategy; Section 4 presents the results, and Section 5 concludes.

2 Data

2.1 Establishment History Panel

The primary data for our study is the Establishment History Panel, or "Betriebs-Historik-Panel" (BHP) which contains the universe of all establishments throughout Germany (Ganzer et al., 2021). We utilize data from 2000 to 2019 as this is the period over which the environmental policies that we study were developed and implemented.[1] Across all sectors the BHP contains on average 2.8 million establishments per year, around 200,000 of which are in the manufacturing sector. The underlying data source for the BHP is the Employee History (Beschäftigten-Historik, BeH) administrative data of the Institute for Employment Research (IAB). An establishment is included in the dataset as long as they have at least one employee subject to social security as of 30 June of a given year. In practice this effectively covers all establishments, providing us with a large representative sample for the whole country.

The administrative data of the BHP are at establishment level. An establishment is "... a regionally and economically delimited unit in which employees work" (Ganzer et al.,

[1] The BHP data does extend back as far as 1975, although pre-1999 the coverage for part-time workers is less comprehensive, and pre-1993 the sample becomes limited to West Germany only. Regardless, these earlier years are not the focus of our analysis.

2021, p. 11). This contrasts to the concept of company or firm, that "... combines all establishment premises and workplaces belonging to the same employer" (Ganzer et al., 2021, p. 12). Firm information is not provided by the BHP data. Therefore, we add linked external company level data based on data from Creditreform and Bureau Van Djik (see below).

In this paper we focus our analysis on establishments in the manufacturing sector. The manufacturing sector is an important sector in Germany, both in terms of its share of the overall economy and its large contribution to energy use and carbon emissions. A number of prior studies have used rich administrative data from the German statistical offices to study trends in energy use and emissions in the German manufacturing sector (Petrick, Rehdanz and Wagner, 2011; von Graevenitz and Rottner, 2023; Rottner and von Graevenitz, 2024). The BHP dataset provides a new and even more comprehensive source of data on the universe of establishments, with a particular wealth of information on employment. To ensure greater comparability with these prior studies we also remove very small establishments that never have more than a few employees over our entire sample period.[2]

To conduct our analysis we merge additional information to the BHP dataset. First we combine information on the firms that establishments belong to using the Creditreform and Bureau Van Djik databases. Second, we identify which establishments are exempt from paying the Renewable Energy Sources Act (EEG) levy. Third, we identify which establishments are regulated by the European Union Emissions Trading Scheme (EU ETS). Beyond the details provided here, a diagram of the sample construction process can be found in Appendix A.

[2]Specifically we limit our sample to establishments that had at least 20 employees during one or more of our sample years. By comparison, the German production census AFiD that has been used in prior studies is limited to firms with at least 20 employees.

2.2 Environmental Regulation

2.2.1 EU ETS Transaction Log

Eligibility for the EU ETS in the manufacturing sector during our sample period was based on a number of criteria. All combustion installations with a rated thermal input of at least 20 MW are obliged to participate in the EU ETS. In addition, some plants are required to participate because they operate specific, CO_2-intensive industrial processes.

For the EU ETS we used information on names and addresses to match installations in the Emissions Transaction Log (EUTL) with establishments in the BHP dataset. The data linkage between the EUTL data and the IAB data was performed by exact matching by establishment name using the procedure set out by Schäffler (2014). From EUTL data, the following variables were used: installation name, account holder (company) name including legal form, address data of both installation and account holder (street, postal code, city), industry code, year of ETS participation, commercial register number. From IAB establishment data we include establishment name, street, postal code, city, industry code, the DWH establishment number and the BvD link. The full sample of establishments was used for the matching. After matching, only establishments that could be matched unambiguously or that were needed to clarify non-ambiguous cases were retained. The time period for this data linkage is from 2005 to 2017.

From 2,561 installations in the EUTL, 2,145 could be matched to the BHP dataset. 930 of these are within the manufacturing sector and after dropping very small establishments (i.e. those that never have more than 20 employees) we are left with 902. The matching with the transaction information available in the EUTL was also conducted on an annual level. As such we observe establishments that were regulated early by the EU ETS (i.e. at its inception in 2005) as well as those that were first regulated in subsequent years. We assume that any affected establishments were effectively treated in the first year that we observe them in the EUTL, and that treatment persisted for all subsequent years.

Figure 1 plots the number of establishments that are first regulated in a given year.

The majority of establishments in our sample are regulated at the inception of the EU ETS in 2005. However, a non-negligible number do also become regulated in later years, including in 2013 when Phase 3 expanded the sectors covered by the regulation due to process emissions.

2.2.2 EEG Levy Exemption Register

Eligibility for the EEG levy exemption, known in Germany as the BesAR ("Besondere Ausgleichsregelung"), depended on the total annual electricity procurement of the installation and the electricity cost intensity in terms of gross value added of the firm. The eligibility criteria changed over time, most notably in 2013 when the number of eligible installations was considerably expanded.

The register of installations exempted from the EEG levy is referred to as the BesAR-list. We used information on names and addresses to match those installations with establishments in the BHP dataset. The BesAR data were linked by exact matching of the address of the power purchase point and the name of the facility, using the method of Schäffler (2014) for linking company and facility data. A power purchase point is a uniquely identifiable local establishment within Germany that has its own electricity receiving station. To achieve the best possible matching result, we used the name of the power purchase point/company name including legal form, street, postal code, city, establishment number, economic sector, years of EEG exemption/reduction ("BesAR year") from the BesAR-list. In addition, we used the establishment name including legal form, street, postal code, city, economic sector, and the technical establishment number from the IAB data (DWH). Due to the data protection rules of the IAB, the record linkage was carried out by the data management team of the IAB. We received anonymized results of this linkage with identifiers that allowed the linkage of the BHP data. After matching, only those establishments that could be unambiguously assigned to a power purchase point were retained.

From 3,476 installations in the BesAR-list, 2,776 could be matched to the BHP dataset and 2,380 of which were within the manufacturing sector. After dropping establishments that never attain 20 employees we are left with 2,268. We also have information on the years that a matched installation appears on the BesAR-list. We assume that any affected establishments were effectively treated in the first year that we observe them on the BesAR-list, and that treatment persisted for all subsequent years. Importantly, the earliest year the BesAR-list provides detail on exemptions granted is 2010. However, establishments could petition for the EEG levy exemption since 2003 so many of the establishments we observe as first being treated in 2010 may have in fact been treated much earlier. In our subsequent analysis we thus drop any establishments that first appeared on the BesAR-list in 2010 to ensure we can be confident of the first year an establishment was treated.

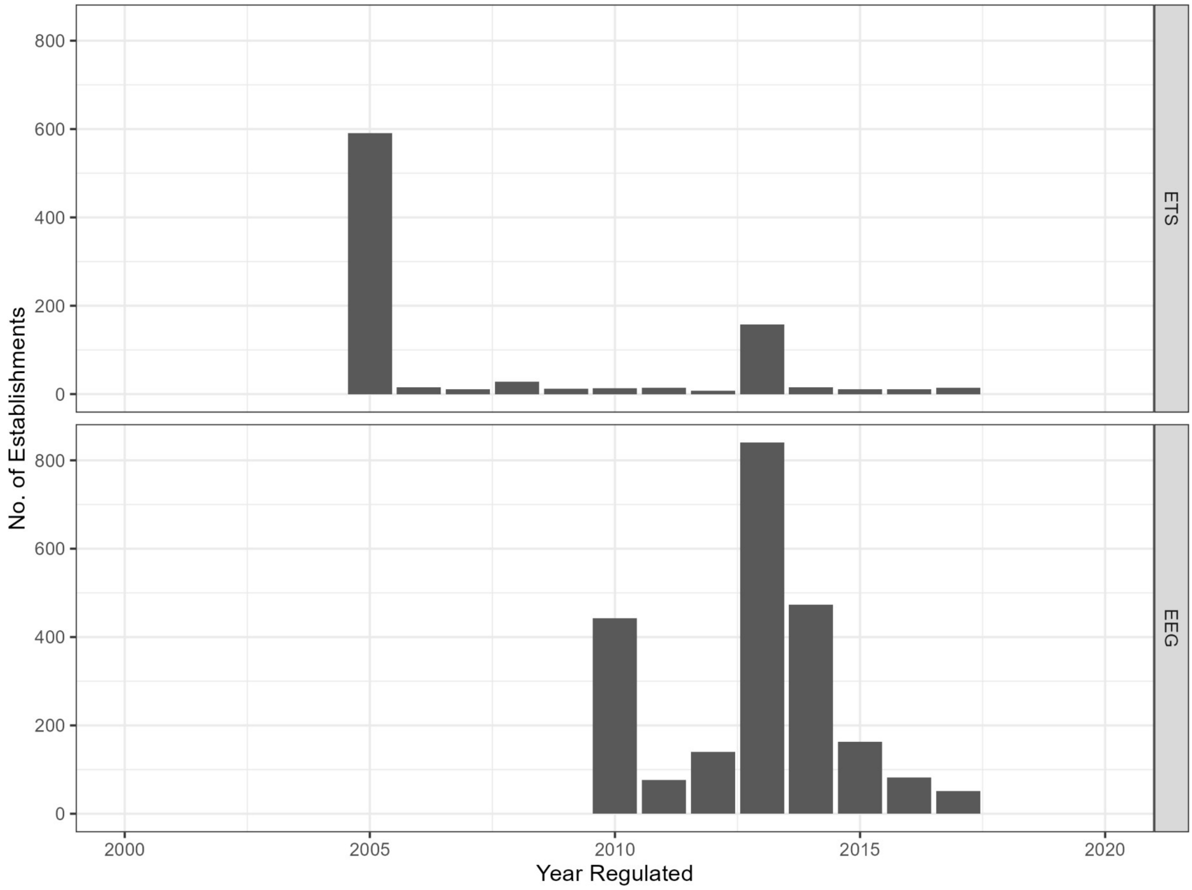
Figure 1 plots the number of establishments that are first subject to the exemption from the levy in a given year. While a significant number appeared on the BesAR-list before 2013, the majority actually first appeared in later years, most notably from 2013 onward when the eligibility criteria were expanded.

2.3 Firm Characteristics

The BHP dataset does not contain information on the firms that own various establishments. In principle, studying the effects of these regulations at the establishment level is in and of itself interesting. However, since one response to these regulations could involve reorganization of workers across the establishments within a given firm, we also aim to consider impacts at the wider firm level.

To do this we use a BHP lookup table that matches unique ID numbers for the establishments in the BHP dataset with the unique ID numbers for firms in the Creditreform database and the Bureau Van Djik (BVD) database. Creditreform is one of Europe's leading credit rating agencies and provides ample information on firms in Germany. BVD is compiled by Moodys and contains a range of financial information about large multinational companies.

Figure 1: First Year Subject to Environmental Regulation



Notes: This figure shows the number of establishments that were first subject to each policy in a given year over our sample period. The top panel refers to the EEG levy exemption and the bottom panel refers to the EU ETS. Note that information on exemption status prior to 2010 is not available and so exempted establishments in 2010 are likely to have been exempt prior to this date.

The external nature of these databases and their focus on larger firms means the coverage is not comprehensive. Approximately 92% of the manufacturing establishments in the BHP dataset can be matched to one of the firms in the Creditreform database. Moreover, our analysis will tend to focus on larger establishments because these are the ones that will be directly affected by the EU ETS and the EEG levy exemption. The matching with the Creditreform database is better for larger firms.

2.4 Sample Summary Statistics

Table 1 provides summary statistics on the establishments in our sample. We limit our sample to manufacturing establishments with at least twenty employees during the 2000 to 2019 period, resulting in approximately 75-90 thousand establishments and more than 1.3 million establishment-year observations.

Table 2 reports establishment-level averages of certain key variables during the pre-treatment period, divided up by treatment status. It is clear that the establishments that are subject to the EU ETS and the EEG levy exemption are quite different to those that are not. 902 establishments are identified as ever being treated by the EU ETS and 2,268 establishments are identified as ever being treated by the EEG levy exemption. Not only do these establishments have a larger workforce but also one that tends to be more male, more highly skilled, and better paid than untreated establishments. As might be expected, treated establishments are more likely to belong to energy-intensive industries such as metals or paper and pulp. Given these differences, a key challenge in our analysis is finding a suitable set of controls from the large number of establishments that were never treated by these policies.

While the underlying data we use are available at the establishment level, we also wish to examine effects at the firm level. We thus calculate firm-level values by combining the establishment level data for all establishments owned by a given firm in each year. Count variables like numbers of employees are summed across all establishments. Average variables like average wages or average worker age are averaged across all establishments,

Table 1: Summary Statistics

Variable	**N**	**Mean (Std. Dev)**
Total No of Employees	1,338,223	94 (484)
Shr Employees (Full-Time)	1,306,078	0.74 (0.22)
Shr Employees (Female)	1,306,078	0.33 (0.24)
Shr Employees (Low-Skilled)	1,306,078	0.14 (0.13)
Shr Employees (Medium-Skilled)	1,306,078	0.75 (0.16)
Shr Employees (High-Skilled)	1,306,078	0.09 (0.13)
Shr Employees (Engineer/Scientist)	1,306,078	0.02 (0.06)
Shr Employees (Apprentice/Trainee)	1,306,078	0.04 (0.06)
Shr Employees (German)	1,306,078	0.92 (0.12)
Average Age of Employees	1,338,223	42.2 (5.2)
Shr Employees (Age 15-34)	1,306,078	0.30 (0.16)
Shr Employees (Age 35-54)	1,306,078	0.52 (0.15)
Shr Employees (Age 55+)	1,306,078	0.18 (0.13)
Median Wage of Employees	1,319,434	36,210 (13,979)
25th Percentile Wage of Employees	1,319,434	30,995 (11,386)
75th Percentile Wage of Employees	1,319,434	44,010 (18,818)
Shr Sector Energy Inputs	1,337,320	0.023 (0.018)

Notes: This table shows key summary statistics for the establishments in our dataset covering the years from 2000 until 2019. Values presented are means with standard deviations in brackets. An observation is an establishment-year. Shares of employees refer to the number of employees of a certain type divided by the total number of employees. Wages are measured in real 2019 euros. The share of sector energy inputs is based on the share of energy input costs in total revenues at the 3-digit sector level. This data is taken from the German industry cost structure survey and is not based on establishment-level data available directly within the BHP dataset.

Table 2: Summary Statistics by Treatment Status

Variable	N	**Overall** N = 76,713	**Treated ETS** **0** N = 75,972	**1** N = 741	p-value
Total No of Employees	76,713	88 (452)	81 (369)	815 (2,586)	<0.001
Average Age of Employees	76,713	40.1 (4.5)	40.1 (4.6)	41.1 (2.7)	<0.001
Median Wage of Employees	76,303	36,862 (12,808)	36,783 (12,798)	44,975 (11,051)	<0.001
Establishment Entered	76,713	0.13 (0.33)	0.13 (0.33)	0.07 (0.26)	<0.001
Establishment Exited	76,713	0.33 (0.47)	0.34 (0.47)	0.10 (0.30)	<0.001
Shr Sector Energy Inputs	76,666	0.024 (0.018)	0.023 (0.017)	0.060 (0.047)	<0.001

(a) EU ETS

Variable	N	**Overall** N = 91,674	**Treated EEG** **0** N = 89,580	**1** N = 2,094	p-value
Total No of Employees	91,674	83 (402)	80 (401)	197 (460)	<0.001
Average Age of Employees	91,674	41.2 (4.5)	41.2 (4.5)	41.7 (3.3)	<0.001
Median Wage of Employees	91,399	35,917 (13,560)	35,881 (13,631)	37,452 (9,941)	<0.001
Establishment Entered	91,674	0.21 (0.41)	0.21 (0.41)	0.22 (0.42)	0.30
Establishment Exited	91,674	0.33 (0.47)	0.34 (0.47)	0.10 (0.30)	<0.001
Shr Sector Energy Inputs	91,620	0.024 (0.018)	0.023 (0.017)	0.042 (0.035)	<0.001

(b) EEG Levy Exemption

	Treated EEG 0	1	Total
Treated ETS			
0	98,063 (97%)	1,853 (1.8%)	99,916 (99%)
1	487 (0.5%)	415 (0.4%)	902 (0.9%)
Total	98,550 (98%)	2,268 (2.2%)	100,818 (100%)

(c) Cross-Tabulation for EEG Exemption vs EU ETS

Notes: This table shows summary statistics for the establishments in our dataset. Values are averaged for all establishments over any pre-treatment years they are in our sample. As well as calculating means and standard deviations, the table also displays these values broken down based on regulation status. Shares of employees refer to the number of employees of a certain type divided by the total number of employees. Wages are measured in euros. The share of sector energy inputs is based on the share of energy input costs in total revenues at the 3-digit sector level. This data is taken from the German industry cost structure survey and is not based on establishment-level data available directly within the BHP dataset. Entered/exited is a binary variable that refers to whether an establishment ever entered or exited during the sample period. The first panel looks at the EU ETS. The second panel looks at the EEG levy exemption. The final bottom panel provides a cross-tabulation of treatment status to convey the extent to which establishments are regulated by both the EU ETS and EEG levy exemption.

weighted by the number of employees in each establishment. Categorical variables like the sector or region are based on the modal value across all establishments, weighted by the number of employees in each establishment. Firms with establishments belonging to multiple divergent sectors are quite rare so this decision does not have a substantial effect on our findings. Less than 5% of firms have establishments belonging to more than one 2-digit sector. We define a firm as being treated where any of its constituent establishments is subject to the EU ETS or the EEG levy exemption.

Summary statistics for firm-level outcomes constructed in this way are reported in Table C.2 in the Appendix. Many of the same differences in observable characteristics for treated and untreated firms mirror those described earlier for treated and untreated establishments. Furthermore, German manufacturing is unusual in being comprised of many establishments that only belong to one individual firm, such that our original sample of 75-90 thousand establishments comprises 70-80 thousand firms. Similarly, 795 firms are identified as ever being treated by the EU ETS and 2,022 firms are identified as ever being treated by the EEG levy exemption. This entails relatively limited aggregation compared to the establishment level numbers of 902 and 2,268 respectively. We thus proceed with much of the main analysis at the establishment level. Results of firm-level analyses are reported in Appendix C.

3 Empirical Strategy

3.1 Outcomes of interest

3.1.1 Employment

Our first outcome of interest is employment. We start with looking at aggregate employment, which has also been studied extensively in other research on the EU ETS. In a valuable new addition we then explore various components of aggregate employment in order to understand changes in the composition of the workforce. For instance, we can look at changes to the number of employees classed as low-, medium- or high-skilled, and to the age composition of the workforce.

3.1.2 Wages

Our second outcome of interest is wages. It is plausible that even if there are no effects on employment, costs associated with environmental regulations may ultimately affect the wages paid to workers in affected establishments. For instance, earlier research found that increases in corporate taxes are passed on through lower wages in Germany (Fuest, Peichl and Siegloch, 2018). To examine whether environmental regulation has a similar effect we use data on median wages provided in the BHP dataset.

3.1.3 Entry and Exit

Our third outcome of interest is whether or not establishments exit, which to date has not been well studied in the literature on the impacts of environmental regulation. The BHP dataset is unique in containing information on the universe of establishments in Germany, rather than being a survey-based sample. The BHP dataset also contains identifiers for whether an establishment entered or exited in a given year. There is additional information on whether these events were outright closures or spin offs to another firm, with the potential to make linkages between the new and old records of a given establishment following such an event.

We employ difference-in-differences regression to analyze continuous outcomes employment and wages and examine exit primarily using a survival analysis. We discuss both methods next.

3.2 Difference-in-Differences

Our goal is to understand how firms and individual establishments were affected by two policies: the EU ETS and the EEG levy exemption. In line with the literature, we adopt a difference-in-differences strategy to do so. Treatment, D_{it}, is determined by whether a given establishment, i, is exposed to a policy in a given year, t.

The first difference exploits cross-sectional variation in which establishments and firms are regulated by the EU ETS or are eligible for the EEG levy exemption. For the EEG levy this depends on the electricity intensity of an establishment's operations. For the EU ETS, this depends on establishments belonging to regulated sectors and meeting certain minimum size requirements (e.g. based on the capacity of thermal combustion plants on their premises). Covered sectors include power stations and various energy-intensive industries (e.g. oil refineries, aluminium, iron and steel, cement, paper, glass etc.). Since 2012 civil aviation has also been covered. We limit our analysis to the manufacturing sector.

The second difference exploits variation in when these two policies were rolled out. For the EU ETS, this began in 2005, and has proceeded through a series of trading phases to the present day. For the EEG levy exemption, this was first introduced in 2003 and the eligibility threshold was further modified in 2013.

Combining these two differences we examine the change in outcomes for regulated firms and establishments relative to non-regulated firms and establishments, before and after the policies are implemented:

$$y_{it} = \beta D_{it} + \gamma X_{it} + \theta_i + \lambda_t + \epsilon_{it}. \tag{1}$$

Our preferred specification includes a full set of unit and year-of-sample fixed effects. We also examine specifications that include sector-by-year and region-by-year fixed effects to further control for differential trends across sectors or regions. Throughout we cluster our standard errors at the 3-digit sector level.[3]

One challenge with this framework is highlighted by Figure 1: The onset of treatment varies across establishments, with many establishments first being treated after the

[3]This gives us 95 distinct 3-digit sector clusters, with a median of 467 establishment-year observations per cluster and no cluster with five or fewer establishments.

initial year when these environmental regulations were each introduced. This staggered treatment timing has been shown to potentially bias results estimated using the kind of standard two-way fixed effects model set out here (Goodman-Bacon, 2021; Callaway and Sant'Anna, 2021).

To simplify our analysis and avoid the issue of staggered treatment, we opt to focus on establishments that become subject to either the EU ETS or EEG levy exemption during a single compliance phase of each policy. For the EU ETS we focus on establishments that were first regulated during Phase 1 between 2005 and 2008. These make up the majority of the treated establishments during our sample period, both in number and scale of emissions. We effectively assume these plants are treated in 2005 and remain treated for the remainder of our sample period. We drop any treated establishments that are first treated in later compliance phases. For the EEG levy exemption we focus on establishments that were first regulated from 2013 onwards. This aligns with a change in the eligibility criteria of the program and the period where we can be confident we have accurately captured the initial treatment year. These establishments again comprise the majority of the treated establishments in our sample period. We effectively assume these establishments are treated in 2013 and remain treated for the remainder of our sample period. We drop any treated establishments that are first treated prior to 2013.

3.3 Matching

Importantly, treatment in this setting is clearly not randomly assigned. The establishments that participate in the EU ETS or receive an EEG levy exemption are a selected subset of all establishments. The summary statistics presented earlier provided a sense of the observable characteristics that appear to be correlated with treatment by each of these two policies. As already noted, the treated establishments tend to be larger than untreated manufacturing establishments. They are also much more likely to be in energy-intensive industries, such as chemicals, paper, and metals. When running our difference-in-difference analysis on the unmatched sample we see clear evidence of significant pre-trends, indicating meaningful divergence between treated and control establishments that presents a threat to a difference-in-difference design.

Given the extent of selection into treatment, our central challenge is to find a credible set of control establishments on which we can construct our counterfactual. Here we shall follow a number of prior studies in this area by integrating matching into our difference-in-difference specifications (Fowlie, Holland and Mansur, 2012; Calel and Dechezleprêtre, 2016; Gerster and Lamp, 2022; Colmer et al., 2025).

To conduct our matching we use exact matching on a few key covariates. We implement this by employing the "MatchIt" package in R (Ho et al., 2011) based on pre-treatment data in our sample. We match on a three-year window from four years prior to treatment until two years prior to treatment, so for the ETS this is 2001-2003 and for the EEG this is 2009-2011. We use a three-year matching window to avoid the analysis being affected by the idiosyncracies of a single year. Our matching windows end two years prior to treatment to avoid capturing anticipation effects that may arise in the year prior to each policy coming into force.

We prefer exact matching due to a number of documented issues with propensity score matching (King and Nielsen, 2019) and because our limited available covariates means we are reliant on matching establishments along three key dimensions: size, growth, and sector. Size is determined by total number of employees, which we break into bins.[4] Growth is determined based on the annualized growth rate of the number of employees over our matching window, which we break into three bins.[5] The sector match is done at the 2-digit level.[6] We did examine results that match at the more detailed 3-digit level but this resulted in a high degree of sparsity in our interacted matching cells that would entail dropping a large portion of the sample.[7] We also explored matching on the age of

[4] These are 10-20, 20-50, 50-100, 100-200, 200-500, 500-1000, 1000-2000, and 2000+ employees.

[5] The annualized change in log employment is either Low ($<$ -0.03), Mid (-0.03 to +0.03) or High ($>$ +0.03).

[6] The 2-digit classification gives us 24 manufacturing sectors in our sample. Sectors are classified according to the WZ08 system. This is the "Industrial Classification of Economic Activities, 2008 Edition" of the Federal Statistical Office. The WZ08 is based on the statistical system of economic activities in the European Community, NACE Rev.2.

[7] The 3-digit classification gives us 95 manufacturing sectors in our sample.

establishments given that we observe the date they began operating. However, this did little to improve match balance and came at the cost of significantly increasing sparseness in our matching cells.

Further details on the matching analysis can be found in the appendix. This includes summary statistics and diagnostic figures on the number of matched establishments, balance across key covariates, the extent of common support, and the role of certain categories of matched establishments in driving the overall results.

Unfortunately, the BHP dataset does not provide other variables to match on that have been used in other studies, such as energy consumption or emissions. Where we can match some of these at the establishment level (e.g. emissions from the EU ETS) we can only do so for treated establishments and have no data available for potential control establishments. While establishment-level data on energy use and emissions from the manufacturing census are available through the Research Data Centre of the Statistical Offices of the Federal States, these datasets cannot be merged to our core datasets maintained by IAB, a different entity. Therefore, a regression discontinuity design based on the EEG levy exemption thresholds for electricity consumption or energy cost, as employed by Gerster and Lamp (2024), is infeasible as we cannot construct the necessary running variables.

3.4 Survival Analysis

To study establishment exits, we turn to survival analysis. We plot survival curves using the Kaplan-Meier method and estimate coefficients for differences in hazard ratios using the Cox-Proportional Hazards model. We implement these steps using the "survival" package in R (Therneau, 2023).

We examine separate survival curves based on treatment status to see if either the EEG levy exemption or ETS policies led to differential rates of exit. This means estimating the hazard

$$h(t|X_i) = h_0(t)e^{(\beta D_i)} \tag{2}$$

where β denotes the differential rate of exit between treated and control establishments. We apply the same matching approach here as set out above for the difference-in-difference analysis.

For our main analysis, we conduct a single, integrated analysis of exit from the inception of the two policies we study. For the ETS this starts in 2005. For the EEG levy exemption we start in 2013 due to the limited number of establishments with a known treatment date before this point.

As a complement to the establishment-level survival analysis, we also conduct an analysis using counts of establishments. Specifically, we calculate the annual number of establishments in our sample by sector, size, growth, and treatment status for the ETS or EEG policies respectively. These groupings are based on the pre-determined values of sector, size, growth and treatment status and so the assignment of establishments to categories does not change over the post-period. Note that the first three of these variables are based on the categories we use for matching, and then year and treatment status ensures we can compare treated and non-treated establishments over time. Treatment status here is time-invariant in that it refers to ever being treated in the program phase we opt to focus on for each of these policies. As with the prior difference-in-difference analysis, we view treatment as an absorbing state such that once an establishment has first become subject to either policy, we assume they remain treated for the rest of the sample period. When calculating our establishment counts we limit the sample to establishments that were present in the pre-treatment matching window before the treatment phase of the policy that we study goes into effect. This ensures we can implement the relevant matching approach and allows us to focus on the specific issue of exits.

We then implement the same two-way fixed effects difference-in-difference approach set out earlier, but with establishment counts as the dependent variable. The count nature of the dependent variable means we estimate using Poisson and effects can be interpreted as proportional changes. The resulting effects tell us how exposure to either the ETS or EEG policies affects the number of establishments in a given year, and so can shed further light on whether there are differential rates of exit. Throughout we include cross-sectional fixed effects at the sector-size-growth-treatment cell level. We also examine versions of these regressions that include interaction effects to statistically test whether there are differential rates of exit for the ETS based on compliance phase and leakage status. Where doing so we ensure our establishment counts are calculated separately for leakage and non-leakage designated sectors.

4 Results

Our analysis studies the impact of both the EU ETS and the EEG levy exemption on three key outcomes: employment, wages and exits. We present results for each of these in turn for the two policies. Our preferred specifications are provided in the form of event studies and Kaplan-Meier plots. The coefficients from standard difference-in-difference with two-way-fixed-effects and Cox-Proportional Hazards regressions can be found in the appendix.

4.1 EU ETS

Figure 2 shows the effect of the EU ETS on employment and wages. Before the policy goes into effect we see that treated and control establishments appear to experience similar trends in employment and wages. In the unmatched sample there are substantial pre-trends in both employment and wages, indicating our matching empirical strategy is helping mitigate this issue and strengthen identification.

After the policy goes live and the treated establishments become regulated by the EU ETS we do not see any immediate effects in the event plots. The average effects aggregated across post-treatment periods amount to +2.3% for employment and +1.3% for wages, with neither estimate being statistically significant (see Appendix Table B.3).

Notwithstanding this, the visual impression from Figure 2 is that of a steady relative rise in wages over time for treated establishments. Appendix Figure B.2 further substantitates this by plotting the evolution of the control and treated establishment separately. While the two move closely both before and soon after 2005, wages at ETS establishments do seem to pick up in later years at a faster rate than is seen for non-ETS establishments. We return to these possible wage effects in subsequent results.

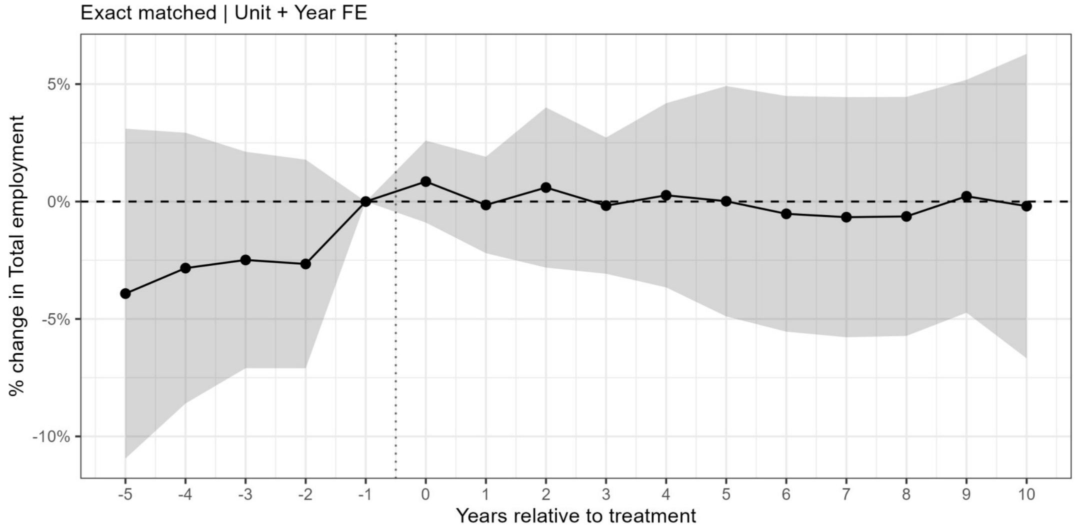
In Appendix Table B.4 we examine impacts across different worker characteristics. Here again we do not see clear statistically significant effects (e.g. when looking at worker age, gender or skill level). The strongest indication of any effect on wages is in the 75th percentile, but again there is a lack of clear statistically significant results.

To better understand these impacts we examine whether the estimated effects on employment and wages vary across the different compliance phases of the EU ETS, and for establishments in sectors designated as being at risk of leakage. To identify the latter we use the so-called Carbon Leakage List of sectors and subsectors which the EU Commission deemed to be exposed to a significant risk of carbon leakage.[8] The 2009 Carbon Leakage List, as well as later amendments to this first list, determine which sectors continue to receive permits free-of-charge even after the EU Commission began to phase out free permit allocation beginning in Trading Phase 3. We merge leakage sectors based on their 4-digit WZ08 industry code where possible, and then by their 3-digit WZ08 industry code otherwise. Note that the sectors on the leakage list were announced near the start of Phase 2 and the distinction in permit allocation by leakage status came into effect in Phase 3. Of the twenty-four 2-digit manufacturing sectors in our sample, half of them have within-sector variation in leakage status.

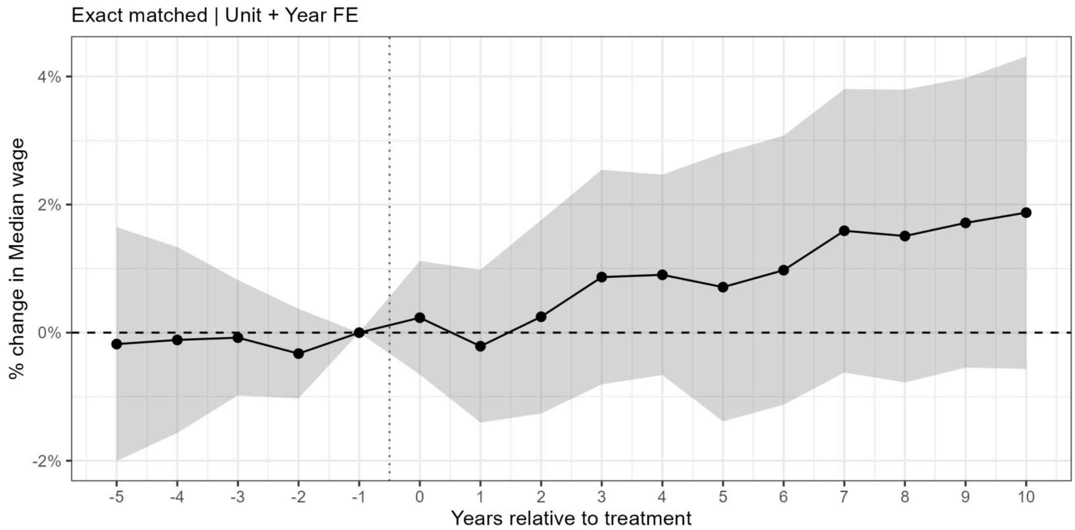
Table 3 reports the results from difference-in-difference regressions using a matched sample of ETS and non-ETS establishments, after including additional interactions for trading phase and leakage designation. For employment, we observe no significant vari-

[8] Commission Decision 2010/2/EU determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, a list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage (2010) OJ L 1/10 (Carbon Leakage Decision).

Figure 2: ETS Event Study Results



(a) Employment



(b) Wages

Notes: This figure shows event study estimates for log employment and log wages in different years for treated establishments relative to control establishments. Effect sizes are plotted relative to the first pre-treatment year, which in the case of the ETS is 2004.

Table 3: EU ETS Difference-in-difference Results with Interaction Effects

Dependent Variables:	Employment		Wages	
Model:	(1)	(2)	(3)	(4)
Variables				
ETS Regulated	0.0281	0.0139	0.0023	0.0077
	(0.0251)	(0.0246)	(0.0093)	(0.0097)
ETS Regulated (Phase 2)	-0.0065	0.0059	0.0092**	-0.0113
	(0.0156)	(0.0420)	(0.0046)	(0.0079)
ETS Regulated (Phase 3)	-0.0063	0.0898	0.0171**	-0.0198
	(0.0264)	(0.0670)	(0.0078)	(0.0162)
ETS Regulated × ETS Leakage		0.0164		-0.0062
		(0.0253)		(0.0098)
ETS Regulated (Phase 2) × ETS Leakage		-0.0142		0.0235***
		(0.0411)		(0.0081)
ETS Regulated (Phase 3) × ETS Leakage		-0.1098		0.0424**
		(0.0671)		(0.0174)
Fixed-effects				
Establishment	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Fit statistics				
Observations	120,007	120,007	119,688	119,688
R^2	0.93148	0.93149	0.93635	0.93638
Within R^2	4.82×10^{-5}	0.00032	0.00064	0.00108
Dep. Var. Mean	100.3	100.3	34,916.6	34,916.6

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table shows the results of the standard two-way fixed effects difference-in-difference specifications with additional interaction effects. An observation is an establishment-year. Columns 1–2 have employment as the dependent variable. Columns 3–4 have wages as the dependent variable. All specifications include establishment and year-of-sample fixed effects. The coefficients by phase show the effect estimated separately for each compliance phase of the EU ETS. All regressions use our balanced matched sample with matching for the ETS done on the years 2001-2003. Leakage is a binary variable that captures whether an establishment is in one of the 3-digit sectors on part B of the leakage list.

ation across these two dimensions. For wages, we do observe some heterogeneity. The positive effect on wages appears to steadily emerge over time, reaching its largest level in the third compliance phase. Moreover, the effect appears to be most pronounced in the later compliance phases for establishments classed as being at risk of leakage.[9]

These findings seem to align with the operation of the EU ETS, in particular with free permit allocation. During the first two trading phases, all ETS-regulated establishments benefited from free permit allocation. Free permits may have conferred tangible windfall gains that could be passed on to workers through higher wages. This could explain the steady rise in relative average wage in Figure 2 and the increased coefficients in the later trading phases in Table 3 (column 3).[10] Moreover, such wage increases were confined to establishments on the Carbon Leakage List which continued to receive permits free-of-charge even after free allocation was dropped as a general principle with the beginning of Phase 3 (column 4). Since the first Carbon Leakage list was published early in Phase 2, establishments in listed sectors could rationally anticipate future windfall gains as they were setting wages in Trading Phase 2. These effects remain moderate in size and concentrated among the most energy-intensive and trade-exposed sub-sectors, consistent with the limited rent-sharing found in Mertens, Mueller and Neuschaeffer (2026).

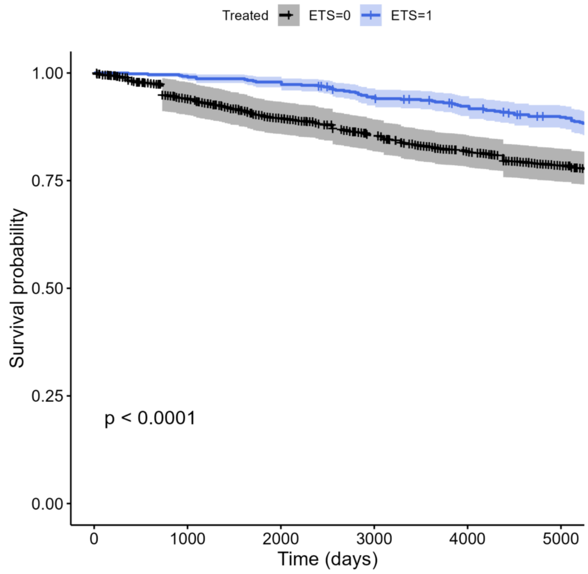
Figure 3 shows the effect of the EU ETS on the likelihood of establishments exiting. Here we find a statistically significant reduction in the hazard of exiting, such that treated establishments exit at 0.51 times the rate that control establishments exit (see Appendix Table B.5). This suggests that the benefit of free permit allocation – which is lost when an establishment exits – could outweigh the incentive certain establishments face to close due to higher carbon costs.

To examine this further, we consider whether there were differential exit rates depending on eligibility for continued permit allocation and treatment phase. In Appendix Table

[9]In the first compliance phase, it is the establishments *not* at risk of leakage that see a larger positive point estimate, yet this effect is not statistically significant and vanishes in the later compliance phases.

[10]The estimated wage increase in Trading Phase 1 is not statistically significant. Windfall gains in that period were limited due to the collapse of the permit price in April 2006, when it became evident that the Phase-1 cap was not binding. Reforms to the system made sure the cap was binding in later phases, making permits valuable.

Figure 3: EU ETS Survival Results



(a) ETS

Notes: This figure shows Kaplan-Meier survival curves for treated establishments relative to control establishments. The curve is black for control establishments and blue for treated establishments. Effects capture exits since the the year the treatment policy began. For this aggregated analysis this entails the survival curve beginning at the start of Phase 1 in 2005. All results use exact matching weights and matching is done separately for each phase.

B.5 we observe that splitting our survival analysis by leakage status appears to reveal that establishments not classified as being at risk of leakage (and thus with reduced access to free permit allocations over time) see a weaker effect on exits than establishments that are classified as being at risk of leakage. However, splitting the analysis in this way limits our ability to make statistical determinations about this apparent divergence. As such we turn to our difference-in-difference analysis of exit counts.

Table 4 shows the effect of the EU ETS on the total number of establishments. Again we find evidence of a reduction in the likelihood of exit for the treated establishments. Being regulated by the EU ETS resulted in a statistically significant 12% increase in the number of treated establishments relative to our matched set of control establishments. Since control establishments exit at a faster rate than treated ones, the gap between the number of treated and control establishments rises from 1% during Phase 1 to 16% in Phase 3. This cumulative effect aligns with the growing divergence of the survival curves in Figure 3. When allowing for differential exit by leakage status, we see that treated

Table 4: EU ETS Survival Results with Establishment Counts and Interaction Effects

Model:	(1)	(2)	(3)
Variables			
ETS Regulated	0.1230***	0.0274***	0.0139
	(0.0137)	(0.0040)	(0.0122)
ETS Regulated (Phase 2)		0.0844***	0.0867***
		(0.0108)	(0.0187)
ETS Regulated (Phase 3)		0.1558***	0.1744***
		(0.0227)	(0.0446)
ETS Regulated × ETS Leakage			0.0147
			(0.0128)
ETS Regulated (Phase 2) × ETS Leakage			-0.0024
			(0.0177)
ETS Regulated (Phase 3) × ETS Leakage			-0.0197
			(0.0454)
Fixed-effects			
Sector-Size-Growth-Treated	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	5,431	5,431	5,431
Dependent variable mean	33.061	33.061	33.061

Clustered (Sector-Size-Growth-Treated) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table shows the results of exit specifications with additional interaction effects. An observation is the number of establishments in given year for each grouping cell of sector, size, growth, and treatment status. This aligns with the categories on which we conduct our matching. All columns have the count of establishments as the dependent variable and so are estimated using Poisson regression. All specifications include cell and year-of-sample fixed effects. Standard errors are also clustered by cell. The coefficients by phase show the effect estimated separately for each compliance phase of the EU ETS. All regressions use our balanced matched sample with matching for the ETS done on the years 2001-2003. Leakage is a binary variable that captures whether an establishment is in one of the 3-digit sectors on part B of the leakage list.

establishments designated at risk of leakage were even less likely to exit than those not on the leakage list. However, these differences by leakage status are small and noisily estimated so are not statistically significant.

4.2 EEG Levy Exemption

Figure 4 plots the effects of the EEG levy exemption on employment and wages by year. Before the policy goes into effect, we see that treated establishments appear to experience a relative downward trend in employment and wages. Appendix Figure B.4 provides further context by plotting the evolution of the control and treated establishment separately, indicating any mismatch in trends does at least seem less pronounced for wages than for employment. In the unmatched sample pre-trends are significantly more pronounced, particularly for employment, indicating our matching empirical strategy is helping mitigate this issue to a degree. Even so, the existence of these pre-trends does mean the EEG results should be interpreted carefully with this in mind.

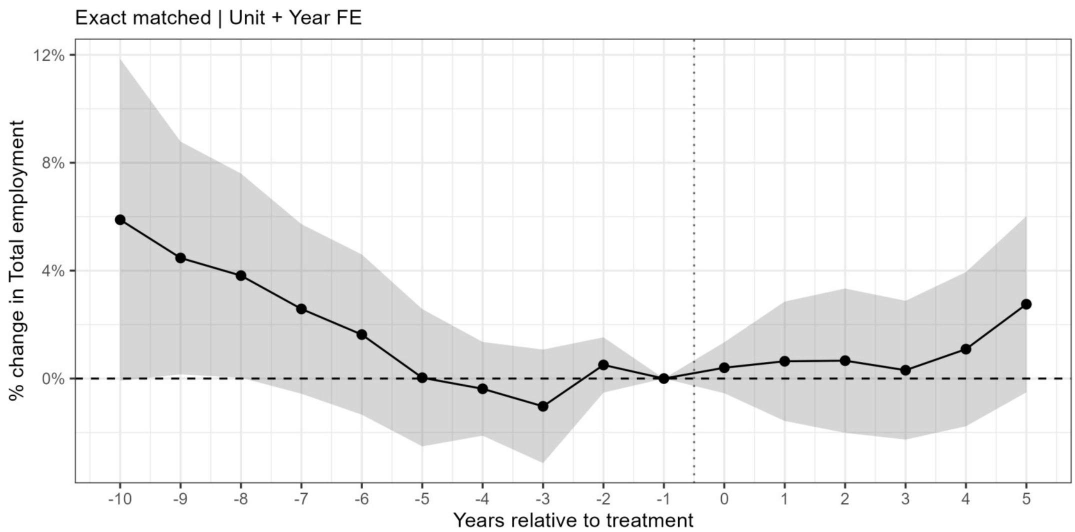
After the policy goes live and the treated establishments become subject to the EEG levy exemption we do not see a clear immediate effect. Appendix Table B.8 reports the aggregated average post-period effects at -1.5% for employment and -1.5% for wages. Only the latter of these is statistically significant. We cannot rule out, however, that this is due to a continuation of the downward sloping pre-trend for treated establishments, rather than any genuine reduction in wages due to the policy.

In Appendix Table B.9 we examine impacts across different worker characteristics. Here again we do not see clear statistically significant effects on employment (e.g. when looking at worker age or gender) although we do find a significant fall in high skill employment. The reduction in wages found in the overall sample appears to be strongest in the 25th percentile, but again we interpret this finding with caution given it may simply be attributable to pre-existing trends.

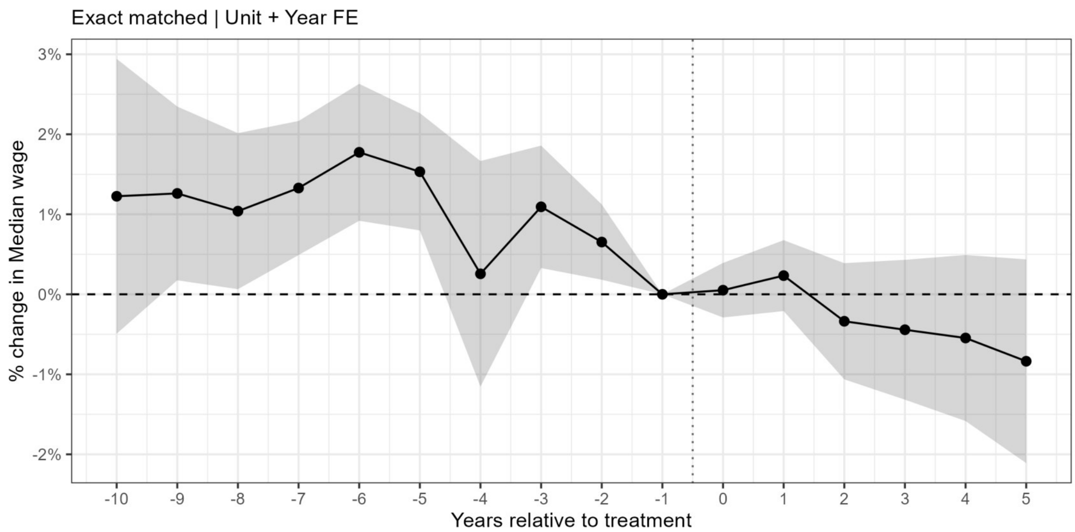
Our findings are consistent with earlier research showing no significant effects of the

EEG levy exemption on employment (Gerster and Lamp, 2024) based on data from the manufacturing census which is generally less well-suited to study extensive margin responses as it has a reporting threshold of 20 employees. Our results suggest that this shortcoming bears no relevance for qualitative effect on employment. The German setting with high employee protection simply makes adjustments to the labor force very costly.

Figure 4: EEG Levy Exemption Event Study Results



(a) Employment

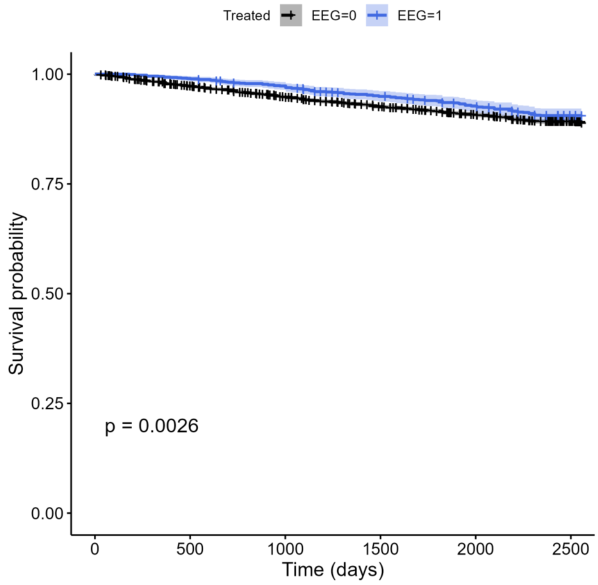


(b) Wages

Notes: This figure shows event study estimates of the change in employment and wages in different years for treated establishments relative to control establishments. Effect sizes are plotted relative to the year in which an establishment was first treated.

Figure 5 shows the estimated effect of the EEG levy exemption on the likelihood of establishments exiting. Here we focus on establishments that first received the levy exemption during the second phase, so from 2013 onward. We find a statistically significant reduction in the hazard of exiting, although the size of the difference is small, such that treated establishments exit at 0.84 times the rate that control establishments exit (see Appendix Table B.10).

Figure 5: EEG Levy Exemption Survival Results



Notes: This figure shows Kaplan-Meier survival curves for treated establishments relative to control establishments. The curve is black for control establishments and blue for treated establishments. Effects capture exits since the the year the treatment policy began. Due to the small number of establishments where we observe their treatment start date in Phase 1 the analysis here focuses only on Phase 2 and thus begins in 2013. All results use exact matching weights and matching is done separately for each phase.

Table 5 reports the effect of the EEG levy exemption on the total number of establishments, estimated via Poisson regression. Consistent with economic theory, we find a reduction in the chance of exit for the treated establishments. Receiving the EEG levy exemption resulted in a small but highly statistically significant 7% increase in the number of treated establishments relative to our matched set of control establishments. As noted previously, this results should be interpreted with some caution given the limitations of our matching approach.

Table 5: EEG Survival Results with Establishment Counts

Model:	(1)
Variables	
EEG Levy Exemption	0.0740***
	(0.0098)
Fixed-effects	
Sector-Size-Growth-Treated	Yes
Year	Yes
Fit statistics	
Observations	9,403
Dependent variable mean	82.414

Clustered (Sector-Size-Growth-Treated) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table shows the results of exit specification estimated by Poisson regression. An observation is the number of establishments (dependent variable) in given year for each grouping cell of sector, size, growth, and treatment status. This aligns with the categories on which we conduct our matching. Cell and year-of-sample fixed effects are included. Standard errors are also clustered by cell.

4.3 Discussion

Our results indicate that both the EEG levy exemption and the EU ETS had fairly muted effects on the workforce of regulated establishments, with no substantial effect on aggregate employment or average wages in most cases. The one exception is a small positive increase in wages for EU ETS regulated establishments. Importantly, these findings are all based on a balanced sample of establishments that do not enter or exit over our twenty year sample period. Intensive margin adjustments prior to exit are therefore not reflected in our results. Our results suggest that prior work may indeed be missing an important margin of adjustment: the decision to shut down and exit.

Our analysis therefore provides new evidence on the way both these policies had additional effects by reducing the likelihood of establishments exiting. For the EEG levy exemption the impact on exit is small, but even a small reduction is consistent with the intended goal of the policy.

For the EU ETS, our finding that regulated firms saw a significant reduction in their likelihood of exiting may seem less intuitive. However, it is in line with previous research documenting positive effects of the EU ETS on economics performance of manufacturing firms in Germany (Lutz, 2016; Löschel, Lutz and Managi, 2019). Our analysis points to a mechanism by which the significant amount of free permit allocation that occurred in the ETS, particularly in the early trading phases and for establishments deemed at risk of leakage, created rents that prevented firms from closing.[11] Some of the windfall gains from free permit allocation to ETS regulated establishments could have also have helped them avoid reducing their workforce, and may have been partly passed on to employees in the form of higher wages. In addition, where evidence of increased patenting also reflects greater innovation compared to unregulated establishments (Calel and Dechezleprêtre, 2016), there may be longer-term dynamic factors at work leading regulated establishments to be less likely to exit. Unfortunately, we have no innovation data to test this alternative channel.

One caveat with the findings set out here is that they are contingent on the quality of the matching approach used throughout. There remains a risk that our observed effects could still reflect unobserved differences between our treated and control establishments that we have not managed to fully account for. As the statistics in Table 2 make clear, regulated establishments tend to be larger and are much less likely to exit in general. While the divergence is even greater for the unmatched analysis, there is still a risk that our existing matching strategy has its limitations, especially as we were unable to match on certain important characteristics like establishment level energy or emissions intensity.

5 Conclusion

In this paper we have examined the impact of two significant climate policies on the competitiveness and economic performance of affected establishments. Using a comprehensive dataset on the universe of German establishments, we examine how the EU ETS and the EEG levy exemption affected employment, wages and exits in the manufacturing

[11] The Carbon Leakage Decision deters plant closures or relocation to non-EU countries with an allocation rule that 'punishes' establishments that significantly reduce their output compared to historical activity levels by granting significantly fewer permits for free (see, e.g., Martin et al., 2014, for an in-depth analysis). Free permit allocation creates rents because regulated entities can pass through more than half of the costs of permits to product prices (Hintermann et al., 2024).

sector.

The EU ETS created new compliance costs for affected firms as they now had to procure allowances to cover the carbon emissions of their regulated establishments. However, it also came with significant transitional support including the large-scale free allocation of permits to incumbent firms. We do not find significant effects for the EU ETS on employment but we observe a small increase in average wages for a select group of establishments. Most striking though is the substantial reduction in the likelihood of establishments exiting that we find.

The EEG levy exemption provided a subsidy to large energy intensive firms with the aim of assisting those that may be at risk from foreign competitors that were not subject to the same costs. Policymakers might reasonably have expected this kind of policy to reduce the risks of job losses and closures. We do not find clear evidence of significant effects on employment or wages at affected firms, although we do see some evidence of a reduction in the likelihood of firms exiting.

Overall our results confirm a number of prior studies that have also found that environmental policies, and efforts to support industries affected by them, can often have quite muted effects on firm performance. Building on this work, we provide new evidence that there can be important impacts on another key margin of adjustment that has largely been understudied in prior work: the decision to shut down and exit. We expect this is likely to be a fruitful avenue for further research.

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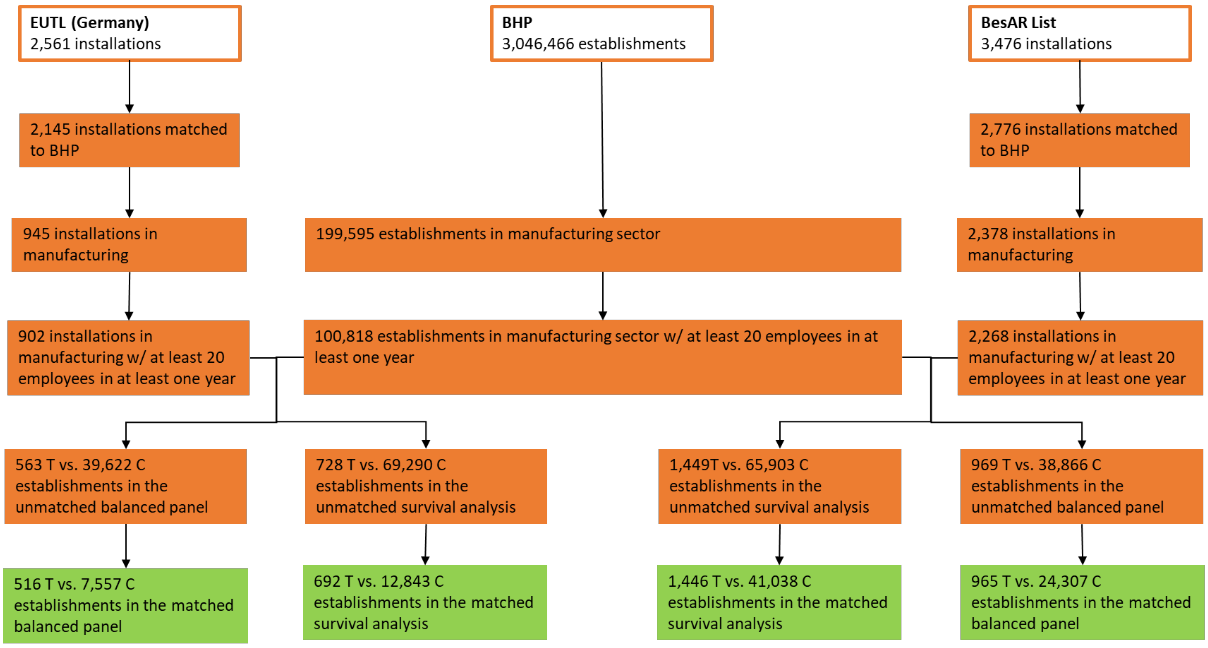
Online Supplementary Appendix

A Sample Construction

Figure A.1 shows a diagram of the main sample construction process. We start with the BHP dataset covering the universe of establishments in Germany. We then restrict our sample to manufacturing establishments above a certain size threshold and merge our data with establishment participation in both the EEG levy exemption and the EU ETS. Counts for the numbers of establishments at each stage of the data merging and matching process are shown throughout.

Figure A.1: Sample Construction



Notes: This figure shows a diagram of the main sample construction process, including counts for the numbers of establishments at each stage of the data merging and matching.

B Further Summary Statistics and Results Detail

B.1 EU ETS

Table B.1 reproduces Table 2 but now accounts for the sample used in our regression analysis and shows how balance changes due to matching. After applying our matching weights we can see that key average differences between treated and untreated firms (e.g. size, wages) are reduced. Note these are not completely eliminated as our exact matching approach is centered on discrete bins of three key margins (size, growth, and sector). See further discussion of this below.

Table B.1: Summary Statistics by Treatment Status and Matching for EU ETS

			Treated ETS		
Variable	**N**	**Overall** N = 39,950	**0** N = 39,517	**1** N = 433	**p-value**
Total No of Employees	39,950	105 (594)	95 (477)	1,059 (3,293)	<0.001
Average Age of Employees	39,950	39.8 (4.2)	39.8 (4.2)	41.0 (2.4)	<0.001
Median Wage of Employees	39,888	36,775 (11,284)	36,691 (11,280)	44,426 (8,782)	<0.001
Establishment Entered	39,950	0.0180 (0.1331)	0.0182 (0.1337)	0.0046 (0.0679)	<0.001
Establishment Exited	39,950	0.0068 (0.0819)	0.0068 (0.0819)	0.0069 (0.0830)	0.97
Shr Sector Energy Inputs	39,918	0.024 (0.018)	0.023 (0.017)	0.062 (0.052)	<0.001

(a) Unmatched

			Treated ETS		
Variable	**N**	**Overall** N = 6,072	**0** N = 5,663	**1** N = 409	**p-value**
Total No of Employees	6,072	900 (3,174)	896 (3,166)	952 (3,294)	0.33
Average Age of Employees	6,072	40.2 (2.7)	40.2 (2.7)	41.0 (2.5)	<0.001
Median Wage of Employees	6,072	42,078 (13,402)	41,934 (13,663)	44,076 (8,797)	<0.001
Establishment Entered	6,072	0.0047 (0.0686)	0.0047 (0.0685)	0.0049 (0.0698)	0.96
Establishment Exited	6,072	0.0029 (0.0539)	0.0026 (0.0509)	0.0073 (0.0854)	0.27
Shr Sector Energy Inputs	6,065	0.040 (0.033)	0.038 (0.030)	0.063 (0.053)	<0.001

(b) Matched

Notes: This table shows summary statistics for the establishments in our dataset. Values are based on the balanced sample using data from pre-treatment (i.e. before 2005 for the ETS). As well as calculating means and standard deviations across the full sample, the table also displays these values broken down based on regulation status. Shares of employees refer to the number of employees of a certain type divided by the total number of employees. Wages are measured in euros. The share of sector energy inputs is based on the share of energy input costs in total revenues at the 3-digit sector level. This data is taken from the German industry cost structure survey and is not based on establishment-level data available directly within the BHP dataset. Establishment entered/exited is a binary variable that refers to whether an establishment ever entered or exited during the sample period. Balance is a binary variable that refers to whether an establishment is present over the entire sample window. The top panel refers to the regression sample without matching weights. The bottom panel refers to the regression sample with matching weights.

Table B.2 provides additional detailed summary statistics on the performance of the exact matching based on the EU ETS. In the unmatched pre-treatment data the treated establishments tend to be larger than control establishments (i.e. in terms of number of employees). EU ETS regulated establishments also appear to be more likely to be experiencing low or declining employment growth. We can also see that treatment is more prevalent in certain manufacturing sectors, such as food (ID=10), paper (ID=17), chemicals (ID=20), non-metallic minerals (ID=23), and basic metals (ID=24). The exact matching algorithm reweights the observations such that the control group means match those in the treated group during the pre-treatment matching window.

Table B.2: Detailed Matching Balance Statistics by Treatment Status for EU ETS

Variable	Mean Treated	Mean Control	Std. Mean Diff	Mean Treated (Matched)	Mean Control (Matched)	Std. Mean Diff (Matched)
Employees 10-20	0.025	0.209	-1.165	0.027	0.027	0
Employees 20-50	0.069	0.379	-1.220	0.073	0.073	0
Employees 50-100	0.109	0.161	-0.168	0.115	0.115	0
Employees 100-200	0.176	0.097	0.206	0.183	0.183	0
Employees 200-500	0.300	0.066	0.512	0.318	0.318	0
Employees 500-1000	0.139	0.018	0.350	0.139	0.139	0
Employees 1000-2000	0.062	0.007	0.231	0.056	0.056	0
Employees 2000+	0.120	0.002	0.362	0.088	0.088	0
Sector ID 10 (Food products)	0.129	0.132	-0.008	0.137	0.137	0
Sector ID 11 (Beverages)	0.025	0.018	0.045	0.017	0.017	0
Sector ID 12 (Tobacco products)	0.002	0.001	0.034	0.000	0.000	0
Sector ID 13 (Textiles)	0.002	0.019	-0.354	0.002	0.002	0
Sector ID 16 (Wood and of products of wo...)	0.016	0.029	-0.104	0.017	0.017	0
Sector ID 17 (Paper and paper products)	0.169	0.018	0.404	0.174	0.174	0
Sector ID 18 (Printing and reproduction ...)	0.005	0.040	-0.524	0.005	0.005	0
Sector ID 19 (Coke and refined petroleum...)	0.030	0.002	0.166	0.024	0.024	0
Sector ID 20 (Chemicals and chemical pro...)	0.085	0.031	0.196	0.090	0.090	0
Sector ID 21 (Basic pharmaceutical produ...)	0.012	0.007	0.046	0.005	0.005	0
Sector ID 22 (Rubber and plastic products)	0.018	0.065	-0.342	0.020	0.020	0
Sector ID 23 (Other non-metallic mineral...)	0.353	0.040	0.655	0.374	0.374	0
Sector ID 24 (Basic metals)	0.058	0.034	0.103	0.037	0.037	0
Sector ID 25 (Fabricated metal products,...)	0.009	0.187	-1.857	0.010	0.010	0
Sector ID 26 (Computer, electronic and o...)	0.012	0.054	-0.402	0.012	0.012	0
Sector ID 27 (Electrical equipment)	0.007	0.042	-0.421	0.007	0.007	0
Sector ID 28 (Machinery and equipment n....)	0.012	0.137	-1.173	0.012	0.012	0
Sector ID 29 (Motor vehicles, trailers a...)	0.035	0.022	0.067	0.037	0.037	0
Sector ID 30 (Other transport equipment)	0.014	0.006	0.066	0.015	0.015	0
Sector ID 32 (Other manufacturing)	0.007	0.053	-0.555	0.005	0.005	0
Growth: Low	0.252	0.344	-0.212	0.259	0.259	0
Growth: Mid	0.566	0.299	0.538	0.560	0.560	0
Growth: High	0.182	0.357	-0.452	0.181	0.181	0

Notes: This table shows the results of the matching analysis. Columns 1–3 show sample means by treatment status and standardized mean differences in the full unmatched sample. Columns 4–6 show sample means by treatment status and standardized mean differences in the matched sample after exact matching. Three matching variables are used: the number of employees, the growth rate employment, and the 2-digit sector.

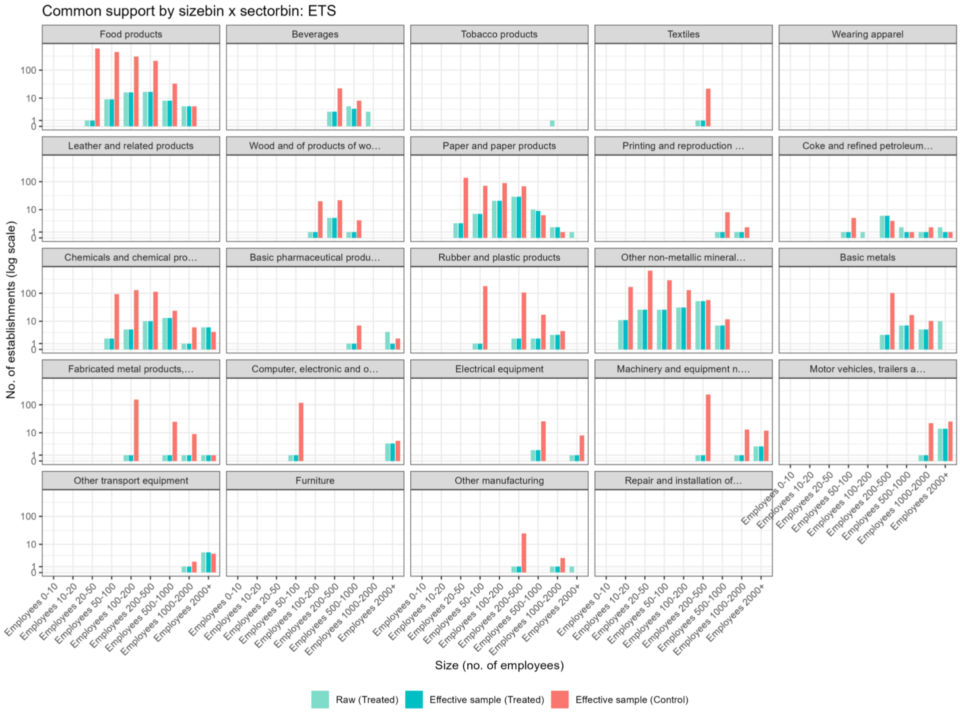
Figure B.1 provides additional diagnostics for the matching analysis. The top panel highlights the combination of sectors and establishment sizes where we have common support. Note here we only plot the control establishments scaled by their equivalent sample size (ESS). In practice there are many more control establishments, including in sector-by-size bins where there are no treated establishments, but a more meaningful comparison for our purpose is to account for the size of the control establishments' respective matching weights when comparing to our treated units. Only a small portion of the overall treated establishments (24 units or 5.5%) are dropped due to a lack of available controls in the relevant matching cell.

The bottom panel of Figure B.1 highlights which combinations of sectors and establishment sizes receive the highest weight in the overall analysis. Here we can the important role played mid-sized establishments (100-500 employees) in sectors such as non-metallic mineral products, paper and paper products, and food products. However, it is also clear our analysis is not overly dependent on certain sectors or establishment sizes, suggesting our results are informative about the manufacturing sector more broadly.

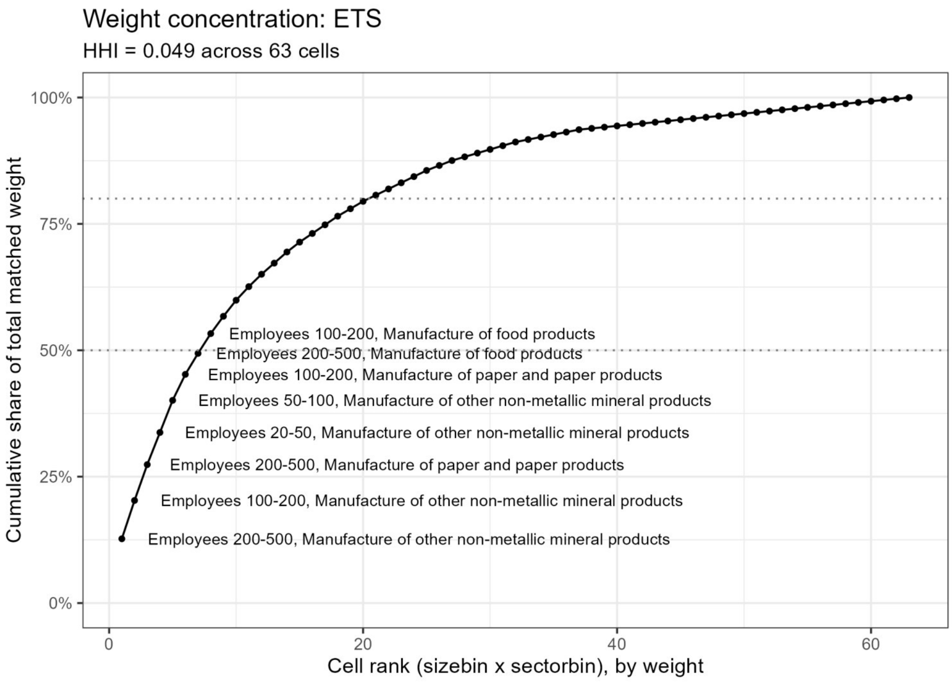
Table B.3 provides results from standard two-way fixed effects difference-in-difference specifications for the EU ETS. Looking at the unmatched regressions, we can see there are significant effects with a very large reduction in employment and substantial increase in wages. These results are likely biased by the lack of balance between treated and control establishments. When moving to the matched regressions we can see that a significant fraction of the control establishments are discarded. Consistent with the findings in Figure 2, in the matched specifications we do not see a clear statistically significant effect of the EU ETS on employment, and we do see a small significant increase in wages. Effects do not vary substantially when including a richer set of fixed effects at the sector-by-year or region-by-year level, especially for the matched specifications.

Table B.4 provides results from standard two-way fixed effects difference-in-difference specifications for the EU ETS for a wide range of employment and wage measures. For total employment we found no significant effects for the EU ETS, while there was a small positive increase in average wages. When breaking employment out by skill level we see no real differences across low- mid- and high-skilled workers. When breaking

Figure B.1: Matching Diagnostics for EU ETS



(a) Common Support



(b) Concentration of Matching Weights

Notes: This figure shows key matching diagnostics. The top panel shows a histogram of treated and control units within each combination of sector and size bin. Treated establishments are shown both in their raw count and their equivalent sample size (ESS) after accounting for matching weights. Any discrepancy can be attributed to a lack of common support from available matching controls. Counts of control establishments are only shown on an ESS basis. The bottom panel shows a cumulative density function of the matched weights that ranks each sector-by-size bin in order of contribution to the matched analysis.

Table B.3: EU ETS Standard Difference-in-difference Results

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
ETS Regulated	-0.2105***	-0.1486***	-0.1460***	0.0231	0.0261	0.0243
	(0.0240)	(0.0241)	(0.0235)	(0.0319)	(0.0322)	(0.0308)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	39,517	39,517	39,517	5,663	5,663	5,663
Treated units	433	433	433	409	409	409
Control units (ESS)	39,517	39,517	39,517	985.6	985.6	985.6
Treated units (ESS)	433	433	433	409	409	409
Fixed-effects						
Establishment	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	788,761	788,761	788,761	120,007	120,007	120,007
R^2	0.89361	0.89529	0.89559	0.93148	0.93408	0.93499
Within R^2	0.00067	0.00032	0.00031	4.59×10^{-5}	6.1×10^{-5}	5.32×10^{-5}
Dep. Var. Mean	44.72	44.72	44.72	100.3	100.3	100.3

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

(a) Employment

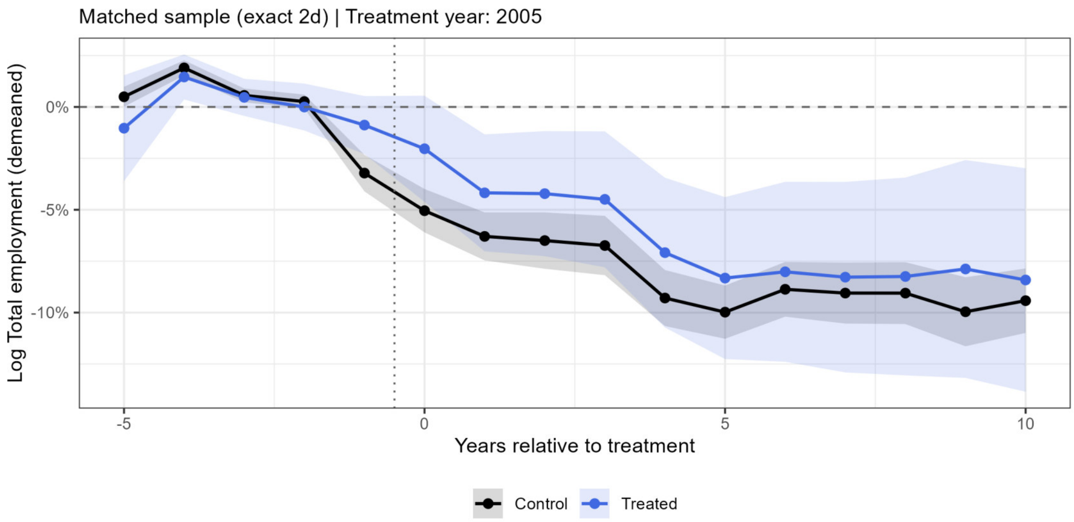
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
ETS Regulated	0.0561***	0.0587***	0.0586***	0.0132	0.0130	0.0103
	(0.0118)	(0.0082)	(0.0084)	(0.0129)	(0.0080)	(0.0084)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	39,517	39,517	39,517	5,663	5,663	5,663
Treated units	433	433	433	409	409	409
Control units (ESS)	39,517	39,517	39,517	985.6	985.6	985.6
Treated units (ESS)	433	433	433	409	409	409
Fixed-effects						
Establishment	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	783,563	783,563	783,563	119,688	119,688	119,688
R^2	0.89657	0.89947	0.90082	0.93633	0.94431	0.94561
Within R^2	0.00058	0.00062	0.00063	0.00033	0.00036	0.00023
Dep. Var. Mean	34,355.9	34,355.9	34,355.9	34,916.6	34,916.6	34,916.6

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

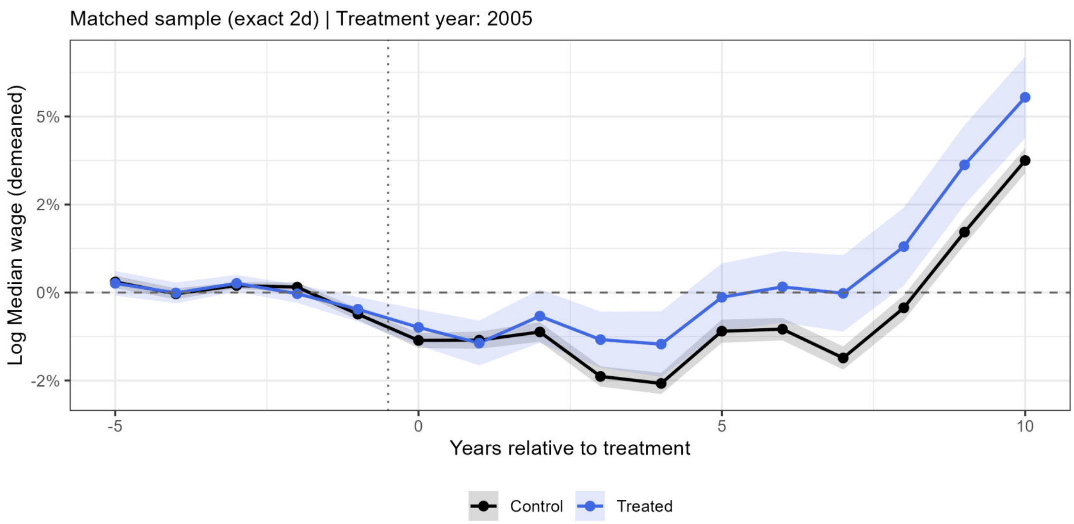
(b) Wages

Notes: This table shows the results of the standard two-way fixed effects difference-in-difference specifications. An observation is an establishment-year. All dependent variables are in logs. Columns 1–3 are for the unmatched sample. Columns 4–6 are for the matched sample. Additional diagnostics with rows on the number of treated and control units (establishments) used in each specification. ESS stands for equivalent sample size and refers to the number of units after accounting for the size of their respective matching weights. All specifications include establishment and year-of-sample fixed effects. Columns 2 and 5 add in sector-by-year fixed effects. Columns 3 and 6 add in sector-by-year and region-by-year fixed effects.

Figure B.2: EU ETS Event Study Results



(a) Employment



(b) Wages

Notes: This figure shows event study estimates of the change in employment and wages in different years for treated establishments relative to control establishments. Effect sizes are plotted relative to the year in which an establishment was first treated.

employment out by gender we see a significant positive effect for female workers. When breaking employment out by age we do see a sizable and significant effect for the youngest 15–34 age group, but no significant effects for the older 35-54 and 54+ age groups. When looking at changes in wages at different points on the pay distribution we do not see clear differences in wage effects for low or high wage workers.

Table B.4: EU ETS Standard Difference-in-difference Results for Various Employment and Wage Measures

Dependent Variables:	Total	Low Skill	Mid Skill	High Skill	Female	Age 15-34	Age 35-54	Age 55+	Median	P25	P75
	Employment								Wages		
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables											
ETS Regulated	0.0231	-0.0206	0.0207	-0.0779*	0.0285	0.0767*	-0.0219	0.0135	0.0132	0.0134	0.0217*
	(0.0319)	(0.0435)	(0.0300)	(0.0462)	(0.0315)	(0.0408)	(0.0339)	(0.0328)	(0.0129)	(0.0119)	(0.0127)
Fixed-effects											
Establishment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics											
Observations	120,007	112,517	119,841	100,314	118,644	117,962	119,777	118,354	119,688	119,688	119,688
R^2	0.93148	0.92093	0.93006	0.95061	0.94871	0.92450	0.93525	0.91445	0.93633	0.92463	0.94112
Within R^2	4.59×10^{-5}	2.83×10^{-5}	3.84×10^{-5}	0.00046	8.02×10^{-5}	0.00040	4.32×10^{-5}	1.31×10^{-5}	0.00033	0.00031	0.00077
Dep. Var. Mean	100.3	13.63	74.50	8.388	26.42	26.37	53.58	16.36	34,916.6	30,346.1	42,138.9

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table shows the results of the standard two-way fixed effects difference-in-difference specifications across a wide range of outcome variables. All dependent variables are in logs. All regressions use exact matching weights. Additional diagnostics with rows on the number of treated and control units (establishments) used in each specification. ESS stands for equivalent sample size and refers to the number of units after accounting for the size of their respective matching weights. All specifications include establishment and year-of-sample fixed effects. Columns 1 and 8 refer to the results for total employment and median wages examined in the main analysis. Columns 2–4 examine employment by low-, medium and high-skill levels. Columns 5–7 examine employment by age groups. Columns 9–10 examine wages by quartile.

Table B.5 provides results from Cox-Proportional Hazards specifications for the EU ETS. These results confirm those in the Kaplan-Meier plots in Figure 3. Establishments regulated by the EU ETS have a statistically significant reduction in their likelihood of exit. Specifically, they exit at 0.45 times the rate of control establishments that are not regulated. We also see further differences in hazard rates when breaking the survival analysis out by leakage status.

Table B.5: EU ETS Survival Results

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
ETS	0.51	0.37, 0.69	¡0.001

[1]HR = Hazard Ratio, CI = Confidence Interval

(a) ETS

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
ETS	0.81	0.40, 1.64	0.6

[1]HR = Hazard Ratio, CI = Confidence Interval

(b) ETS (No Leakage)

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
ETS	0.48	0.34, 0.67	¡0.001

[1]HR = Hazard Ratio, CI = Confidence Interval

(c) ETS (Leakage)

Notes: This table shows the results of the Cox-Proportional Hazards regressions for treated establishments relative to control establishments. Effects capture exits since the year the treatment policy began. Throughout this entails the survival curve beginning at the start of Phase 1 in 2005. We then show results estimated separately for establishments in sectors that are on the leakage list and those that are not. All results use exact matching weights and matching is done separately for each phase where relevant.

B.2 EEG Levy Exemption

Table B.6 reproduces Table 2 but now accounts for the sample used in our regression analysis and shows how balance changes due to matching. After applying our matching weights we can see that key average differences between treated and untreated firms (e.g. size) are reduced.

Table B.6: Summary Statistics by Treatment Status and Matching for EEG Levy Exemption

			Treated EEG		
Variable	**N**	**Overall** N = 39,554	**0** N = 38,708	**1** N = 846	**p-value**
Total No of Employees	39,554	105 (566)	104 (571)	149 (295)	<0.001
Average Age of Employees	39,554	41.1 (4.0)	41.1 (4.0)	41.8 (3.0)	<0.001
Median Wage of Employees	39,540	35,697 (11,301)	35,681 (11,353)	36,402 (8,621)	<0.001
Establishment Entered	39,554	0.0185 (0.1348)	0.0186 (0.1351)	0.0142 (0.1183)	0.28
Establishment Exited	39,554	0.0062 (0.0783)	0.0063 (0.0791)	0.0000 (0.0000)	<0.001
Shr Sector Energy Inputs	39,523	0.023 (0.017)	0.023 (0.017)	0.039 (0.031)	<0.001

(a) Unmatched

			Treated EEG		
Variable	**N**	**Overall** N = 25,656	**0** N = 24,814	**1** N = 842	**p-value**
Total No of Employees	25,656	138 (220)	138 (218)	143 (284)	0.071
Average Age of Employees	25,656	41.2 (3.4)	41.2 (3.4)	41.8 (3.0)	<0.001
Median Wage of Employees	25,655	35,226 (10,519)	35,190 (10,578)	36,314 (8,537)	<0.001
Establishment Entered	25,656	0.0126 (0.1114)	0.0125 (0.1112)	0.0143 (0.1186)	0.68
Establishment Exited	25,656	0.0030 (0.0550)	0.0031 (0.0559)	0.0000 (0.0000)	<0.001
Shr Sector Energy Inputs	25,656	0.031 (0.022)	0.030 (0.021)	0.039 (0.031)	<0.001

(b) Matched

Notes: This table shows summary statistics for the establishments in our dataset. Values are based on the balanced sample using data from pre-treatment (i.e. before 2013 for the EEG). As well as calculating means and standard deviations across the full sample, the table also displays these values broken down based on regulation status. Shares of employees refer to the number of employees of a certain type divided by the total number of employees. Wages are measured in euros. The share of sector energy inputs is based on the share of energy input costs in total revenues at the 3-digit sector level. This data is taken from the German industry cost structure survey and is not based on establishment-level data available directly within the BHP dataset. Establishment entered/exited is a binary variable that refers to whether an establishment ever entered or exited during the sample period. Balance is a binary variable that refers to whether an establishment is present over the entire sample window. The top panel refers to the regression sample without matching weights. The bottom panel refers to the regression sample with matching weights.

Table B.7 provides basic summary statistics on the performance of the exact matching based on the EEG levy exemption. Consistent with the findings in Table 2 we can see that in the unmatched data the treated establishments tend to be larger than control establishments (i.e. in terms of number of employees). We can also see that treatment is more prevalent in certain manufacturing sectors, such as food (ID=10), wood (ID=16), rubber and plastic (ID=22), non-metallic minerals (ID=23), and basic metals (ID=24). The exact matching algorithm then reweights the observations such that the distribution of control group observations across sector, size and growth groupings matches those in the treated group.

Table B.7: Detailed Matching Balance Statistics by Treatment Status for EEG Levy Exemption

Variable	Mean Treated	Mean Control	Std. Mean Diff	Mean Treated (Matched)	Mean Control (Matched)	Std. Mean Diff (Matched)
Employees 0-10	0.001	0.031	-0.854	0.001	0.001	0
Employees 10-20	0.051	0.191	-0.636	0.051	0.051	0
Employees 20-50	0.292	0.400	-0.237	0.293	0.293	0
Employees 50-100	0.280	0.176	0.231	0.281	0.281	0
Employees 100-200	0.193	0.106	0.220	0.194	0.194	0
Employees 200-500	0.132	0.069	0.188	0.133	0.133	0
Employees 500-1000	0.035	0.018	0.093	0.034	0.034	0
Employees 1000-2000	0.012	0.007	0.049	0.010	0.010	0
Employees 2000+	0.004	0.003	0.003	0.002	0.002	0
Sector ID 10 (Food products)	0.187	0.131	0.143	0.188	0.188	0
Sector ID 11 (Beverages)	0.024	0.018	0.036	0.024	0.024	0
Sector ID 13 (Textiles)	0.034	0.019	0.084	0.034	0.034	0
Sector ID 15 (Leather and related products)	0.001	0.004	-0.072	0.001	0.001	0
Sector ID 16 (Wood and of products of wo. . .)	0.064	0.028	0.146	0.064	0.064	0
Sector ID 17 (Paper and paper products)	0.019	0.018	0.008	0.019	0.019	0
Sector ID 18 (Printing and reproduction . . .)	0.011	0.041	-0.293	0.011	0.011	0
Sector ID 19 (Coke and refined petroleum. . .)	0.006	0.002	0.056	0.005	0.005	0
Sector ID 20 (Chemicals and chemical pro. . .)	0.044	0.031	0.064	0.044	0.044	0
Sector ID 22 (Rubber and plastic products)	0.199	0.060	0.347	0.200	0.200	0
Sector ID 23 (Other non-metallic mineral. . .)	0.123	0.041	0.249	0.122	0.122	0
Sector ID 24 (Basic metals)	0.113	0.031	0.260	0.112	0.112	0
Sector ID 25 (Fabricated metal products,. . .)	0.134	0.189	-0.162	0.134	0.134	0
Sector ID 26 (Computer, electronic and o. . .)	0.011	0.054	-0.422	0.011	0.011	0
Sector ID 27 (Electrical equipment)	0.009	0.042	-0.338	0.010	0.010	0
Sector ID 28 (Machinery and equipment n.. . .)	0.011	0.139	-1.250	0.011	0.011	0
Sector ID 29 (Motor vehicles, trailers a. . .)	0.009	0.023	-0.142	0.010	0.010	0
Sector ID 31 (Furniture)	0.001	0.022	-0.592	0.001	0.001	0
Sector ID 32 (Other manufacturing)	0.001	0.054	-1.538	0.001	0.001	0
Growth: Low	0.262	0.243	0.045	0.261	0.261	0
Growth: Mid	0.403	0.351	0.106	0.404	0.404	0
Growth: High	0.335	0.406	-0.151	0.335	0.335	0

Notes: This table shows the results of the matching analysis. Columns 1–3 show sample means by treatment status and standardized mean differences in the full unmatched sample. Columns 4–6 show sample means by treatment status and standardized mean differences in the matched sample after exact matching. Three matching variables are used: the number of employees, the growth rate of employment, and the 2-digit sector.

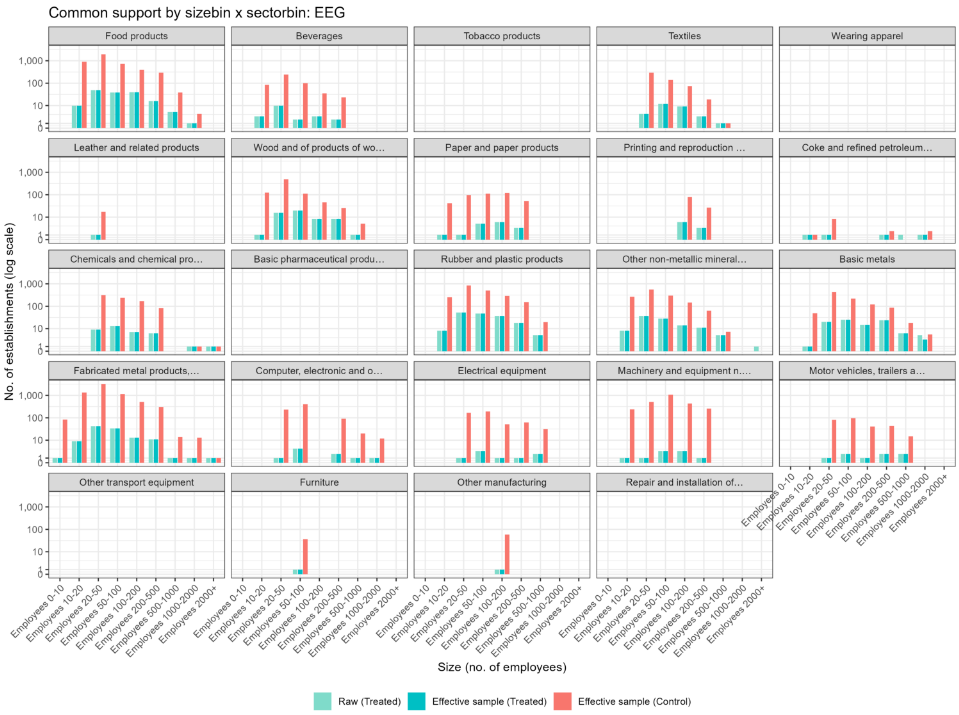
Figure B.3 provides additional diagnostics for the matching analysis. The top panel highlights the combination of sectors and establishment sizes where we have common support. Only a very small portion of the overall treated establishments (4 units or 0.5%) are dropped due to a lack of available controls in the relevant matching cell.

The bottom panel of Figure B.1 highlights which combinations of sectors and establishment sizes receive the highest weight in the overall analysis. Here we can the important role played small-to-mid-sized establishments (20-200 employees) in sectors such as rubber and plastic products, food products, fabricated metal products, and non-metallic mineral products. However, it is also clear our analysis is not overly dependent on certain sectors or establishment sizes, suggesting our results are informative about the manufacturing sector more broadly.

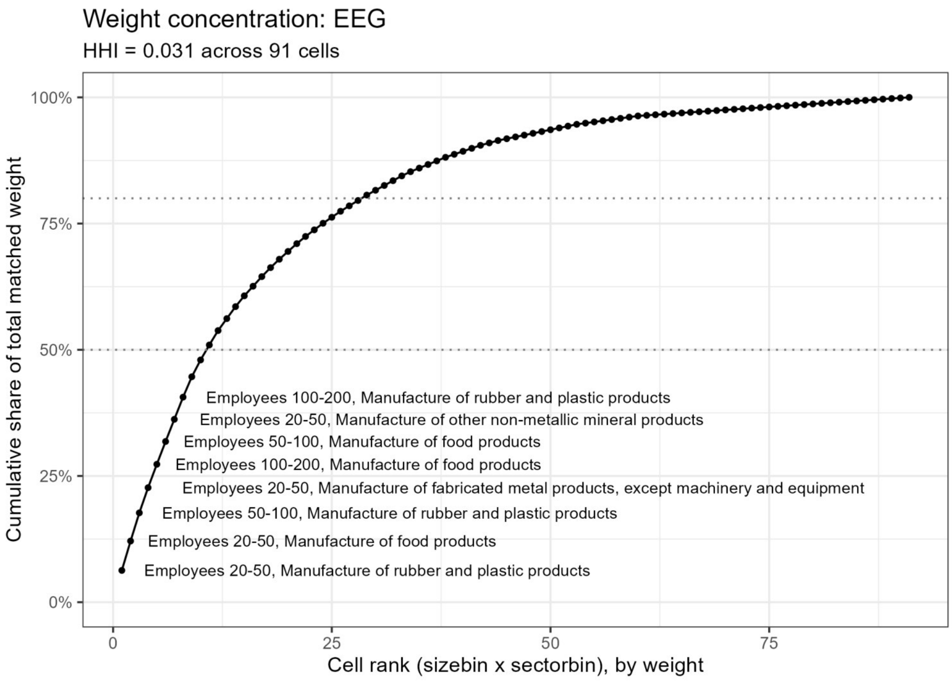
Table B.8 provides results from standard two-way fixed effects difference-in-difference specifications for the EEG levy exemption. Looking at the unmatched regressions, we can see there are significant effects with a sizable reduction in employment, although no meaningful change in wages. These results are likely biased by the lack of balance between treated and control establishments. When moving to the matched regressions we can see that a significant fraction of the control establishments are discarded. Consistent with the findings in Figure 4, in the matched specifications we do not see a clear effect of the EEG levy exemption on employment. We do observe a small negative effect on wages although this is likely due to biases in the standard difference-in-difference approach. Effects also do not vary substantially when including a richer set of fixed effects at the sector-by-year or region-by-year level.

Table B.9 provides results from standard two-way fixed effects difference-in-difference specifications for the EEG levy exemption for a wide range of employment and wage measures. For total employment and we found no significant effects for the EEG levy exemption. For total wages we found no significant effects when accounting for staggered treatment, although there was a small negative effect using the standard difference-in-difference approach. When breaking employment out by skill level we do potentially see a reduction in high-skill employment, although this is a small fraction of total employment with the large majority being classed as mid-skilled. When breaking employment out by gender we see no significant divergence for female vs male employees. When breaking employment out by age we do see a significant effect for the 35–54 age group, but no significant effects for the younger 15–34 or older 54+ age groups. When looking at changes in wages at different points on the pay distribution any small significant reduction in wages appears to be concentrated at the lower end of the wage distribution.

Figure B.3: Matching Diagnostics for EEG Levy Exemption



(a) Common Support



(b) Concentration of Matching Weights

Notes: This figure shows key matching diagnostics. The top panel shows a histogram of treated and control units within each combination of sector and size bin. Treated establishments are shown both in their raw count and their equivalent sample size (ESS) after accounting for matching weights. Any discrepancy can be attributed to a lack of common support from available matching controls. Counts of control establishments are only shown on an ESS basis. The bottom panel shows a cumulative density function of the matched weights that ranks each sector-by-size bin in order of contribution to the matched analysis.

Table B.8: EEG Levy Exemption Standard Difference-in-difference Results

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
EEG Levy Exemption	-0.0506**	-0.0370**	-0.0337**	-0.0146	-0.0141	-0.0138
	(0.0199)	(0.0154)	(0.0150)	(0.0188)	(0.0145)	(0.0140)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	38,708	38,708	38,708	24,814	24,814	24,814
Treated units	846	846	846	842	842	842
Control units (ESS)	38,708	38,708	38,708	9,110.7	9,110.7	9,110.7
Treated units (ESS)	846	846	846	842	842	842
Fixed-effects						
Establishment	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	782,441	782,441	782,441	508,414	508,414	508,414
R^2	0.89550	0.89717	0.89750	0.90872	0.91078	0.91129
Within R^2	9.41×10^{-5}	4.98×10^{-5}	4.15×10^{-5}	1.51×10^{-5}	1.44×10^{-5}	1.38×10^{-5}
Dep. Var. Mean	44.31	44.31	44.31	47.09	47.09	47.09

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

(a) Employment

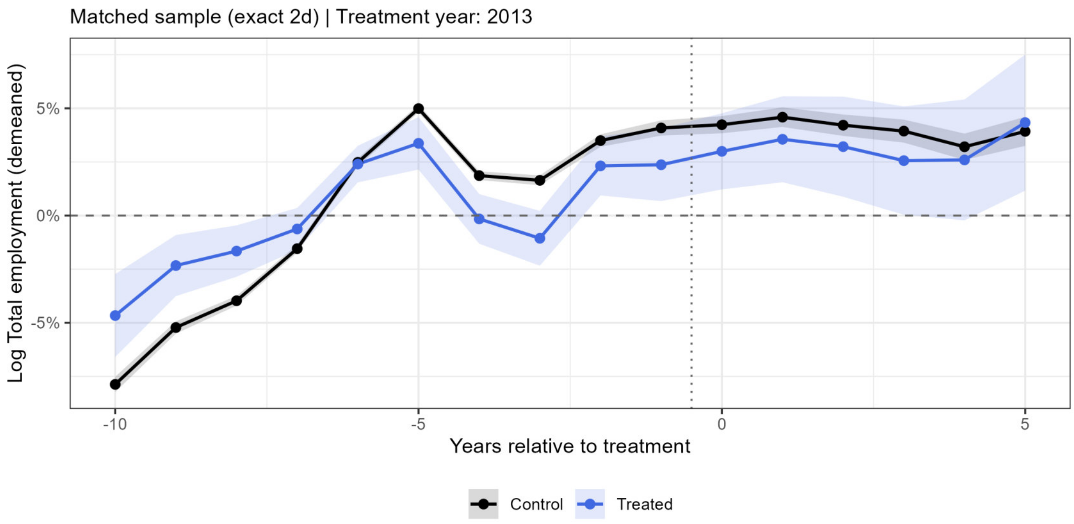
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
EEG Levy Exemption	-0.0136**	-0.0098**	-0.0117**	-0.0145***	-0.0136***	-0.0158***
	(0.0061)	(0.0046)	(0.0045)	(0.0052)	(0.0046)	(0.0046)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	38,708	38,708	38,708	24,814	24,814	24,814
Treated units	846	846	846	842	842	842
Control units (ESS)	38,708	38,708	38,708	9,110.7	9,110.7	9,110.7
Treated units (ESS)	846	846	846	842	842	842
Fixed-effects						
Establishment	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	777,375	777,375	777,375	506,651	506,651	506,651
R^2	0.89632	0.89924	0.90058	0.91904	0.92131	0.92289
Within R^2	8.01×10^{-5}	4.15×10^{-5}	5.98×10^{-5}	0.00020	0.00018	0.00024
Dep. Var. Mean	34,284.1	34,284.1	34,284.1	33,415.5	33,415.5	33,415.5

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

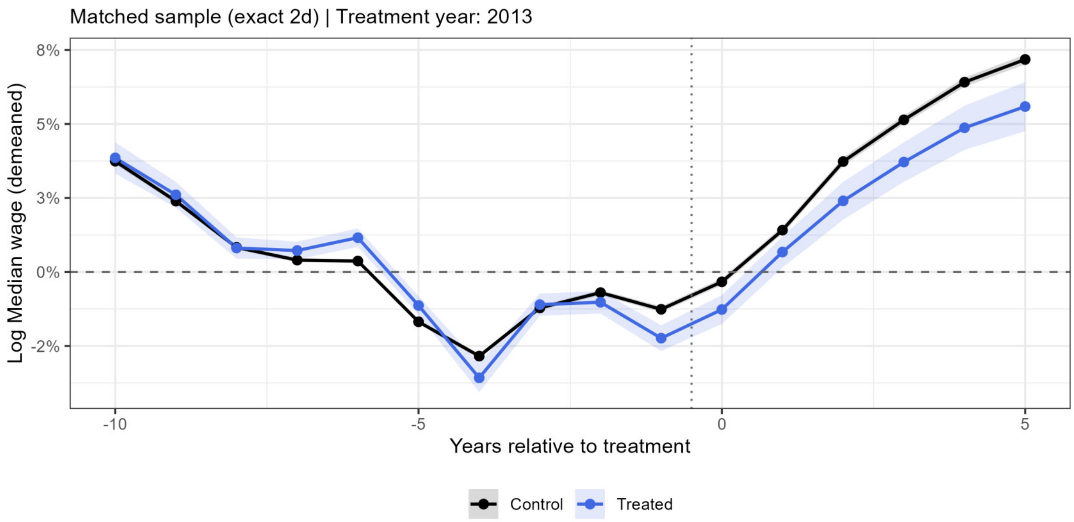
(b) Wages

Notes: This table shows the results of the standard two-way fixed effects difference-in-difference specifications. An observation is an establishment-year. All dependent variables are in logs. Columns 1–3 are for the unmatched sample. Columns 4–6 are for the matched sample. Additional diagnostics with rows on the number of treated and control units (establishments) used in each specification. ESS stands for equivalent sample size and refers to the number of units after accounting for the size of their respective matching weights. All specifications include establishment and year-of-sample fixed effects. Columns 2 and 5 add in sector-by-year fixed effects. Columns 3 and 6 add in sector-by-year and region-by-year fixed effects.

Figure B.4: EEG Levy Exemption Event Study Results



(a) Employment



(b) Wages

Notes: This figure shows event study estimates of the change in log employment and wages in different years for treated establishments relative to control establishments. Effect sizes are plotted relative to the year in which an establishment was first treated.

Table B.9: EEG Levy Exemption Standard Difference-in-difference Results for Various Employment and Wage Measures

Dependent Variables:	Total	Low Skill	Mid Skill	High Skill	Female	Age 15-34	Age 35-54	Age 55+	Median	P25	P75
				Employment						Wages	
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables											
EEG Levy Exemption	-0.0146	-0.0003	-0.0083	-0.0844***	-0.0298	0.0208	-0.0447*	0.0035	-0.0145***	-0.0222***	-0.0086
	(0.0188)	(0.0289)	(0.0165)	(0.0281)	(0.0221)	(0.0270)	(0.0260)	(0.0192)	(0.0052)	(0.0070)	(0.0052)
Fixed-effects											
Establishment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics											
Observations	508,414	463,441	508,004	374,500	503,082	500,416	507,291	490,311	506,651	506,651	506,651
R^2	0.90872	0.87206	0.90897	0.90905	0.91748	0.85963	0.90714	0.86315	0.91904	0.88940	0.92027
Within R^2	1.51×10^{-5}	3.29×10^{-9}	4.87×10^{-6}	0.00035	5.13×10^{-5}	1.55×10^{-5}	0.00013	5.29×10^{-7}	0.00020	0.00031	6.2×10^{-5}
Dep. Var. Mean	47.09	6.453	35.07	4.301	11.98	12.80	23.83	7.969	33,415.5	28,668.7	40,184.9

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: This table shows the results of the standard two-way fixed effects difference-in-difference specifications across a wide range of outcome variables. An observation is an establishment-year. All dependent variables are in logs. All regressions use exact matching weights. Additional diagnostics with rows on the number of treated and control units (establishments) used in each specification. ESS stands for equivalent sample size and refers to the number of units after accounting for the size of their respective matching weights. All specifications include establishment and year-of-sample fixed effects. Columns 1 and 8 refer to the results for total employment and median wages examined in the main analysis. Columns 2–4 examine employment by low-, medium and high-skill levels. Columns 5–7 examine employment by age groups. Columns 9–10 examine wages by quartile.

Table B.10 provides results from Cox-Proportional Hazards specifications for the EEG levy exemption. These results confirm those in the Kaplan-Meier plots in Figure 5. Establishments receiving the EEG levy exemption starting in Phase 1 are 0.79 times as likely to exit as establishments that do not receive the exemption.

Table B.10: EEG Levy Exemption Survival Results

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
EEG	0.84	0.70, 1.00	0.056

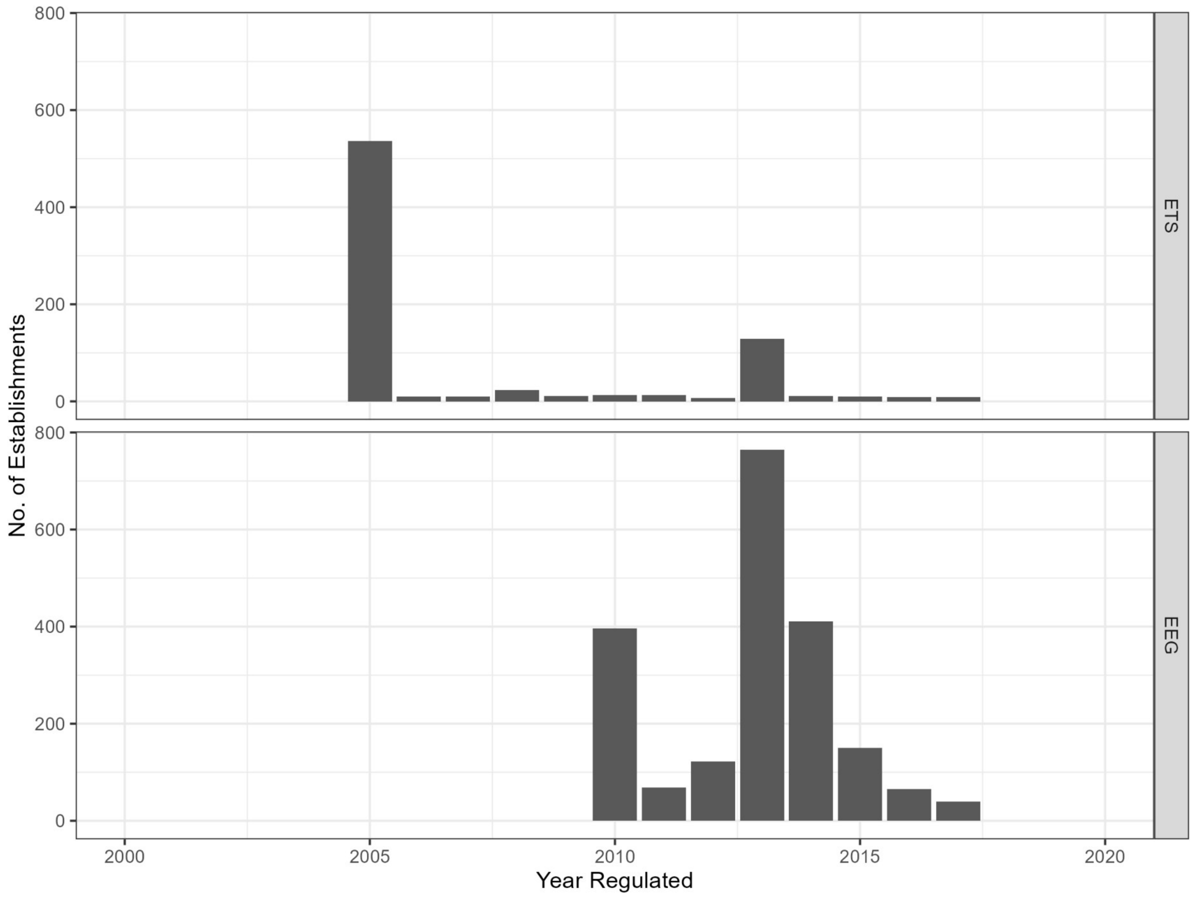
[1] HR = Hazard Ratio, CI = Confidence Interval

Notes: This table shows the results of the Cox-Proportional Hazards regressions for treated establishments relative to control establishments. Effects capture exits since the the year the treatment policy began. Due to the small number of establishments where we observe their treatment start date in Phase 1 the analysis here focuses only on Phase 2 and thus begins in 2013. All results use exact matching weights and matching is done separately for each phase where relevant.

C Firm-level Summary Statistics and Results Detail

Figure 1 plots the number of firms that are first subject to the EEG exemption or the EU ETS in a given year. Consistent with the establishment level version of the data, some EEG exemption firms were covered from the beginning of the program in 2010, but the significant majority actually joined after 2013 when the eligibility criteria were expanded. The majority of firms in our sample regulated by the EU ETS joined at the inception of the EU ETS in 2005. However, a non-trivial number do also become regulated in later years, including in 2013 when Phase 3 expanded the sectors covered by the regulation.

Figure C.1: First Year Subject to Environmental Regulation (Firm-level)



Notes: This figure shows the number of firms that were first subject to each policy in a given year over our sample period. The top panel refers to the EEG levy exemption and the bottom panel refers to the EU ETS.

Table 1 provides summary statistics on the firms in our sample. After aggregating up from the establishment level we go from approximately 75-90 thousand establishments with more than 1.3 million establishment-year observations to approximately 70-80 thousand firms with more than 1.2 million firm-year observations. This highlights the extent to which our sample is dominated by firms that essentially have one establishment.

Table C.1: Summary Statistics (Firm-Level)

Variable	**N**	**Mean (Std. Dev)**
Total No of Employees	1,232,356	98 (509)
Shr Employees (Full-Time)	1,207,342	0.73 (0.22)
Shr Employees (Female)	1,207,342	0.33 (0.24)
Shr Employees (Low-Skilled)	1,207,342	0.14 (0.12)
Shr Employees (Medium-Skilled)	1,207,342	0.75 (0.16)
Shr Employees (High-Skilled)	1,207,342	0.09 (0.13)
Shr Employees (Engineer/Scientist)	1,207,342	0.02 (0.06)
Shr Employees (Apprentice/Trainee)	1,207,342	0.04 (0.06)
Shr Employees (German)	1,207,342	0.92 (0.12)
Average Age of Employees	1,207,342	42.0 (5.1)
Shr Employees (Age 15-34)	1,207,342	0.30 (0.16)
Shr Employees (Age 35-54)	1,207,342	0.52 (0.15)
Shr Employees (Age 55+)	1,207,342	0.18 (0.13)
Median Wage of Employees	1,193,897	35,719 (13,056)
25th Percentile Wage of Employees	1,193,897	30,543 (10,690)
75th Percentile Wage of Employees	1,193,897	43,440 (17,567)
Shr Sector Energy Inputs	1,206,597	0.023 (0.017)

Notes: This table shows key summary statistics for the firms in our dataset. Values presented are means with standard deviations in brackets. An observation is an firm-year. Wages are measured in euros. The share of sector energy inputs is based on the assumed share of energy input costs in total material input costs at the 3-digit sector level.

Table 2 reports firm-level averages of certain key variables divided up by treatment status. As with the establishment level sample, it is clear that the firms that are subject to the EU ETS and the EEG levy exemption are quite different to those that are not. 795 firms are identified as ever being treated by the EU ETS and 2,022 firms are identified as ever being treated by the EEG levy exemption. As well as being larger, as measured by total number of employees, they also tend to have a workforce that is more male, more highly skilled, and better paid. As might be expected they are also more likely to be in energy intensive industries such as metals or paper and pulp.

Table C.2: Summary Statistics by Treatment Status (Firm-Level)

Variable	N	Overall N = 69,134	Treated ETS 0 N = 68,472	Treated ETS 1 N = 662	p-value
Total No of Employees	69,134	91 (478)	82 (387)	946 (2,755)	<0.001
Average Age of Employees	69,134	40.0 (4.5)	40.0 (4.5)	41.0 (2.6)	<0.001
Median Wage of Employees	68,801	36,428 (12,244)	36,345 (12,227)	45,054 (10,907)	<0.001
Establishment Entered	69,134	0.11 (0.31)	0.11 (0.31)	0.06 (0.23)	<0.001
Establishment Exited	69,134	0.32 (0.46)	0.32 (0.46)	0.08 (0.27)	<0.001
Shr Sector Energy Inputs	69,098	0.023 (0.017)	0.023 (0.017)	0.057 (0.047)	<0.001

(a) EU ETS

Variable	N	Overall N = 79,854	Treated EEG 0 N = 77,974	Treated EEG 1 N = 1,880	p-value
Total No of Employees	79,854	86 (433)	82 (428)	227 (586)	<0.001
Average Age of Employees	79,854	41.1 (4.4)	41.0 (4.4)	41.6 (3.2)	<0.001
Median Wage of Employees	79,654	35,353 (12,612)	35,308 (12,669)	37,221 (9,788)	<0.001
Establishment Entered	79,854	0.19 (0.39)	0.19 (0.39)	0.20 (0.39)	0.58
Establishment Exited	79,854	0.31 (0.46)	0.32 (0.46)	0.10 (0.29)	<0.001
Shr Sector Energy Inputs	79,813	0.023 (0.017)	0.023 (0.016)	0.041 (0.034)	<0.001

(b) EEG Levy Exemption

	Treated EEG 0	Treated EEG 1	Total
Treated ETS			
0	83,424 (97%)	1,653 (1.9%)	85,077 (99%)
1	426 (0.5%)	369 (0.4%)	795 (0.9%)
Total	83,850 (98%)	2,022 (2.4%)	85,872 (100%)

(c) Cross-Tabulation of EEG Levy Exemption vs EU ETS

Notes: This table shows summary statistics for the firms in our dataset. Values are averaged for all firms over any pre-treatment years they are in our sample. As well as calculating means and standard deviations, the table also displays these values broken down based on regulation status. Shares of employees refer to the number of employees of a certain type divided by the total number of employees. Wages are measured in euros. The share of sector energy inputs is based on the share of energy input costs in total revenues at the 3-digit sector level. This data is taken from the German industry cost structure survey and is not based on establishment-level data available directly within the BHP dataset. Entered/exited is a binary variable that refers to whether an firm ever entered or exited during the sample period. The first panel looks at the EU ETS. The second panel looks at the EEG levy exemption. The final bottom panel provides a cross-tabulation of treatment status to convey the extent to which firms are regulated by both the EU ETS and EEG levy exemption.

C.1 EU ETS

Table C.3 provides results from standard two-way fixed effects difference-in-difference specifications for the EU ETS at the firm level. The results broadly mirror those discussed for the establishment level specifications in Table B.3, although with slightly larger effect sizes for employment and a smaller effect on wages. Both are not statistically significant.

Table C.4 provides results from Cox-Proportional Hazards specifications for the EU ETS at the firm level. Again these results largely mirror from those found at the establishment level in Table B.5. Firms regulated by the EU ETS are significantly less likely to exit than firms that are not regulated. However, here we see a less pronounced divergence in hazard rates when breaking the survival analysis out by leakage status.

C.2 EEG Levy Exemption

Table C.5 provides results from standard two-way fixed effects difference-in-difference specifications for the EEG levy exemption at the firm level. Again we see results that mirror the establishment level findings in Table B.8. Similar caution should be applied when interpreting the significant fall in wages for treated firms given prior concerns about divergent pre-trends even with the matched sample.

Table C.6 provides results from Cox-Proportional Hazards specifications for the EEG levy exemption at the firm level. These results largely mirror those found at the establishment level in Table B.10. Firms that receive the EEG levy exemption are less likely to exit than firms that are not exempt, although the effect is not as large as observed for the EU ETS.

Table C.3: EU ETS Standard Difference-in-difference Results (Firm-Level)

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
ETS Regulated	-0.1741***	-0.1124***	-0.1120***	0.0381*	0.0414*	0.0363
	(0.0263)	(0.0257)	(0.0254)	(0.0229)	(0.0220)	(0.0228)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	37,480	37,480	37,480	4,465	4,465	4,465
Treated units	417	417	417	403	403	403
Control units (ESS)	37,480	37,480	37,480	588.3	588.3	588.3
Treated units (ESS)	417	417	417	403	403	403
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	749,274	749,274	749,274	96,344	96,344	96,344
R^2	0.90045	0.90210	0.90241	0.95269	0.95398	0.95535
Within R^2	0.00051	0.00020	0.00020	0.00021	0.00025	0.00020
Dep. Var. Mean	45.43	45.43	45.43	116.0	116.0	116.0

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

(a) Employment

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
ETS Regulated	0.0548***	0.0563***	0.0563***	0.0046	0.0039	0.0015
	(0.0116)	(0.0086)	(0.0086)	(0.0132)	(0.0090)	(0.0093)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	37,480	37,480	37,480	4,465	4,465	4,465
Treated units	417	417	417	403	403	403
Control units (ESS)	37,480	37,480	37,480	588.3	588.3	588.3
Treated units (ESS)	417	417	417	403	403	403
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	744,721	744,721	744,721	96,108	96,108	96,108
R^2	0.89667	0.89959	0.90095	0.93628	0.94471	0.94637
Within R^2	0.00059	0.00061	0.00062	5.33×10^{-5}	4.37×10^{-5}	6.87×10^{-6}
Dep. Var. Mean	34,162.3	34,162.3	34,162.3	35,653.6	35,653.6	35,653.6

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

(b) Wages

Notes: This table shows the results of the standard two-way fixed effects difference-in-difference specifications. An observation is a firm-year. All dependent variables are in logs. Columns 1–3 are for the unmatched sample. Columns 4–6 are for the matched sample. Additional diagnostics with rows on the number of treated and control units (firms) used in each specification. ESS stands for equivalent sample size and refers to the number of units after accounting for the size of their respective matching weights. All specifications include firm and year-of-sample fixed effects. Columns 2 and 5 add in sector-by-year fixed effects. Columns 3 and 6 add in sector-by-year and region-by-year fixed effects.

Table C.4: EU ETS Survival Results (Firm-Level)

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
ETS	0.46	0.33, 0.63	¡0.001

[1] HR = Hazard Ratio, CI = Confidence Interval

(a) ETS

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
ETS	0.52	0.21, 1.26	0.15

[1] HR = Hazard Ratio, CI = Confidence Interval

(b) ETS (No Leakage)

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
ETS	0.45	0.32, 0.64	¡0.001

[1] HR = Hazard Ratio, CI = Confidence Interval

(c) ETS (Leakage)

Notes: This table shows the results of the Cox-Proportional Hazards regressions for treated firms relative to control firms. Effects capture exits since the the year the treatment policy began. For the aggregated analysis this entails the survival curve beginning at the start of Phase 1 in 2005. For the phase level analysis this entails the survival curve beginning at the start of a given phase and ending at the end of that phase. All results use exact matching weights and matching is done separately for each phase where relevant.

Table C.5: EEG Levy Exemption Standard Difference-in-difference Results (Firm-Level)

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
EEG Levy Exemption	-0.0541***	-0.0424***	-0.0409***	-0.0141	-0.0145	-0.0161
	(0.0194)	(0.0144)	(0.0144)	(0.0191)	(0.0148)	(0.0143)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	36,761	36,761	36,761	23,299	23,299	23,299
Treated units	803	803	803	801	801	801
Control units (ESS)	36,761	36,761	36,761	8,674.9	8,674.9	8,674.9
Treated units (ESS)	803	803	803	801	801	801
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	743,977	743,977	743,977	478,142	478,142	478,142
R^2	0.90171	0.90334	0.90364	0.91428	0.91642	0.91705
Within R^2	0.00011	6.93×10^{-5}	6.47×10^{-5}	1.5×10^{-5}	1.62×10^{-5}	2.01×10^{-5}
Dep. Var. Mean	44.97	44.97	44.97	47.81	47.81	47.81

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

(a) Employment

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
EEG Levy Exemption	-0.0140**	-0.0101**	-0.0115**	-0.0133**	-0.0126***	-0.0139***
	(0.0060)	(0.0046)	(0.0046)	(0.0054)	(0.0047)	(0.0047)
Matching Details:						
Matched	No	No	No	Yes	Yes	Yes
Control units	36,761	36,761	36,761	23,299	23,299	23,299
Treated units	803	803	803	801	801	801
Control units (ESS)	36,761	36,761	36,761	8,674.9	8,674.9	8,674.9
Treated units (ESS)	803	803	803	801	801	801
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Year-Sector (2D)		Yes	Yes		Yes	Yes
Year-Region			Yes			Yes
Fit statistics						
Observations	739,538	739,538	739,538	476,642	476,642	476,642
R^2	0.89639	0.89933	0.90068	0.91989	0.92215	0.92370
Within R^2	8.79×10^{-5}	4.6×10^{-5}	6×10^{-5}	0.00017	0.00016	0.00020
Dep. Var. Mean	34,100.5	34,100.5	34,100.5	33,251.5	33,251.5	33,251.5

Clustered (Sector (3D)) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

(b) Wages

Notes: This table shows the results of the standard two-way fixed effects difference-in-difference specifications. An observation is a firm-year. All dependent variables are in logs. Columns 1–3 are for the unmatched sample. Columns 4–6 are for the matched sample. Additional diagnostics with rows on the number of treated and control units (firms) used in each specification. ESS stands for equivalent sample size and refers to the number of units after accounting for the size of their respective matching weights. All specifications include firm and year-of-sample fixed effects. Columns 2 and 5 add in sector-by-year fixed effects. Columns 3 and 6 add in sector-by-year and region-by-year fixed effects.

Table C.6: EEG Levy Exemption Survival Results (Firm-Level)

Characteristic	**HR**[1]	**95% CI**[1]	**p-value**
EEG	0.77	0.63, 0.95	0.013

[1] HR = Hazard Ratio, CI = Confidence Interval

Notes: This table shows the results of the Cox-Proportional Hazards regressions for treated firms relative to control firms. Effects capture exits since the the year the treatment policy began. Due to the small number of firms where we observe their treatment start date in Phase 1 the analysis here focuses only on Phase 2 and thus begins in 2013. All results use exact matching weights and matching is done separately for each phase where relevant.