The Impact of the UK's Withdrawal from the EU ETS on Firms' Carbon Emissions: Evidence from the UK ETS

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Abstract

We examine the impact of the United Kingdom's withdrawal from the European Union Emissions Trading System (EU ETS) on firms' carbon emissions following the introduction of the UK Emissions Trading Scheme (UK ETS). Using a matched difference-in-differences approach, we compare UK-regulated firms with a counterfactual group of EU ETS firms to assess whether the implementation of the UK ETS altered emissions behavior during its early stages. Our results indicate no statistically significant effect of the UK's departure from the EU ETS on firms' emissions. Sectoral analysis reveals that, both in the UK and in the EU, energy firms experienced greater average emissions reductions than manufacturing firms, suggesting sector-specific differences in decarbonization incentives and emissions-reduction capabilities. This study contributes to the ongoing discussion on potential linkages between ETSs.

Keywords: UK ETS; EU ETS; Verified Emissions; Propensity Score Matching; Difference-in-Differences.

Key Policy Insights

- Our analysis shows that UK firms have maintained emissions reduction commitments comparable to their EU counterparts during the initial years of the UK ETS.
- Linking the UK ETS with the EU ETS would provide firms with access to a deeper and more liquid carbon market, reducing administrative burdens and lowering compliance costs, while also mitigating risks of carbon leakage across borders.
- Early alignment between the UK and EU ETSs is essential: for example, the Swiss-EU experience demonstrates that delays in negotiations increase complexity and the risk of future divergence in system design.
- A UK-EU ETS linkage would not only strengthen both regions' climate policies but also serve as a precedent for broader international carbon market integration, enhancing efficiency and reducing reliance on unilateral mechanisms such as the CBAM.

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1 Introduction

Carbon markets play a vital role in shielding domestic industries from economic disruptions, and generating funds that can be redirected to sustainable development projects (Weng et al., 2022, Wang et al., 2023, 2024, Haites et al., 2024). The United Kingdom has been a pioneer in emissions trading since April 2002, when it established the world's first large-scale Emissions Trading System (ETS). This system was instrumental in the creation of the European Union ETS (EU ETS) (Smith and Swierzbinski, 2007) in 2005, currently among the largest carbon markets in the world.[1]

An empirically relevant feature of the UK's climate policy is the transition of UK firms from the EU ETS to the newly established UK Emissions Trading Scheme (UK ETS) in 2021, following the UK's formal withdrawal from the European Union in 2020. This development effectively constitutes a quasi-natural experiment, enabling the assessment of the impact of this policy change on firms' environmental performance.

ETSs employ a cap-and-trade framework that sets a limit on total emissions while enabling firms to trade allowances, thus fostering cost-efficient emission reductions (Ellerman et al., 2016, Bayer and Aklin, 2020, Ren et al., 2022, Colmer et al., 2024). Various regions and countries have established independent ETSs with their distinct structures, regulatory frameworks, and pricing mechanisms, creating a fragmented ETS landscape.[2]

While the UK ETS was designed to closely mirror the EU ETS, several channels could, in principle, lead to divergence in firms' emissions performance following institutional separation. First, policy uncertainty associated with the transition may weaken firms' commitment to environmental objectives (Yu et al., 2021, Bose et al., 2024) and increase compliance and adjustment costs (Babonneau et al., 2018, Tol, 2018). Uncertainty over future regulatory frameworks may delay emissions-reducing investments and affect firms' strategic decisions (Bocse, 2020, Benlemlih and Yavaş, 2024). Consistent with theoretical models, investment in green technologies critically depends on expectations about future climate policy, potentially giving rise to multiple equilibria driven by self-fulfilling beliefs (Biais and Landier, 2022).

Second, the smaller size of the UK ETS, together with the absence of direct allowance transfer

[1]Source: `https://climate.ec.europa.eu/eu-action/carbon-markets/about-eu-ets_en`.

[2]Notable examples include individual systems covering the European Union, the United Kingdom, Switzerland, China, New Zealand, South Korea, Mexico, Kazakhstan, Tokyo-Saitama in Japan, Québec in Canada, and certain states of the United States (e.g., California). Other ETSs are currently under development, for instance, in Brazil, India, Turkey, and Colombia (Source: `https://icapcarbonaction.com/en/ets`).

or linkage with the EU ETS, may limit trading activity and reduce market liquidity. This, in turn, may affect price formation and increase volatility, weakening the informational content of carbon prices. Since carbon pricing is a key driver of firms' behavior and emissions management practices (Adamolekun, 2024, Flori et al., 2024), less liquid markets may provide weaker and more volatile signals, potentially influencing firms' behavior (Ranson and Stavins, 2016, Narassimhan et al., 2018) and their marginal abatement incentives (Hintermann, 2010, Hintermann et al., 2016, Bayer and Aklin, 2020).

Third, differences in cap stringency and expectations about future policy design may further shape firms' incentives. The UK ETS introduced a cap that was 5% lower than the UK's notional share under the EU ETS and is set to decline more rapidly in line with the UK's net-zero 2050 target. In addition, the UK ETS incorporates a reserve price and a cost-containment mechanism (CCM), whereas the EU ETS relies on a quantity-based adjustment mechanism, the Market Stability Reserve (MSR).[3]

More broadly, institutional separation may introduce frictions, as highlighted in the literature on the termination of links between carbon markets (Pizer and Yates, 2015, Borghesi and Zhu, 2020, Kerr et al., 2021). At the same time, emissions reductions are typically driven by long-term investments and regulatory expectations, which may not respond immediately to institutional changes (Stern, 2008, Jakob et al., 2022). Finally, post-Brexit macroeconomic adjustments may also affect emissions dynamics, as the economic slowdown experienced by the UK may have reduced emissions through lower output and energy demand (Bloom et al., 2025). Therefore, whether institutional separation translates into different emissions outcomes remains an empirical question.

In this paper, we evaluate the early-stage effects of the UK's withdrawal from the EU ETS on the carbon emissions of UK firms. By focusing on ETS-regulated firms, we are able to leverage verified emissions data which, unlike estimated emissions or ESG-based proxies typically used for non-ETS firms, are generally more accurate and reliable due to mandatory reporting requirements and third-party verification (Benchora and Galanti, 2024). In contrast, self-reported emissions often lack a consistent legal basis, raising concerns about their reliability (Aswani et al., 2024), while vendor-based estimates tend to show only moderate agreement between providers and rely heavily on assumptions about business models and industry averages (Busch et al., 2022).

We employ a matched difference-in-differences framework that compares UK ETS firms to a counterfactual group of similar EU ETS firms, using a combination of emissions data and balance

[3]Source: https://icapcarbonaction.com/en/ets/uk-emissions-trading-scheme.

sheet information covering the period 2013-2023. The counterfactual group is constructed through propensity score matching based on a set of accounting variables from the pre-intervention period, combined with exact sectoral matching at the 4-digit NACE Rev. 2 level. This approach aims to ensure a high degree of comparability between treated (UK) and control (EU) firms.

A widely adopted carbon pricing framework is considered an important policy pillar for reducing climate change (Stern, 2008), ensuring broad coverage and consistency across sectors and regions, especially in a global economy integrated through international trade (Jakob et al., 2022). Although ETSs share the overarching objective of reducing GHG emissions, their lack of integration constrains the prospects for a unified global carbon market (Qi and Weng, 2016, Boyce, 2018). This fragmentation reflects the diversity of political, economic, and environmental priorities across jurisdictions, producing a patchwork of systems rather than a cohesive global framework (Villoria-Sáez et al., 2016).

The coexistence of multiple independent ETSs entails both advantages and challenges. On the one hand, the proliferation of different ETSs encourages broader adoption, allowing jurisdictions to tailor design to their specific needs and circumstances (Flachsland et al., 2009a). On the other hand, divergence across systems may generate misalignments, such as disparities in regulatory standards or allowance prices (Chang et al., 2018), which undermine the consistency of global abatement efforts (Kornek et al., 2021). Such heterogeneity complicates policy convergence and can exacerbate issues like allowance arbitrage and carbon leakage, ultimately weakening the environmental benefits achieved by more stringent regimes (De Beule et al., 2022, Wang and Kuusi, 2024).

The UK's withdrawal from the EU ETS represents a concrete case for assessing this trade-off. While it introduced additional regulatory fragmentation within Europe, the persistence of long-standing policy alignment may have mitigated the risks of divergence in emissions reduction efforts. Our analysis indicates that carbon emissions for both treated and control firms have declined significantly over time, from approximately 657,830 metric tonnes of CO_2 equivalent (tCO_2e) in 2013 to about 330,435 tCO_2e in 2023. However, we do not find a statistically significant effect of the UK's departure from the EU ETS. This result is robust across the full sample and within the two most represented sectors in our data, manufacturing and energy, which account for approximately 62% (68%) and 22% (20%) of regulated firms in the UK (EU) ETS, respectively. Although our findings cover only three years post-implementation, they remain robust across multiple checks on matching techniques, parameters and periods related to the EU referendum,[4] as well as with respect to alternative measures of

[4]The EU referendum took place on June 23, 2016.

environmental outcome.

The European Commission (EC) has long highlighted that integrating the EU ETS with other robust systems can reduce abatement costs, improve market liquidity, stabilize carbon prices, and promote international climate cooperation.[5] These potential benefits underscore the strategic relevance of a UK-EU ETS linkage[6], a possibility explicitly encouraged by the EU-UK Trade and Cooperation Agreement (TCA).[7] Although the UK ETS was intended to maintain close regulatory alignment with the EU ETS, several factors could, in principle, have distorted the emissions patterns of UK firms, potentially weakening the policy's overall effectiveness. However, our findings suggest that these potential sources of divergence have not resulted in statistically significant differences in carbon emissions in the short run. In this respect, our analysis contributes to the ongoing debate on the possible linkage between the UK ETS and the EU ETS[8], contributing to the broader literature on the linking solutions between carbon policies (Flachsland et al., 2009b, Mehling and Haites, 2009, Dellink et al., 2014, Zeng et al., 2018, Evans and Wu, 2021, Aarnio and de Vries, 2025).

The remainder of the paper is structured as follows. Section 2 illustrates the design, scope, and implementation of the UK ETS. Sections 3 and 4 describe data and the methodology, respectively. Next, Section 5 presents the empirical results of the main and robustness analyses, as well as a policy discussion. Finally, Section 6 reports the conclusions.

2 UK ETS: Design, Scope, and Implementation

The implementation of the UK ETS followed the November 2000 UK Climate Change Programme, which also included two other interlinked instruments to drive emissions reductions, namely the Cli-

[5]Source: `https://climate.ec.europa.eu/document/download/5dee0b48-a38f-4d10-bf1a-14d0c1d6febd_en?filename=factsheet_ets_en.pdf`.

[6]In the context of ETSs, linkage refers to institutional arrangements that allow regulated entities to use emission allowances issued in one system for compliance in another. The literature identifies different types of linking along multiple dimensions (Lazarus et al., 2015, Borghesi et al., 2016, Schneider et al., 2017, Quemin and de Perthuis, 2019). First, according to the direction of recognition, linkages can be unilateral (one-way use of external allowances), bilateral (mutual recognition between two systems), or multilateral (mutual recognition across multiple systems). Second, according to the channel of interaction, linkages can be direct, where systems mutually accept each other's allowances, or indirect, when they are connected through a common third mechanism, such as offset credits. Third, linkages may differ in their degree, ranging from full linking, with unrestricted mutual recognition, to restricted linking, where the use of external allowances is subject to quantitative or qualitative limitations.

[7]Source: `https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:22021A0430(01)`.

[8]Sources: `https://www.reuters.com/world/uk/britain-considering-linking-with-eu-carbon-market-2025-03-20/`; `https://www.bbc.com/news/articles/cgk7zjdy34xo`; `https://ec.europa.eu/commission/presscorner/detail/ro/SPEECH_20_3`.

mate Change Levy (CCL) and Climate Change Agreements (CCAs).[9] CCL was a tax on fossil fuel users, and CCAs allowed participants to reduce their CCL payments by meeting sector-wide energy efficiency targets. Firms exceeding these targets could participate in the carbon market established by the UK ETS, providing additional flexibility and incentives.

The emissions trading component of the UK Climate Change Programme aimed to offer firms flexibility in achieving emissions reduction targets while positioning London's financial markets as the global hub for environmental trading. The scheme included 34 direct participants who committed to mandatory reduction targets in exchange for government subsidies. Additionally, approximately 6,000 firms involved in CCAs gained access to the UK ETS. The UK ETS significantly predated the launch of the EU ETS in 2005. The transition period saw an overlap between the two systems in 2005 and 2006; however, by 2007, UK ETS had been effectively phased out and replaced by the EU ETS. While the UK ETS remained voluntary, the mandatory nature of the EU ETS gave it precedence and ensured its eventual dominance.

The EU ETS covers around 10,000 installations in the energy and manufacturing sectors, along with aircraft operators flying within the EU and to Switzerland and the UK.[10] It is based on the "cap-and-trade" principle, where all installations associated with a liable entity must collectively comply with a specific limit on GHG emissions. Relatedly, European Union Allowances (EUAs) are carbon permits that enable the holder to emit one metric tonne of CO_2 or its equivalent. Firms that emit less than their allocated allowances can either retain the excess permits for future use or trade them to other participants facing a shortfall in allowances.

The EU ETS has evolved through successive phases with stricter targets (Dechezleprêtre et al., 2023, Pahle et al., 2025). Phase I (2005–2007) set the system's infrastructure and rules (Hintermann, 2010, Anderson and Di Maria, 2011). Phase II (2008–2012) aligned with the Kyoto Protocol and expanded participation (Hepburn et al., 2006, Hintermann et al., 2016). Phase III (2013–2020) introduced a single EU-wide cap, extended sectoral coverage, made auctioning the default allocation method (57% of allowances auctioned), and established the Market Stability Reserve (operational since 2019). Phase IV (2021–2030) reflects the EU's Green Deal and "Fit for 55" targets, aiming for a 55% emissions cut by 2030 (vs. 1990) and climate neutrality by 2050 (European Commis-

[9]Source: https://www.edf.org/sites/default/files/EDF_IETA_United_Kingdom_Case_Study_May_2013.pdf.

[10]Source: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/scope-eu-ets_en.

sion, 2020, 2021). Current reforms include expanding coverage to maritime shipping (2024) and road transport (ETS2), and implementing a Carbon Border Adjustment Mechanism (CBAM) to prevent carbon leakage (Mörsdorf, 2022).

The UK's formal withdrawal from the EU in 2020 impacted the EU ETS as a new UK ETS was established,[11] commencing operations in January 2021 and covering around 1,000 installations in the power and industrial sectors, as well as around 400 aircraft operators flying within the UK (including flights departing the UK to the European Economic Area (EEA) and Switzerland).[12] The UK ETS is closely modeled on the EU ETS, but it operates independently. This separation required adjustments to the EU ETS, particularly in how allowances were distributed and how the Market Stability Reserve managed the removal of surplus permits from the system after the UK's exit.[13] The establishment of the UK ETS necessitated the creation of the United Kingdom Allowances (UKAs), whose first auction took place on May 19, 2021. Figure A1 in the Appendix illustrates the price trends of UKAs compared to EUAs over the period May 19, 2021-December 31, 2023. At its inception, the UK ETS introduced a cap on allowances that was 5% lower than the UK's notional share under the EU ETS. This reduction made the UK ETS cap more stringent than the EU ETS[14], which initially adopted a linear reduction factor (LRF) of 2.2% per year, underscoring the UK's intent to accelerate emissions reductions beyond the EU's trajectory. Following the EU ETS, on December 18, 2023, the UK Government announced plans to introduce its carbon border adjustment mechanism (UK CBAM) and a carbon levy starting in 2027 (Lydgate and Winters, 2025).[15] Figure A2 in the Appendix compares the main characteristics of the UK ETS and the EU ETS.

[11] Northern Ireland electricity generators remain in the EU ETS under the Ireland/Northern Ireland Protocol.

[12] Source: https://www.gov.uk/government/publications/uk-emissions-trading-scheme-markets/uk-emissions-trading-scheme-markets.

[13] Source: https://assets.publishing.service.gov.uk/media/657c4d9595bf65001071908c/evaluation-of-uk-ets-phase-1-report.pdf.

[14] In Phase II, the cap was set at 6.5% below 2005 levels; in Phase III, a yearly linear reduction factor of 1.74% was introduced; in Phase IV, the reduction factor increased to 2.2% for 2021–2023, 4.3% for 2024–2027, and 4.4% for 2028–2030.

[15] Source: https://assets.publishing.service.gov.uk/media/672a00dfabb279b2de1e8b8a/_Updated__4038_-_Introduction_of_a_UK_Carbon_Border_Adjustment_Mechanism_from_January_2027_-_Government_response_to_the_policy_design_consultation.pdf.

3 Data

We build a comprehensive dataset for UK ETS and EU ETS firms utilizing various established data providers. First, we collect data from the European Union Transaction Log (EUTL) repository.[16] The repository provides information on annual allowance allocations and verified emissions for each installation, as well as allowance transactions between accounts.[17] Within the EUTL repository, allowance allocations and verified emissions at the installation level are available in the ”Compliance” section from 2005 to 2023. UK installations are covered from 2005 to 2020, before the transition to the UK ETS. Information regarding the accounts and how they are related to installations is retrieved from the ”Accounts” and ”Operator Holding Accounts” sections.

Concerning the UK ETS, we obtain data on annual allowance allocations and verified emissions from 2021 to 2023 from the UK Emissions Trading Registry.[18] Similarly to the EUTL repository, allowance allocations and verified emissions at the installation level are available under the ”Compliance Report Emissions and Surrenders” section. This section also indicates the Account Holder Name of each installation. We map firms in the UK ETS with those previously regulated within the EU ETS dataset based on the Account Holder Name. Installations that cannot be mapped exactly based on the Account Holder Name are matched using approximate string matching and then manually verified to ensure the accuracy of the mapping.

The sample used in the analysis spans the period 2013-2023, covering Phase III and partially Phase IV of the EU ETS, and Phase I of the UK ETS. Data are aggregated at the account holder level.

Next, we incorporate additional information at the firm level from Orbis, accessed through the Bureau van Dijk identifier (BvD id).[19] The collected information include regional locations (NUTS 2 and NUTS 3 levels) and the 4-digit NACE Rev.2 classification code. We also consider a number of accounting variables (in thousands of GBP), such as total assets, current assets, current liabilities, book value, intangible assets, EBIT, revenues, net income, long-term debt, number of employees, cash flow, total liabilities, and payables. We gather these variables annually from 2013 to 2023.

Our full sample consists of 366 UK ETS firms[20] and 8,641 EU ETS firms, mainly established

[16] The EUTL repository is available at: `https://ec.europa.eu/clima/ets/`.

[17] Each installation is required to open an operator holding account (OHA), which manages allowance transactions with other OHAs, government accounts, and voluntary participating entities. Each OHA is linked to an account holder, representing the firm that owns the installation and manages the underlying account.

[18] The UK Emissions Trading Registry is available at: `https://reports.view-emissions-trading-registry.service.gov.uk/ets-reports.html`.

[19] Source: `https://login.bvdinfo.com/R1/Orbis`.

[20] At the time of data collection, we identify 906 unique Account Holder Name within the Compliance Report - Emis-

in the manufacturing and energy sectors, as shown in Figure A3 in the Appendix. Table A1 in the Appendix exhibits descriptive statistics for verified emissions and accounting data on UK ETS (left panel) and EU ETS firms (right panel). To ensure data completeness and quality, we retain only firms with fully available accounting data for the pre-matching period. As a result, our final unmatched dataset comprises 213 UK ETS firms and 2,357 EU ETS firms, whose verified emissions account for approximately 71% and 40% of the total verified emissions in the full UK ETS and EU ETS samples, respectively.

Figure A4 in the Appendix shows the number of installations and the cumulative verified emissions by NUTS 3 regions in the UK over the period 2013-2023. The ten NUTS 3 regions with the highest number of installations and verified emissions are shown, respectively, in the left and right panels of Table A2 in the Appendix.

4 Methodology

In line with previous studies on causal inference in the EU ETS context (e.g., Dechezleprêtre et al. 2018, Colmer et al. 2024), we adopt a matched difference-in-differences (DiD) framework to estimate the causal impact of the UK's departure from the EU ETS on UK firms' carbon emissions. This framework allows us to compare the post-treatment outcomes of UK ETS firms (treated group) with a well-constructed counterfactual group of EU ETS firms (control group), thereby isolating the treatment effect from broader trends and unobserved heterogeneity. To ensure strong comparability between the treated and control units, we employ propensity score matching (PSM) based on a rich set of firm-level pre-treatment characteristics.

Specifically, we match UK ETS firms to EU ETS firms exactly on 4-digit NACE Rev.2 industry codes, ensuring alignment within sectors, thereby controlling for sector-specific shocks or regulatory heterogeneity. Within each sector, we use 1:1 nearest neighbor matching without replacement on a comprehensive set of accounting variables, such as total assets, current assets, current liabilities,

sions and Surrenders of the UK ETS Public Repository, including 445 Operator Holding Accounts and 462 Aircraft Operator Holding Accounts. We exclude from our analysis Aircraft Operator Holding Accounts since they entered the EU ETS framework only in 2013 and present peculiar characteristics. Among the Operator Holding Accounts, we exclude the following NACE sectors: "Data processing, hosting and related activities", "Defence activities", "Other research and experimental development on natural sciences and engineering", "Passenger air transport", "Repair and maintenance of aircraft and spacecraft", "Tertiary education", "Veterinary activities", and "Wired telecommunications activities". Overall, our 366 mapped UK ETS firms account for roughly 93% of the total verified emissions of UK ETS Operator Holding Accounts, excluding the above mentioned sectors.

book value, intangible assets, EBIT, revenues, net income, long-term debt, employees, cash flow, total liabilities, and payables, computed as averages over the 2013–2020 pre-treatment window.

We then implement a DiD regression on the matched sample, comparing the change in average carbon emissions of UK ETS firms before and after treatment with the corresponding change for their matched EU ETS counterparts. The DiD regression equation is given by:

$$Y_{it} = \gamma UK_{it} + \delta_i + \lambda_t + \epsilon_{it} \tag{1}$$

where Y_{it} is the outcome variable (carbon emissions) of firm i at time t, UK_{it} is a dummy variable equal to 1 for UK ETS firms post-treatment, δ_i controls for firm-level fixed effects and accounts for potential pre-treatment differences between UK and EU firms, λ_t represents time-fixed effects common to all firms, and ϵ_{it} is the residual term. Standard errors are clustered at the firm level.

5 Empirical results and discussion

5.1 Main Analysis

Table 1 presents the mean values of the accounting data for UK ETS and EU ETS firms before and after the PSM described in Section 4, along with the p-values for the differences in the means. Before matching, UK ETS and EU ETS firms exhibit statistically significant differences in cash flow, EBIT, number of employees, long-term debt, and payables. After matching, these differences are eliminated.

Insert Table 1 here.

Furthermore, Table A3 in the Appendix reports the p-values for the differences in the mean values of the accounting variables across matched UK ETS and EU ETS firms, assessed annually, in the pre-matching period. The consistently high p-values confirm successful matching across covariates and time. To complement this evidence, Table A4 in the Appendix reports standardized mean differences after matching. These indicate that covariate balance improves following the matching procedure, with most variables exhibiting differences below conventional threshold of 0.1.

To provide a more comprehensive assessment of the matching results for the full sample, Table A5 in the Appendix reports logit regression models of the treatment variable, equal to 1 for UK ETS firms and 0 for EU ETS firms, including an increasing set of accounting variables. Columns 1-4 show no significant differences between UK ETS and EU ETS firms, either before or after matching, for a subset of variables. However, Column 5 indicates significant pre-matching differences in long-term debt and payables (5% level), and in cash flow, EBIT, and employees (10% level). These differences disappear after matching (Column 6). Additionally, Figure A5 in the Appendix shows a substantial overlap in the distribution of propensity scores between EU and UK firms, further supporting the quality of the matching procedure.

The 190 matched UK ETS firms account for around 66% of verified emissions of all UK ETS firms included in our dataset.[21] Figure 1 illustrates the time trajectories of the average values of unscaled verified emissions for matched UK ETS and EU ETS firms. Over the analyzed period, both UK ETS and EU ETS firms exhibit a general decline in emissions, aligning with the environmental objectives of these climate policies. Before treatment, the emissions of UK and EU firms does not differ significantly, as shown by similar mean values and overlapping 95% confidence intervals. This parallel trend suggests a robust matching procedure with no statistically significant differences in emissions performance between matched UK ETS and EU ETS firms before treatment. After treatment, there is no statistically significant evidence to indicate that the UK's departure from the EU ETS has affected the emissions of UK firms relative to their EU counterparts. Such results are confirmed when computing the p-values of t-tests for differences in verified emissions between treated and control groups, which are consistently high across all years (see Table A6 in the Appendix). This indicates that the distributions of emissions are statistically similar between the two groups and suggests that, despite potential channels of divergence arising from institutional separation, UK firms and EU counterparts have exhibited similar emissions performance in the early stages of the UK ETS.

Insert Figure 1 here.

We then employ the DiD regression of Equation 1 to assess the causal impact of the UK's departure from the EU ETS on the emissions of the matched firms. The estimates of the γ coefficient are reported in column Full matched sample of Table A7 in the Appendix and Figure 2, and indicate that,

[21] In the full unmatched sample, UK ETS firms span 80 distinct 4-digit NACE sectors. The matching procedure leaves 23 UK firms unmatched and leads to the exclusion of 9 sectors. Among these, 4 belong to Section C - Manufacturing, namely NACE codes 2223 (Manufacture of builders' ware of plastic), 2432 (Cold rolling of narrow strip), 2446 (Processing of nuclear fuel), and 3299 (Other manufacturing n.e.c.). The remaining excluded firms operate in sectors labeled as "OTHER" in Figure A3 of the Appendix (e.g., NACE 0161, Support activities for crop production, within Section A - Agriculture, forestry and fishing).

both before and after the introduction of the UK ETS, emissions have remained statistically comparable. To assess the validity of the parallel trends assumption, we perform a joint Wald (F) test of the pre-treatment coefficients. The test fails to reject the null hypothesis that these coefficients are jointly equal to zero (F = 0.302, p-value = 0.921), indicating no evidence of differential pre-trends between treated and control firms prior to treatment. These results suggest that the emissions of UK firms have not diverged significantly from those of EU ETS-regulated firms following the introduction of the UK ETS.

Insert Figure 2 here.

We also complement the baseline DiD estimates with the Honest DiD procedure proposed by Rambachan and Roth (2023). This approach relaxes the strict parallel trends assumption by allowing for bounded deviations in pre-treatment trajectories. Figure A6 and Table A8 in the Appendix indicate that the estimated average treatment effects are consistent with the baseline findings.

These findings are derived from only three years of post-implementation of the UK ETS. Acknowledging the limitations inherent in the data, we perform a series of robustness checks, summarized in Section 5.2, to further corroborate our results. Specifically, Section 5.2.1 shows the results obtained for alternative measures of the outcome variable, such as emissions scaled by revenues, emissions scaled by total assets, and the reverse log transformation of emissions scaled by total assets. In Section 5.2.2, we perform several alternative specifications of the matching procedure, including calipers of 0.1 and 0.2, Mahalanobis regression distance, the nearest neighbor method with a 1:2 ratio, and matching with replacement. In Section 5.2.3, we repeat the DiD analysis by selecting three alternative matching periods: only year 2013, marking the beginning of our observation window and the start of Phase III of the EU ETS; 2013-2015, ending in the year preceding the EU referendum; and 2016-2020, namely the years between the EU referendum and the implementation of the UK ETS. Finally, Section 5.2.4 reports the outcomes of incorporating additional variables into the matching procedure, although this substantially reduces the sample size. For comparison, we also estimate a more parsimonious specification with fewer covariates, which allows us to retain a larger sample. All these variants are in agreement and corroborate the main findings.

Having shown that the implementation of the UK ETS has, for the time being, not significantly affected the emissions of regulated firms, we proceed to examine whether firms in the two most relevant sectors covered by the policy, namely, energy and manufacturing, have responded differently to the regulatory divergence stemming from the UK's departure from the EU ETS. Table A9 in the Appendix confirms successful matching across covariates and time, particularly for manufacturing firms, as p-values are above 0.10. For energy firms, while matching generally reduces differences across many variables, some differences remain in certain years in the Intangibles, Payables, and Revenues. However, in most cases, these differences are not statistically significant at the 5% level.

Figure 3 shows average emissions for matched energy and manufacturing firms in the UK ETS and EU ETS. The largest reduction in emissions in our matched sample is observed among energy firms (approximately -51% over 2013-2023), while manufacturing firms exhibit a smaller decline of about -35%.[22]

This more pronounced decline in the energy sector is consistent with a combination of structural policy changes and market dynamics in European electricity systems. In particular, the continued allocation of free allowances under the EU ETS to the manufacturing sector, aimed at mitigating carbon leakage concerns (De Beule et al. 2022, Wang and Kuusi 2024), contrasts with the situation of power plants, which generally need to purchase allowances (with some exceptions for firms located in lower-income Member States) and are typically short of allowances (Chèze et al. 2020).

Additionally, environmental regulation under the Industrial Emissions Directive (Directive 2010/75/EU),[23] together with the expansion of renewable energy under the Renewable Energy Directive (Directive (EU) 2018/2001),[24] and national coal phase-out policies (Rentier et al., 2019, Oei et al., 2020, Bang et al., 2022), have contributed to a progressive reduction in the carbon emissions of electricity generation (International Energy Agency 2023b). These policies have had a stronger impact on the energy sector, where emissions are directly linked to the fuel mix and firms can adjust production more flexibly in response to regulatory and price signals.

At the same time, the power sector is particularly responsive to changes in relative fuel and carbon prices. The interaction between carbon pricing and fossil fuel prices has reinforced fuel-switching dynamics, allowing firms to substitute across generation technologies in response to changing market conditions (Bai and Okullo 2023). This flexibility helps explain why emissions reductions are more

[22] Overall, considering the whole EU ETS, verified emissions from installations are around 47.6% below 2005 levels and well on track to achieve the 2030 target of -62%. Source: https://climate.ec.europa.eu/news-other-reads/news/2024-carbon-market-report-stable-and-well-functioning-market-driving-emissions-power-and-industry-2024-11-19_en?.

[23] Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32010L0075.

[24] Source: https://eur-lex.europa.eu/eli/dir/2018/2001/oj/eng.

pronounced in the energy sector than in manufacturing, where production processes are more rigid and firms continue to benefit from free allowance allocation.

Lastly, the recent energy crisis triggered by Russia's invasion of Ukraine introduced significant short-term volatility. The resulting gas supply shock led to sharp increases in natural gas prices and disruptions in European energy markets (International Energy Agency 2023a,b). In the short run, this contributed to some temporary reliance on more carbon-intensive generation in 2022, reflecting high gas prices and constraints on alternative generation sources.[25] However, over the medium term, the combination of carbon pricing, renewable expansion, and structural changes in electricity markets has continued to support a stronger decline in emissions in the power sector relative to manufacturing (Nissen et al., 2025).

Columns "Energy" and "Manufacturing" of Table A7 in the Appendix summarize the DID estimates from Equation 1, showing that emissions of matched firms remain comparable within each sector both before and after the introduction of the UK ETS.

Insert Figure 3 here.

5.2 Robustness analyses

5.2.1 Robustness checks on the outcome variable

Figure A7 in the Appendix reports results using alternative measures of environmental performance. Specifically, we consider carbon intensity defined as emissions scaled by revenues (in thousands of GBP; Panel A; see, e.g., Hart and Ahuja 1996, Iwata and Okada 2011), carbon intensity defined as emissions scaled by total assets (in thousands of GBP; Panel B; see, e.g., Aragón-Correa 1998, Wagner 2005, Misani and Pogutz 2015, Trumpp et al. 2015, Hsu et al. 2023), and the inverse log transformation of emissions scaled by total assets (Panel C; see, e.g., Flori et al. 2024). Table A10 in the Appendix summarizes the corresponding results of the difference-in-differences in the outcome variables for each robustness analysis and across all years. Consistent with the results in Section 5.1, we do not find any statistical evidence of divergence in the outcome variable between matched UK ETS and EU ETS firms.

[25] Source: https://climate.ec.europa.eu/news-other-reads/news/eu-carbon-market-continues-deliver-emission-reductions-2023-10-31_en.

5.2.2 Robustness checks on the PSM technique

We conduct a series of robustness checks to validate our matching procedure by testing variations in key matching parameters, including the matching ratio and distance. We also present results that incorporate a caliper and perform matching with replacement. These additional matching procedures reported in Table A11 in the Appendix confirm high p-values for differences in the mean values of the accounting variables across matched UK ETS and EU ETS firms, assessed annually.

Plots A and B of Figure A8 in the Appendix correspond to matching with a caliper of 0.1 and 0.2, respectively. Plot C represents matching with a 1:2 ratio, while Plot D is based on Mahalanobis distance. Plot E corresponds to matching with replacement. The results of the DiD are summarized in Table A12 and confirm the findings presented in the main analysis, reinforcing the robustness of our conclusions.

5.2.3 Robustness checks on the PSM period

We also examine variations in the matching period. As in previous analyses, we generally find high p-values for the differences in the mean values of the accounting variables between the matched UK ETS and EU ETS firms, assessed on an annual basis (see Table A13 in the Appendix).

Specifically, Plot A of Figure A9 designates 2013 as the starting year for analysis, Plot B considers the 2013-2015 period to capture emissions trends before the EU referendum, while Plot C considers the 2016-2020 period. The DiD results, summarized in Table A14 in the Appendix, remain consistent with our previous findings.

5.2.4 Robustness check on the PSM variables

We also perform a matching analysis in which we extend the set of accounting variables used in Section 5.1 by including return on equity (ROE), short-term bank debt, solvency ratio, cost of goods sold, cost of personnel, goodwill, fixed assets, financial interests, depreciation and amortization (D&A), receivables, and final products. While this enriched matching procedure allows us to combine a broader set of firm characteristics, it substantially reduces the size of the matched sample to 105 firms, which account for roughly 31% of total verified emissions.

Finally, we perform a matching analysis in which we include a subset of accounting variables used in Section 5.1, namely employees, net income, fixed assets, total liabilities, and cash flow. This parsimonious approach allows us to increase the size of the matched sample to 248 UK ETS firms and 3,424 EU ETS firms, whose verified emissions account for approximately 80% and 62% of the total verified emissions in the full UK ETS and EU ETS samples, respectively.

On both approaches, we confirm the high p-values for the differences in the mean values of the accounting variables between the matched UK ETS and EU ETS firms, assessed on an annual basis (see Table A15 in the Appendix). Figure A10 and Table A16 in the Appendix confirm similar time trajectories for matched UK ETS and EU ETS firms.

5.3 Discussion

Although linking ETSs can offer economic and environmental advantages (Flachsland et al., 2009b), particularly in the case of bilateral agreements (Mehling and Haites, 2009), its success depends on regulatory alignment, institutional quality, and geographic proximity (Evans and Wu, 2021). These considerations are especially relevant for a potential UK-EU ETS linkage.

At the same time, a growing strand of the literature emphasizes that linking is not the mirror image of de-linking. While linking aims to integrate heterogeneous systems to enhance efficiency and liquidity, de-linking may generate transitional frictions, institutional uncertainty, and potential inefficiencies (Pizer and Yates, 2015, Tol, 2018). Empirical evidence from the delinking of the New Zealand ETS from the Kyoto Protocol shows that institutional adjustments and policy credibility play a key role in shaping market outcomes (Kerr et al., 2021). More broadly, Borghesi and Zhu (2020) highlight that the effects of (de-)linking critically depend on the degree of regulatory alignment across systems, while Babonneau et al. (2018) discuss the potential welfare implications of a hard Brexit in the context of European climate policy.

In this respect, the UK case represents a distinctive form of de-linking under a high degree of regulatory continuity. The UK also played a crucial role in the EU ETS, having been one of the most active national registries and a key hub for the trading of allowances within the European system (Borghesi and Flori, 2019). This makes Brexit an unusual case relative to the standard literature, where de-linking typically involves substantial regulatory divergence. Against this background, our results suggest that, despite institutional separation, regulated firms under the two systems have demonstrated a comparable commitment to environmental performance and emissions reduction in the early stages following the UK's exit. This finding is consistent with the idea that, when regulatory alignment is strong, de-linking may not immediately translate into divergent emissions outcomes at the firm level.

Hence, our analysis contributes to the policy debate on the feasibility of a UK-EU carbon market link (Aarnio and de Vries, 2025). While the UK initially adopted a standalone ETS, the government is now actively exploring reconnection.[26] Political signals on both sides support this direction: Prime Minister Keir Starmer has prioritized climate cooperation with the EU,[27] and European Commission President Ursula von der Leyen has emphasized joint climate action.[28] The EC has also stressed the need for alignment in ambition levels, given past disparities in allowance prices. Consistent with this, UKA prices rose by 13% and 7% on January 28 and March 12, 2025, respectively,[29] reflecting expectations of linkage.[30] Momentum culminated at the EU-UK summit of May 19, 2025, where both sides agreed to pursue formal linkage.[31]

From a market perspective, integration would grant UK participants access to the deeper liquidity of the EU ETS (over 1.5 billion allowances vs. 156 million in the UK) and reduce administrative burdens for firms operating across jurisdictions. It could also mitigate carbon leakage and generate modest economic gains (around 0.1% of GDP in a linked scenario).[32] Regulatory coherence, especially in electricity markets, remains crucial to prevent carbon leakage (Zeng et al., 2018).

However, linkage negotiations are complex and time-consuming: the Swiss-EU agreement took nearly a decade,[33] and other attempts (e.g., with China and Australia) have not materialized (Li et al., 2019, Evans and Wu, 2021), despite potential benefits (Ranson and Stavins, 2016). Delays may therefore increase future barriers if regulatory divergence widens.

More broadly, a UK-EU ETS linkage could strengthen climate cooperation, foster a more integrated global carbon market, and reduce reliance on unilateral measures such as the CBAM. In this sense, it may represent a step toward a more coherent and cost-effective transition to net zero.[34]

[26] Source: https://www.reuters.com/world/uk/britain-considering-linking-with-eu-carbon-market-2025-03-20/.

[27] Source: https://www.bbc.com/news/articles/cgk7zjdy34xo.

[28] Source: https://ec.europa.eu/commission/presscorner/detail/ro/SPEECH_20_3.

[29] These developments fall outside our sample period (2013–2023) and are included for institutional context only.

[30] Sources: https://www.ft.com/content/f03d0e82-4527-4a2e-8df8-e744f6238952, https://www.spglobal.com/commodity-insights/en/news-research/latest-news/energy-transition/031225-uk-carbon-prices-rally-7-on-day-amid-news-of-eu-ets-linkage-considerations.

[31] Source: https://www.europarl.europa.eu/thinktank/it/document/EPRS_BRI(2025)775873.

[32] Source: https://www.gov.uk/government/publications/methodology-note-preliminary-economic-impacts-of-linking-the-uk-eu-emission-trading-schemes/methodology-note-assessing-the-preliminary-economic-impacts-of-linking-the-uk-eu-emission-trading-schemes.

[33] Source: https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6708.

[34] Source: https://publications.parliament.uk/pa/cm201415/cmselect/cmenergy/739/739

6 Conclusions

This study examines the early-stage impact of the UK's departure from the EU ETS on the carbon emissions of regulated firms following the introduction of the UK ETS. Employing a propensity score matching approach combined with a difference-in-differences framework, the results reveal no statistically significant differences in carbon emissions between firms regulated under the UK ETS and their counterparts in the EU ETS. These findings hold across multiple robustness checks, including alternative specifications of the outcome variable, as well as variations in the matching parameters and periods. This suggests that, in its initial years, the UK ETS firms have maintained emissions performances aligned with their EU ETS counterparts. However, it is important to note that the analysis is based only on three years of post-implementation emissions data and a longer observation period would be necessary to fully evaluate the long-term effects of such a policy shift.

We also find that energy firms consistently exhibit higher average carbon emissions than manufacturing firms. Notably, the most significant reductions in carbon emissions are observed within the energy sector of EU ETS firms, likely reflecting stronger regulatory incentives and greater technological capacity for emissions abatement.

The UK ETS has shown an ability to uphold its objectives in alignment with European standards despite challenges to the continuity of environmental goals. To ensure continued progress, policymakers should prioritize policies that address sectoral and regional disparities, promote technological innovation, and increase market confidence.

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Declaration of Interest

'Declarations of interest: none'.

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1 Tables

	Mean UK ETS pre-PSM	Mean EU ETS pre-PSM	p-value	Mean UK ETS post-PSM	Mean EU ETS post-PSM	p-value
Book Value	692, 370	425, 685	0.244	737, 625	665, 113	0.683
Cash Flow	78, 739	255, 218	0.093	79, 993	88, 480	0.181
Current Assets	644, 193	1, 304, 032	0.357	615, 380	433, 583	0.398
Current Liabilities	417, 156	1, 135, 315	0.272	398, 113	357, 944	0.319
EBIT	16, 683	129, 000	0.081	21, 892	51, 436	0.153
Employees	1, 483	4, 840	0.094	1, 416	2, 035	0.320
Intangibles	90, 333	400, 311	0.243	85, 338	129, 222	0.285
Long-term Debt	127, 436	659, 986	0.046	131, 569	218, 592	0.195
Net Income	25, 848	51, 372	0.368	27, 475	32, 689	0.543
Payables	80, 823	232, 818	0.039	76, 667	93, 156	0.182
Revenues	908, 255	2, 261, 570	0.210	852, 025	830, 116	0.231
Total Assets	1, 486, 927	3, 617, 217	0.263	1, 471, 061	1, 456, 310	0.498
Total Liabilities	749, 301	2, 452, 104	0.203	733, 436	791, 197	0.251
Number of firms	213	2,357		190	190	

Table 1: Mean values of the accounting variables for UK ETS and EU ETS firms pre- and post-PSM.

2 Figures

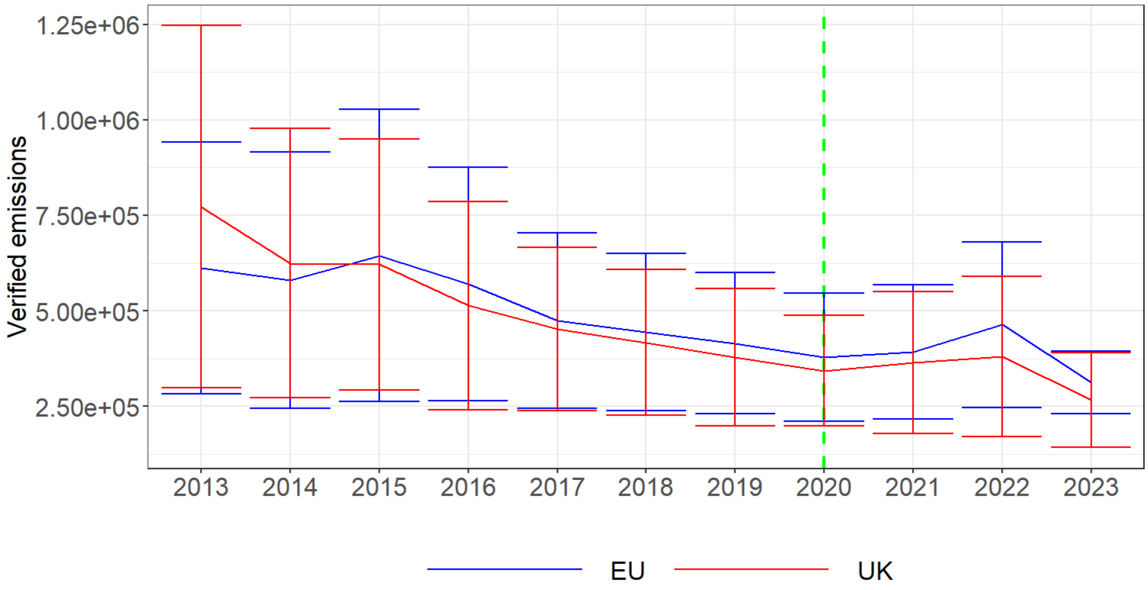


Figure 1: Propensity Score Matching is conducted based on the mean values of book value, cash flow, current assets, current liabilities, EBIT, number of employees, intangible assets, long-term debt, net income, payables, revenues, total assets, and total liabilities over the period 2013-2020. Firms are exactly matched according to the NACE Rev.2 code. Matching is performed without replacement using the nearest neighbor method, logistic regression distance, and a 1:1 ratio. The treatment occurs at the end of 2020 (indicated by the dashed green vertical line). Verified emissions are expressed in tCO_2e. Error bars represent 95% confidence intervals. The number of the matched firms is as follows: 190 for the full matched sample, 40 in the energy sector, 89 in manufacturing, and 61 in other industries.

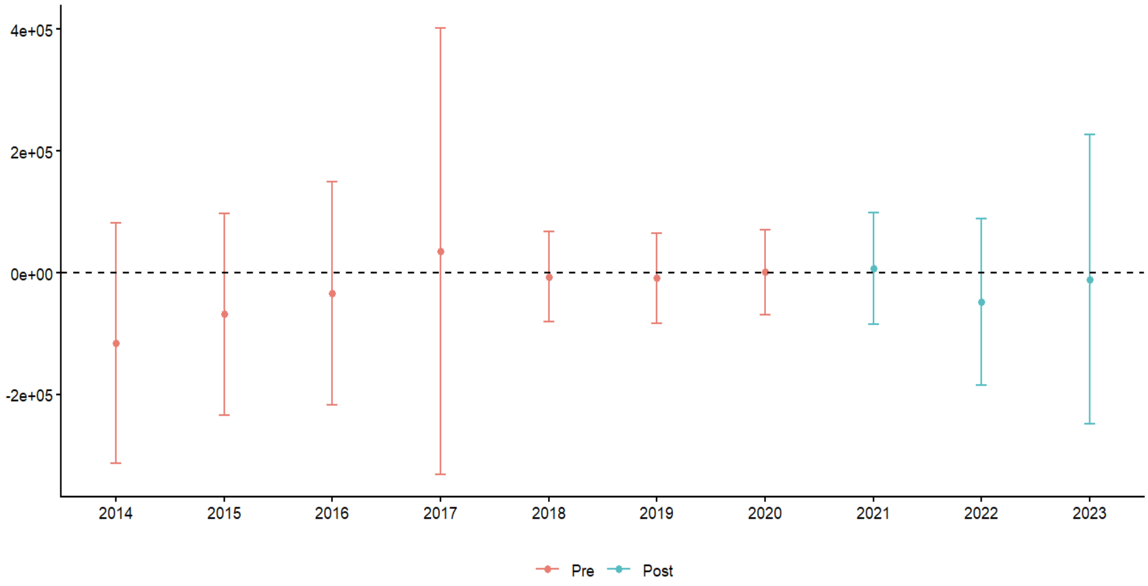
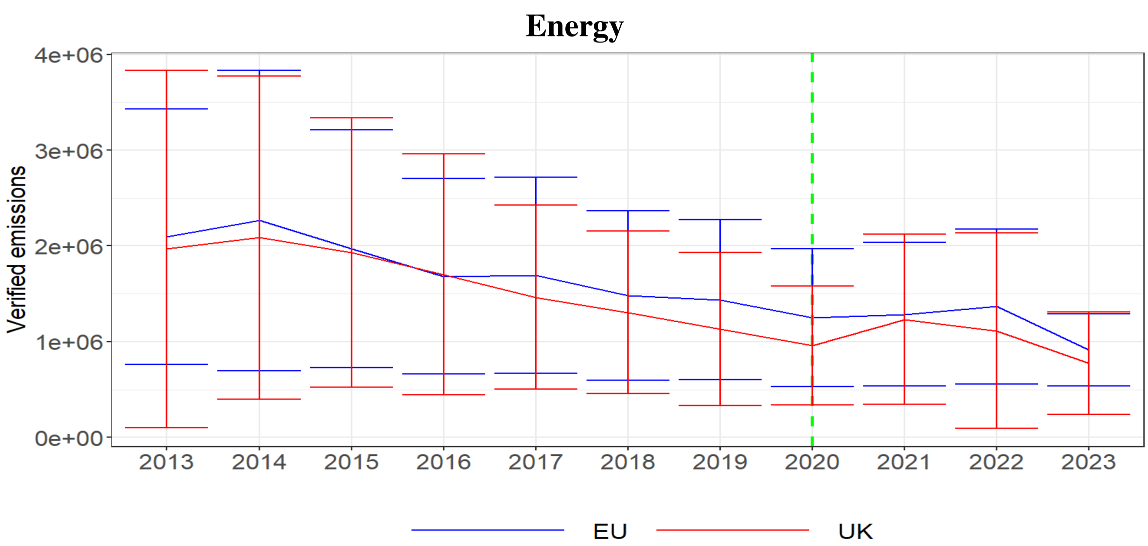


Figure 2: Difference-in-differences (γ coefficient) based on the PSM in Figure 1. The error bars represent 95% confidence intervals. We employ the *att_gt* function of the *did* package of R (see Callaway and Sant'Anna 2021).



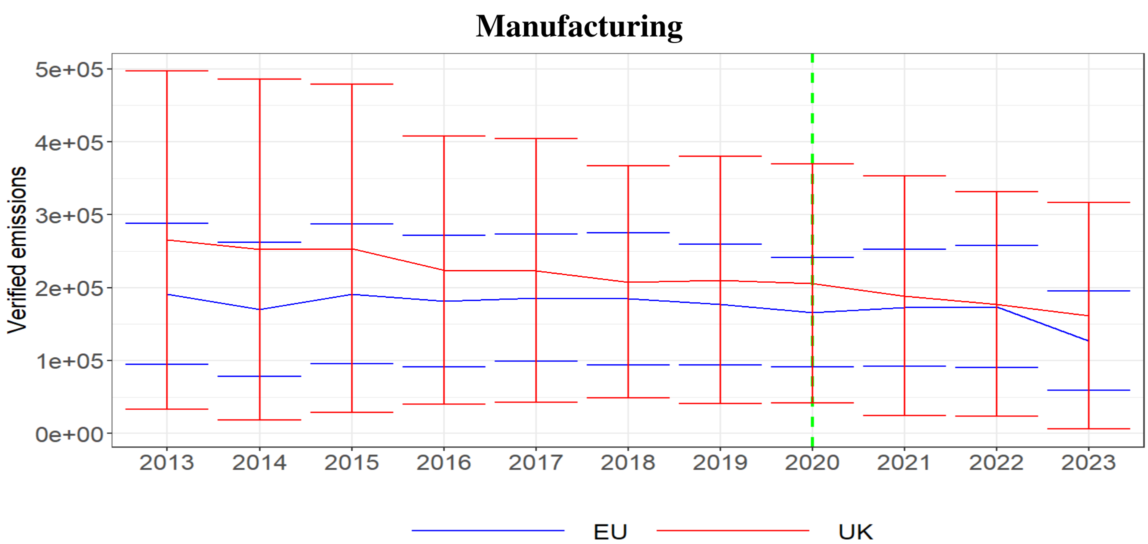


Figure 3: Heterogeneity analysis on energy and manufacturing sectors. Propensity Score Matching is conducted based on the mean values of book value, cash flow, current assets, current liabilities, EBIT, number of employees, intangible assets, long-term debt, net income, payables, revenues, total assets, and total liabilities over the period 2013-2020. Firms are exactly matched according to the NACE Rev.2 code. Matching is performed without replacement using the nearest neighbor method, logistic regression distance, and a 1:1 ratio. The treatment occurs at the end of 2020 (indicated by the dashed green vertical line). Verified emissions are expressed in tCO_2e. Error bars represent 95% confidence intervals. The number of the matched firms is as follows: 40 in the energy sector and 89 in manufacturing sector.

A Appendix

	UK ETS					EU ETS				
	Q1	Median	Q3	Mean	Std. Dev.	Q1	Median	Q3	Mean	Std. Dev.
Book Value	23.988	112.597	310.012	692,370	3,439,646	8.219	31.995	113.470	425,685	3,753,938
Cash Flow	6.665	21.010	63.399	78,739	563,754	1.160	5.549	20.271	255,218	946,995
Current Assets	47.772	120.196	382.511	644,193	2,644,353	10.858	34.170	110.172	1,304,032	4,925,305
Current Liabilities	34.062	95.614	320.244	417,156	1,157,998	7.330	24.554	84.299	1,135,315	4,284,866
EBIT	−0.439	9.220	32.951	16,683	371,751	0.229	2.537	11.570	129,000	791,126
Employees	164.750	523	1,218	1,483	3,011	69.692	212.938	613.911	4,840	19,044
Intangibles	0	1.394	13.694	90,333	508,699	0.045	0.341	2.372	400,311	1,863,767
Long-term Debt	0.958	10.907	74.198	127,436	400,817	0.253	3.720	23.993	659,986	2,941,703
Net Income	−0.077	7.429	27.511	25,848	549,092	0.002	1.455	7.956	51,372	478,373
Payables	4.986	16.548	45.794	80,823	306,524	2.366	8.404	27.488	232,818	772,775
Revenues	92.248	224.725	586.089	908,255	2,399,946	20.631	70.207	244.973	2,261,570	7,267,599
Total Assets	101.374	318.076	858.226	1,486,927	4,705,896	26.793	82.734	267.832	3,617,217	12,958,946
Total Liabilities	60.555	160.869	525.538	749,301	4,825,970	12.732	42.260	152.342	2,452,104	12,680,191
Verified Emissions	15,485	36,644	168,148	459,701	1,549,783	6,426	21,791	73,280	238,193	1,133,889
Number of firms			213					2,357		

Table A1: Descriptive statistics on accounting variables (in thousands of GBP) and verified emissions (in tCO_2e) of UK ETS and EU ETS firms in our sample over the period 2013-2023.

NUTS 3 region	Installations	NUTS 3 region	Verified emissions
Westminster	52	Swindon	203,596,022
Solihull	46	Solihull	112,100,080
Camden and City of London	39	Westminster	66,053,651
Berkshire	26	North and North East Lincolnshire	34,094,230
Lambeth	12	Camden and City of London	24,613,590
West Surrey	12	North Yorkshire CC	20,670,961
Swindon	12	Lambeth	20,544,734
Coventry	11	East Surrey	8,393,493
South Nottinghamshire	10	West Surrey	6,620,694
Edinburgh, City of	10	Cheshire West and Chester	6,580,700

Table A2: List of ten NUTS 3 regions with the highest number of installations and with the highest cumulative verified emissions (expressed in tCO_2e) in the UK in our sample over the period 2013-2023.

Year	Book Value	Cash Flow	Current Assets	Current Liabilities	EBIT	Employees	Intangibles	Long-term Debt	Net Income	Payables	Revenues	Total Assets	Total Liabilities
2013	0.164	0.121	0.207	0.255	0.113	0.281	0.230	0.134	0.257	0.113	0.155	0.172	0.162
2014	0.487	0.160	0.461	0.254	0.142	0.282	0.255	0.155	0.442	0.128	0.182	0.249	0.252
2015	0.646	0.196	0.531	0.370	0.665	0.318	0.319	0.153	0.139	0.199	0.211	0.315	0.322
2016	0.546	0.321	0.399	0.274	0.426	0.314	0.268	0.133	0.420	0.152	0.223	0.262	0.282
2017	0.514	0.158	0.362	0.268	0.097	0.310	0.275	0.193	0.209	0.133	0.186	0.274	0.277
2018	0.458	0.100	0.351	0.274	0.056	0.294	0.211	0.194	0.090	0.143	0.175	0.265	0.254
2019	0.366	0.266	0.277	0.255	0.124	0.292	0.218	0.203	0.989	0.123	0.210	0.241	0.262
2020	0.273	0.106	0.268	0.318	0.160	0.303	0.230	0.164	0.571	0.152	0.228	0.221	0.228

Table A3: P-values of the differences in the mean values of the accounting variables between matched UK ETS and EU ETS firms, presented year by year, in the pre-matching period, for the full matched sample of UK and EU ETS firms.

Variable	$\|SMD\|$
Distance	0.058
Book Value	0.040
Cash Flow	0.065
Current Assets	0.022
Current Liabilities	0.042
EBIT	0.054
Employees	0.031
Intangible	0.086
Long-term Debt	0.085
Net Income	0.004
Payables	0.124
Revenues	0.112
Total Assets	0.008
Total Liabilities	0.005

Table A4: Covariate balance after matching. The table reports absolute standardized mean differences (SMD) after matching. We employ the bal.tab function of the *cobalt* package of R.

	Dependent variable: Treatment					
	(pre-matching)	(post-matching)	(pre-matching)	(post-matching)	(pre-matching)	(post-matching)
Net Income	−0.306	−3.168	0.241	−3.208	0.059	−6.161
	(0.473)	(3.213)	(0.458)	(4.186)	(1.189)	(8.441)
Revenues	−0.005	0.224	0.053	0.241	0.099	0.184
	(0.033)	(0.158)	(0.046)	(0.213)	(0.068)	(0.328)
Total Assets	0.009	−0.117	−0.009	−0.069	0.057	−0.561
	(0.015)	(0.158)	(0.037)	(0.214)	(0.127)	(1.971)
Book Value			0.092	−0.262	−0.023	−0.213
			(0.058)	(0.869)	(0.157)	(1.754)
Cash Flow			−0.445	0.749	−1.416*	5.224
			(0.391)	(4.780)	(0.847)	(10.380)
Employees			−23.495	−30.987	−23.294*	−59.222
			(20.493)	(165.151)	(13.469)	(80.235)
Current Assets					0.461	−2.409
					(0.312)	(1.518)
Current Liabilities					−0.172	3.237
					(0.255)	(2.218)
EBIT					−3.370*	-2.146
					(1.914)	(2.034)
Intangibles					0.038	1.674
					(0.236)	(1.897)
Long-term Debt					−0.601**	−1.818
					(0.258)	(2.858)
Payables					−0.938**	−4.658
					(0.428)	(3.592)
Total Liabilities					−0.339	0.658
					(0.891)	(1.752)
Constant	−2.402***	−0.014	−2.414***	0.005	−2.430***	0.080
	(0.073)	(0.167)	(0.075)	(0.181)	(0.076)	(0.185)
Observations	2,570	380	2,570	380	2,570	380
Log Likelihood	−713.174	−119.877	−709.831	−119.816	−695.193	−115.024
Akaike Inf. Crit.	1,434.347	247.755	1,433.662	253.632	1,416.386	256.049
Note:						*p<0.1; **p<0.05; ***p<0.01

Table A5: Logit regression of the treatment variable on the accounting variables used for matching. The dependent variable is firm treatment status, equal to 1 for UK ETS firms and 0 for EU ETS firms. Odd-numbered columns report pre-matching results, whereas even-numbered columns present post-matching results.

Year	Full matched sample	Energy	Manufacturing
2013	0.583	0.909	0.558
2014	0.856	0.875	0.518
2015	0.928	0.965	0.613
2016	0.784	0.980	0.679
2017	0.894	0.741	0.709
2018	0.846	0.769	0.801
2019	0.781	0.591	0.725
2020	0.753	0.535	0.664
2021	0.831	0.926	0.861
2022	0.588	0.693	0.968
2023	0.702	0.814	0.687

Table A6: P-values of the differences in the mean values of verified emissions between matched UK ETS and EU ETS firms, presented year by year.

Year	Full matched sample	Energy	Manufacturing
2014	-115,656	-48,742	7,733
	[-283,381 ; 52,069]	[-1,031,336 ; 933,852]	[-21,763 ; 37,229]
	(0.177)	(0.923)	(0.607)
2015	-67,865	136,999	-19,558
	[-208,144 ; 72,414]	[-1,561,960 ; 1,835,958]	[-46,266 ; 7,150]
	(0.343)	(0.874)	(0.151)
2016	-33,961	61,475	-19,689
	[-189,000 ; 121,078]	[-618,671 ; 741,621]	[-80,162 ; 40,783]
	(0.668)	(0.859)	(0.523)
2017	35,773	-249,618	-4,937
	[-274,830 ; 346,375]	[-673,909 ; 174,673]	[-23,807 ; 13,934]
	(0.821)	(0.249)	(0.608)
2018	-6,268	51,350	-14,409
	[-69,523 ; 56,988]	[-321,849 ; 424,550]	[-42,606 ; 13,787]
	(0.846)	(0.787)	(0.317)
2019	-8,853	-129,217	10,268
	[-71,236 ; 53,530]	[-417,408 ; 158,973]	[-8,524 ; 29,060]
	(0.781)	(0.380)	(0.284)
2020	959	15,462	5,900
	[-58,323 ; 60,240]	[-283,357 ; 314,282]	[-23,891 ; 35,691]
	(0.975)	(0.919)	(0.698)
2021	7,789	238,083	-23,261
	[-69,906 ; 85,484]	[-146,223 ; 622,389]	[-62,750 ; 16,228]
	(0.844)	(0.226)	(0.192)
2022	-47,495	38,913	-35,851
	[-163,616 ; 68,625]	[-570,016 ; 647,843]	[-82,208 ; 10,506]
	(0.423)	(0.900)	(0.189)
2023	-10,507	24,404	-5,094
	[-211,999 ; 190,985]	[-920,225 ; 969,033]	[-59,360 ; 49,171]
	(0.919)	(0.960)	(0.854)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table A7: Difference-in-differences estimates (γ coefficient) for the full matched sample and for the energy and manufacturing subsamples. Standard errors are clustered at the firm level. Confidence intervals are reported in square brackets. P-values are reported in round brackets. Propensity Score Matching is performed using mean values of firm characteristics (book value, cash flow, current assets and liabilities, EBIT, employees, intangible assets, long-term debt, net income, payables, revenues, total assets, and total liabilities) over the period 2013–2020. Firms are exactly matched by NACE Rev. 2 code. Matching is conducted without replacement using nearest-neighbor matching (1:1) based on logistic propensity scores. The treatment occurs at the end of 2020.

M	Lower bound	Upper bound
0	-840,209	552,958
0.5	-1,615,786	1,328,535
1	-2,779,152	2,506,263
1.5	-4,028,693	3,741,442
2	-5,292,596	5,005,346

Table A8: Honest DiD sensitivity results. M is the parameter that bounds how much pre-treatment trends are allowed to deviate from perfect parallel trends. A larger M means that we allow for greater flexibility in pre-trends. Lower (upper) bound is the lower (upper) limit of the estimated treatment effect that remains valid under deviations up to M.

Year	Book Value	Cash Flow	Current Assets	Current Liabilities	EBIT	Employees	Intangibles	Long-term Debt	Net Income	Payables	Revenues	Total Assets	Total Liabilities
Panel A: Energy firms													
2013	0.224	0.154	0.266	0.327	0.152	0.109	0.134	0.146	0.190	0.117	0.130	0.196	0.187
2014	0.321	0.105	0.284	0.176	0.160	0.131	0.117	0.118	0.236	0.108	0.126	0.198	0.201
2015	0.356	0.154	0.198	0.207	0.280	0.161	0.043	0.124	0.187	0.077	0.074	0.206	0.196
2016	0.478	0.190	0.165	0.124	0.301	0.144	0.120	0.128	0.236	0.091	0.076	0.211	0.221
2017	0.479	0.134	0.149	0.104	0.118	0.163	0.052	0.155	0.132	0.074	0.075	0.229	0.240
2018	0.478	0.162	0.180	0.136	0.138	0.185	0.062	0.110	0.220	0.078	0.095	0.234	0.223
2019	0.497	0.161	0.179	0.114	0.137	0.180	0.060	0.105	0.261	0.065	0.097	0.230	0.235
2020	0.422	0.160	0.163	0.144	0.443	0.158	0.055	0.174	0.294	0.067	0.078	0.174	0.175
Panel B: Manufacturing firms													
2013	0.343	0.388	0.312	0.329	0.445	0.389	0.368	0.356	0.457	0.394	0.420	0.337	0.345
2014	0.352	0.421	0.320	0.337	0.466	0.359	0.380	0.342	0.468	0.400	0.436	0.344	0.348
2015	0.378	0.555	0.384	0.397	0.250	0.366	0.400	0.372	0.350	0.495	0.454	0.381	0.369
2016	0.317	0.366	0.328	0.343	0.394	0.362	0.391	0.376	0.318	0.405	0.428	0.347	0.371
2017	0.351	0.394	0.316	0.342	0.406	0.358	0.391	0.359	0.408	0.399	0.405	0.346	0.349
2018	0.316	0.255	0.311	0.347	0.185	0.342	0.365	0.352	0.156	0.436	0.380	0.336	0.356
2019	0.339	0.345	0.322	0.349	0.311	0.341	0.370	0.352	0.328	0.384	0.386	0.341	0.337
2020	0.318	0.295	0.352	0.411	0.210	0.348	0.356	0.329	0.163	0.403	0.377	0.350	0.359

Table A9: P-values of the differences in the mean values of the accounting variables between matched UK ETS and EU ETS firms, presented year by year, in the pre-matching period. The upper table (Panel A) is related to the energy sector, while the lower table (Panel B) pertains to the manufacturing sector.

Year	Carbon intensity (revenues)	Carbon intensity (total assets)	Reverse log carbon intensity (total assets)
2014	-0.319	−0.010	0.029
	(0.437)	(0.964)	(0.805)
2015	0.100	−0.028	-0.012
	(0.854)	(0.853)	(0.911)
2016	0.015	0.017	0.011
	(0.961)	(0.931)	(0.904)
2017	0.262	0.041	-0.151
	(0.537)	(0.673)	(0.086)
2018	-0.461	−0.032	0.095
	(0.259)	(0.731)	(0.372)
2019	0.004	−0.081	0.003
	(0.975)	(0.205)	(0.971)
2020	0.243	0.033	-0.038
	(0.388)	(0.778)	(0.712)
2021	0.120	−0.079	0.081
	(0.538)	(0.253)	(0.435)
2022	0.019	0.076	0.103
	(0.933)	(0.372)	(0.540)
2023	-0.025	0.089	-0.063
	(0.912)	(0.377)	(0.775)

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table A10: Difference-in-differences (γ coefficient) for matched firms based on propensity score matching presented in Figure A7. P-values are reported in round brackets.

Year	Book Value	Cash Flow	Current Assets	Current Liabilities	EBIT	Employees	Intangibles	Long-term Debt	Net Income	Payables	Revenues	Total Assets	Total Liabilities
Panel A: Caliper = 0.1													
2013	0.292	0.393	0.368	0.401	0.445	0.380	0.341	0.335	0.469	0.415	0.432	0.343	0.312
2014	0.318	0.456	0.398	0.418	0.526	0.385	0.363	0.334	0.525	0.450	0.465	0.366	0.341
2015	0.350	0.528	0.386	0.405	0.072	0.376	0.379	0.360	0.188	0.461	0.439	0.373	0.395
2016	0.290	0.414	0.380	0.388	0.471	0.376	0.367	0.370	0.447	0.426	0.424	0.360	0.367
2017	0.344	0.464	0.378	0.402	0.511	0.379	0.382	0.370	0.544	0.433	0.424	0.370	0.399
2018	0.324	0.308	0.368	0.401	0.245	0.367	0.351	0.356	0.217	0.447	0.410	0.359	0.369
2019	0.350	0.396	0.380	0.406	0.361	0.365	0.365	0.358	0.422	0.408	0.423	0.368	0.353
2020	0.331	0.323	0.382	0.427	0.263	0.368	0.357	0.337	0.207	0.404	0.414	0.363	0.327
Panel B: Caliper = 0.2													
2013	0.274	0.387	0.366	0.385	0.463	0.372	0.327	0.331	0.472	0.388	0.404	0.332	0.345
2014	0.309	0.472	0.401	0.411	0.575	0.377	0.350	0.332	0.577	0.426	0.441	0.360	0.374
2015	0.355	0.530	0.389	0.404	0.039	0.366	0.366	0.352	0.172	0.432	0.420	0.372	0.386
2016	0.278	0.367	0.380	0.384	0.446	0.366	0.358	0.358	0.257	0.400	0.404	0.354	0.369
2017	0.335	0.459	0.376	0.399	0.514	0.370	0.374	0.361	0.555	0.403	0.400	0.364	0.378
2018	0.316	0.297	0.369	0.394	0.245	0.358	0.341	0.356	0.208	0.428	0.393	0.354	0.367
2019	0.347	0.388	0.383	0.398	0.366	0.356	0.350	0.356	0.418	0.380	0.409	0.364	0.381
2020	0.324	0.303	0.384	0.415	0.302	0.360	0.340	0.338	0.181	0.373	0.400	0.358	0.372
Panel C: 1:2 ratio													
2013	0.517	0.192	0.555	0.328	0.172	0.261	0.269	0.193	0.422	0.089	0.188	0.340	0.354
2014	0.756	0.344	0.668	0.311	0.185	0.273	0.312	0.263	0.565	0.110	0.260	0.416	0.431
2015	0.985	0.700	0.847	0.518	0.486	0.360	0.403	0.260	0.121	0.238	0.337	0.548	0.566
2016	0.828	0.662	0.585	0.333	0.304	0.349	0.326	0.238	0.515	0.140	0.327	0.429	0.445
2017	0.863	0.357	0.538	0.336	0.234	0.353	0.333	0.258	0.538	0.146	0.272	0.448	0.464
2018	0.819	0.224	0.513	0.331	0.124	0.331	0.284	0.257	0.313	0.153	0.276	0.435	0.451
2019	0.662	0.567	0.370	0.323	0.276	0.326	0.319	0.284	0.482	0.195	0.310	0.394	0.410
2020	0.477	0.161	0.393	0.474	0.166	0.348	0.318	0.217	0.613	0.174	0.344	0.364	0.380
Panel D: Mahalanobis distance													
2013	0.766	0.456	0.784	0.530	0.478	0.364	0.285	0.370	0.578	0.374	0.459	0.554	0.569
2014	0.950	0.575	0.856	0.513	0.430	0.368	0.299	0.404	0.472	0.413	0.512	0.604	0.621
2015	0.895	0.747	0.775	0.520	0.892	0.360	0.333	0.395	0.466	0.441	0.462	0.626	0.644
2016	0.941	0.710	0.665	0.437	0.401	0.364	0.298	0.392	0.991	0.384	0.437	0.548	0.563
2017	0.888	0.536	0.620	0.446	0.528	0.365	0.306	0.391	0.622	0.388	0.424	0.546	0.560
2018	0.843	0.436	0.592	0.443	0.338	0.355	0.275	0.384	0.435	0.387	0.437	0.527	0.541
2019	0.727	0.642	0.498	0.451	0.511	0.355	0.295	0.388	0.823	0.456	0.456	0.508	0.523
2020	0.534	0.200	0.450	0.473	0.095	0.364	0.294	0.351	0.084	0.361	0.427	0.450	0.465
Panel E: Matching with replacement													
2013	0.752	0.468	0.769	0.544	0.462	0.371	0.291	0.365	0.562	0.382	0.447	0.538	0.521
2014	0.934	0.589	0.841	0.528	0.415	0.375	0.305	0.398	0.458	0.421	0.498	0.588	0.562
2015	0.879	0.732	0.761	0.534	0.876	0.367	0.341	0.389	0.451	0.433	0.448	0.609	0.582
2016	0.927	0.695	0.652	0.451	0.387	0.371	0.306	0.385	0.973	0.392	0.421	0.533	0.507
2017	0.871	0.549	0.607	0.459	0.512	0.372	0.314	0.385	0.608	0.395	0.410	0.531	0.498
2018	0.829	0.448	0.579	0.457	0.321	0.362	0.282	0.378	0.419	0.395	0.421	0.512	0.486
2019	0.713	0.656	0.486	0.463	0.498	0.362	0.302	0.381	0.807	0.463	0.441	0.494	0.468
2020	0.521	0.214	0.439	0.486	0.082	0.371	0.302	0.344	0.071	0.368	0.412	0.437	0.402

Table A11: P-values for the differences in mean values of the accounting variables between matched UK ETS and EU ETS firms, reported year by year.

Year	Caliper = 0.1	Caliper = 0.2	1:2 ratio	Mahalanobis distance	Matching with replacement
2014	-55,658	-41,989	-82,800	-47,640	-107,803
	(0.607)	(0.655)	(0.289)	(0.539)	(0.194)
2015	-63,536	-17,786	-34,839	-880	-62,925
	(0.254)	(0.830)	(0.585)	(0.990)	(0.354)
2016	-17,970	17,897	-25,626	-74,900	-34,557
	(0.775)	(0.788)	(0.708)	(0.137)	(0.675)
2017	-18,691	-50,691	-20,038	-61,018	58,586
	(0.498)	(0.171)	(0.828)	(0.167)	(0.758)
2018	8,935	29,641	-345	-12,626	6,718
	(0.819)	(0.413)	(0.989)	(0.533)	(0.858)
2019	-1,197	973	-24,716	-17,744	-15,909
	(0.939)	(0.975)	(0.394)	(0.406)	(0.629)
2020	24,681	18,390	14,942	-34,492	-5,827
	(0.149)	(0.329)	(0.611)	(0.254)	(0.843)
2021	-13,184	-1,564	-7,373	77,126	8,405
	(0.546)	(0.970)	(0.845)	(0.105)	(0.832)
2022	-64,067	-53,845	-58,700	20,582	-42,483
	(0.293)	(0.371)	(0.349)	(0.831)	(0.483)
2023	43,848	92,252	67,425	68,892	50,309
	(0.446)	(0.150)	(0.392)	(0.494)	(0.539)

Note: *p<0.1; **p<0.05; ***p<0.01

Table A12: Difference-in-differences (γ coefficient) based on propensity score matching presented in Figure A8. P-values are reported in round brackets.

Year	Book Value	Cash Flow	Current Assets	Current Liabilities	EBIT	Employees	Intangibles	Long-term Debt	Net Income	Payables	Revenues	Total Assets	Total Liabilities
Panel A: Matching in 2013													
2013	0.810	0.283	0.718	0.381	0.260	0.273	0.486	0.162	0.468	0.305	0.374	0.385	0.384
2014	0.994	0.328	0.725	0.318	0.178	0.268	0.685	0.169	0.293	0.273	0.390	0.402	0.342
2015	0.971	0.259	0.633	0.347	0.152	0.261	0.836	0.162	0.232	0.311	0.326	0.427	0.361
2016	0.882	0.420	0.476	0.243	0.176	0.278	0.604	0.167	0.598	0.235	0.296	0.344	0.292
2017	0.796	0.280	0.412	0.241	0.211	0.271	0.500	0.165	0.240	0.215	0.273	0.329	0.280
2018	0.635	0.171	0.316	0.220	0.118	0.243	0.283	0.178	0.164	0.225	0.262	0.284	0.264
2019	0.514	0.450	0.230	0.226	0.220	0.234	0.339	0.179	0.754	0.303	0.262	0.266	0.288
2020	0.393	0.070	0.236	0.259	0.051	0.255	0.364	0.158	0.064	0.212	0.245	0.241	0.242
Panel B: Matching in 2013-2015													
2013	0.139	0.169	0.188	0.147	0.152	0.136	0.173	0.070	0.100	0.150	0.167	0.114	0.121
2014	0.189	0.186	0.200	0.131	0.174	0.140	0.187	0.088	0.210	0.157	0.081	0.124	0.132
2015	0.274	0.141	0.238	0.176	0.649	0.185	0.230	0.093	0.478	0.186	0.109	0.154	0.163
2016	0.209	0.164	0.198	0.167	0.130	0.186	0.199	0.081	0.623	0.171	0.114	0.139	0.147
2017	0.219	0.105	0.187	0.159	0.173	0.190	0.195	0.099	0.132	0.174	0.098	0.145	0.153
2018	0.205	0.172	0.177	0.147	0.144	0.184	0.182	0.106	0.176	0.167	0.195	0.141	0.149
2019	0.180	0.180	0.151	0.143	0.131	0.185	0.198	0.118	0.957	0.084	0.111	0.137	0.145
2020	0.140	0.106	0.144	0.170	0.108	0.190	0.196	0.098	0.726	0.176	0.125	0.129	0.138
Panel C: Matching in 2016-2020													
2013	0.172	0.115	0.214	0.247	0.120	0.289	0.224	0.141	0.265	0.118	0.162	0.179	0.169
2014	0.492	0.168	0.455	0.263	0.149	0.276	0.249	0.162	0.435	0.134	0.176	0.256	0.259
2015	0.639	0.205	0.538	0.362	0.657	0.325	0.327	0.147	0.145	0.191	0.218	0.308	0.314
2016	0.552	0.315	0.392	0.282	0.433	0.307	0.272	0.138	0.412	0.158	0.217	0.268	0.289
2017	0.507	0.164	0.356	0.275	0.102	0.317	0.269	0.186	0.216	0.127	0.193	0.281	0.270
2018	0.463	0.094	0.344	0.268	0.061	0.288	0.205	0.201	0.196	0.137	0.182	0.258	0.248
2019	0.373	0.259	0.283	0.248	0.118	0.299	0.225	0.197	0.582	0.129	0.216	0.247	0.269
2020	0.266	0.112	0.274	0.311	0.154	0.296	0.238	0.171	0.565	0.146	0.234	0.228	0.221

Table A13: P-values for the differences in mean values of the accounting variables between matched UK ETS and EU ETS firms, reported year by year.

Year	2013	2013-2015	2016-2020
2014	-53,365	-15,123	-11,980
	(0.281)	(0.786)	(0.797)
2015	-70,506	11,281	-4,636
	(0.386)	(0.840)	(0.944)
2016	-134,584	-42,505	-19,998
	(0.314)	(0.271)	(0.770)
2017	-176,582	-103,821	24,037
	(0.202)	(0.050)	(0.873)
2018	-178,374	-76,589	-173
	(0.228)	(0.199)	(0.994)
2019	-211,586	-76,674	-4,942
	(0.201)	(0.275)	(0.937)
2020	-187,610	-67,655	35,176
	(0.265)	(0.390)	(0.430)
2021	-171,622	-37,946	25,451
	(0.294)	(0.617)	(0.527)
2022	-214,812	-39,312	-60,137
	(0.202)	(0.624)	(0.319)
2023	-226,346	-69,083	-25,989
	(0.255)	(0.617)	(0.791)
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table A14: Difference-in-differences (γ coefficient) based on propensity score matching presented in Figure A9. P-values are reported in round brackets.

Year	BV	CA	CF	CL	COGS	D&A	EBIT	Employees	FA	FI	FP	Goodwill	Intangibles	Lt Debt	NI	Payables	Personnel	Receivables	Revenues	ROE	SR	St Bank Debt	TA	TL
Panel A: Matching with more variables																								
2013	0.142	0.189	0.298	0.231	0.372	0.281	0.101	0.255	0.302	0.163	0.144	0.182	0.209	0.125	0.196	0.092	0.333	0.162	0.141	0.072	0.284	0.118	0.158	0.149
2014	0.421	0.389	0.143	0.272	0.411	0.097	0.121	0.243	0.355	0.171	0.152	0.209	0.247	0.142	0.354	0.115	0.366	0.183	0.174	0.088	0.298	0.134	0.236	0.228
2015	0.572	0.418	0.182	0.351	0.465	0.132	0.582	0.281	0.384	0.185	0.166	0.225	0.302	0.173	0.118	0.164	0.391	0.207	0.202	0.099	0.325	0.152	0.298	0.307
2016	0.488	0.354	0.289	0.241	0.429	0.145	0.368	0.277	0.342	0.179	0.174	0.214	0.251	0.124	0.365	0.138	0.348	0.198	0.183	0.086	0.309	0.139	0.254	0.263
2017	0.451	0.315	0.139	0.228	0.384	0.192	0.189	0.266	0.318	0.177	0.151	0.197	0.239	0.182	0.192	0.121	0.323	0.173	0.167	0.078	0.287	0.121	0.247	0.236
2018	0.402	0.291	0.184	0.243	0.355	0.068	0.147	0.249	0.294	0.159	0.137	0.174	0.198	0.176	0.081	0.108	0.297	0.158	0.154	0.067	0.272	0.109	0.229	0.218
2019	0.312	0.274	0.221	0.211	0.389	0.121	0.102	0.263	0.322	0.173	0.148	0.183	0.214	0.191	0.784	0.114	0.341	0.186	0.171	0.084	0.295	0.126	0.238	0.248
2020	0.238	0.247	0.092	0.289	0.421	0.109	0.139	0.271	0.335	0.166	0.156	0.191	0.229	0.154	0.441	0.132	0.362	0.177	0.163	0.191	0.306	0.138	0.217	0.209
Panel B: Matching with fewer variables																								
2013			0.320					0.300	0.340						0.220									0.180
2014			0.180					0.270	0.380						0.390									0.260
2015			0.240					0.310	0.410						0.160									0.330
2016			0.330					0.300	0.370						0.410									0.290
2017			0.180					0.290	0.340						0.210									0.260
2018			0.210					0.260	0.310						0.130									0.230
2019			0.260					0.300	0.340						0.820									0.280
2020			0.140					0.280	0.360						0.450									0.240

Table A15: P-values of the differences in the mean values of the accounting variables between matched UK ETS and EU ETS firms, presented year by year in the pre-matching period. Panel A reports the matching specification with the full set of variables, while Panel B reports the parsimonious specification based on cash flow, employees, fixed assets, net income, and total liabilities.

Year	Matching with more variables	Matching with fewer variables
2014	-75,897	-62,001
	(0.343)	(0.436)
2015	50,483	93,535
	(0.647)	(0.423)
2016	-51,528	-81,148
	(0.503)	(0.291)
2017	28,557	62,933
	(0.856)	(0.692)
2018	-19,618	17,255
	(0.422)	(0.622)
2019	-15,622	4,535
	(0.605)	(0.912)
2020	-4,647	32,620
	(0.879)	(0.394)
2021	4,132	-45,541
	(0.914)	(0.388)
2022	-59,372	-44,966
	(0.300)	(0.602)
2023	-35,916	11,885
	(0.709)	(0.894)
Note:		*p$<$0.1; **p$<$0.05; ***p$<$0.01

Table A16: Difference-in-differences estimates using alternative matching specifications. P-values are reported in round brackets.

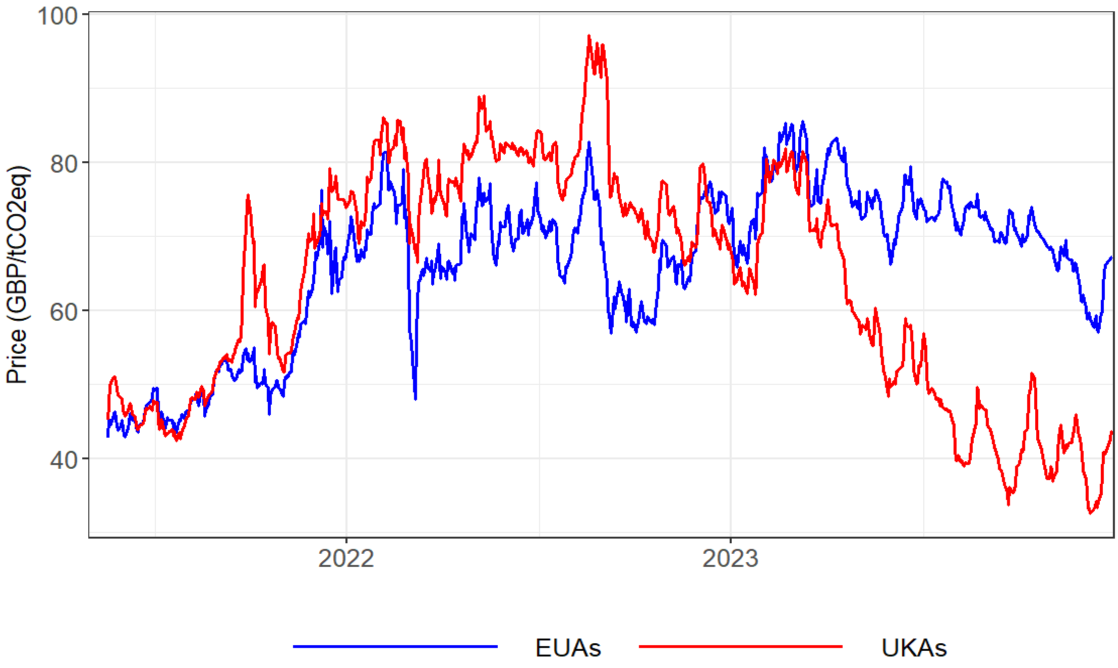


Figure A1: European Union Allowances vs. United Kingdom Allowances prices (GBP/tCO_2e) over May 19, 2021-December 31, 2023.

UK ETS	EU ETS
Coverage Covers around 1,000 installations in the power and industrial sectors, and approximately 400 aircraft operators flying within the UK and to the EEA and Switzerland.	**Coverage** Covers about 10,000 installations across energy and manufacturing sectors, as well as aircraft operators flying within the EU and to Switzerland and the UK. From 2024, includes maritime transport emissions.
Cap Reduction Initially set at 156 million allowances (i.e., 5% below the UK's notional share of the EU ETS cap for its fourth phase). Cap reset to 936 million allowances for 2021–2030 to align with net-zero targets. 53.5 million unallocated allowances to be auctioned between 2023–2027.	**Cap Reduction** Cap reduced by 117 million allowances across two years (two one-off rebasings: –90 million in 2024 and –27 million in 2026). Annual Linear Reduction Factor (LRF): 4.3% (2024–2027), 4.4% (2028–2030).
Auctioning of Allowances Conducted by ICE Futures Europe. Open to UK-based account holders. Includes a Transitional Auction Reserve Price (£22/tonne). Revenues go to the UK Exchequer (not earmarked). Cost Containment Mechanism (CCM) can intervene during price surges.	**Auctioning of Allowances** Conducted by European Energy Exchange (EEX). Open to all EU ETS participants. No fixed reserve price, but uses an MSR to manage surplus. Revenues must be used for climate and energy; EU-level funds support the Innovation Fund and Modernisation Fund. Structured CCM based on multi-year price thresholds.
Free Allocation Free allocation review launched in Dec 2023 to revise allocation methodology. Granted to sectors at risk of carbon leakage, based on product benchmarks. Power generators generally excluded. Phase-out of free allocation aligned with the introduction of UK CBAM (from 2027).	**Free Allocation** Free allocation gradually phased out (2026–2034) for sectors covered by the EU CBAM. Benchmark-based allocation for industrial sectors at risk of carbon leakage. Power generators are excluded from free allocation (with some exceptions). Free allowances phased out for CBAM sectors from 2026 to 2034.
Sectoral Expansion • Domestic maritime: from 2026 • Waste incineration: from 2028 (monitoring from 2026) • Upstream oil and gas CO_2 venting	**Sectoral Expansion** • Maritime: phased in 2024–2026 (100% intra-EU, 50% extra-EU voyages) • Waste incineration: inclusion from 2028, opt-out until 2030 • EU ETS 2: buildings and road transport from 2027

Figure A2: Comparison between the UK ETS and the EU ETS.

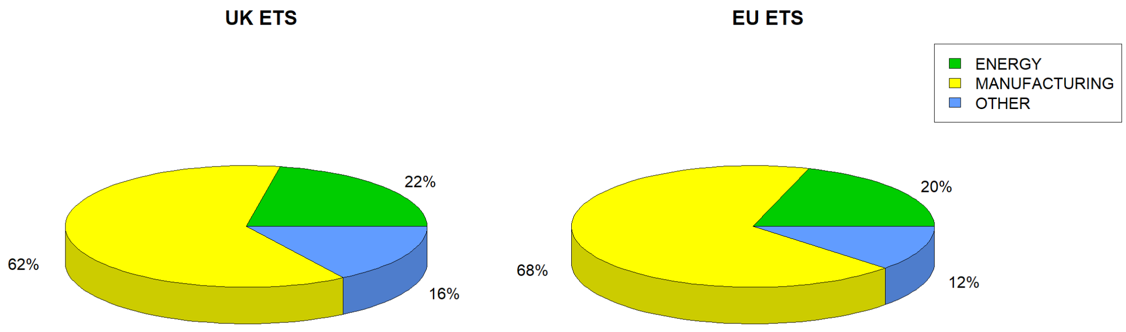


Figure A3: Sector composition in our sample of the UK ETS and EU ETS firms over the period 2013-2023. The “Other” category comprises residual sectors, including ”Mining and Quarrying” and ”Construction”.

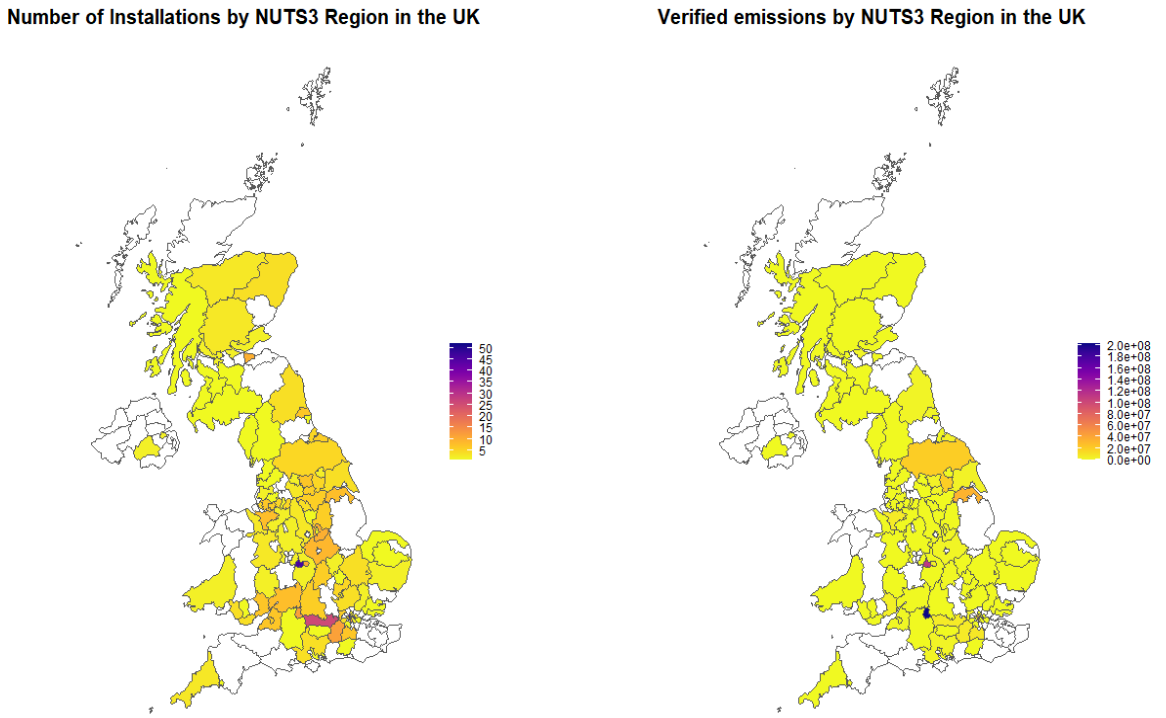


Figure A4: Number of installations and verified emissions (in tCO_2e) by NUTS 3 regions in the UK over the period 2013-2023 in our sample.

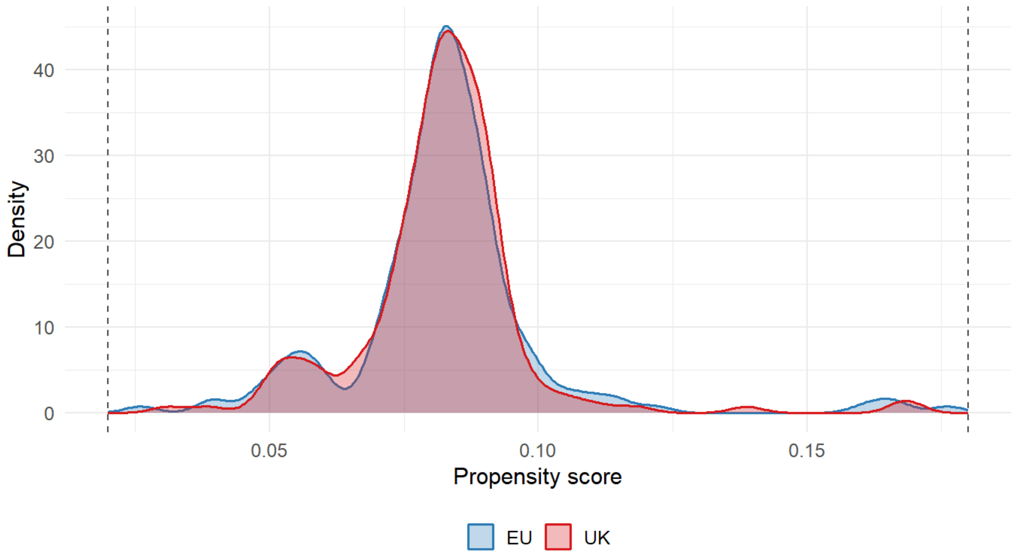


Figure A5: Distribution of propensity scores for EU and UK firms after matching.

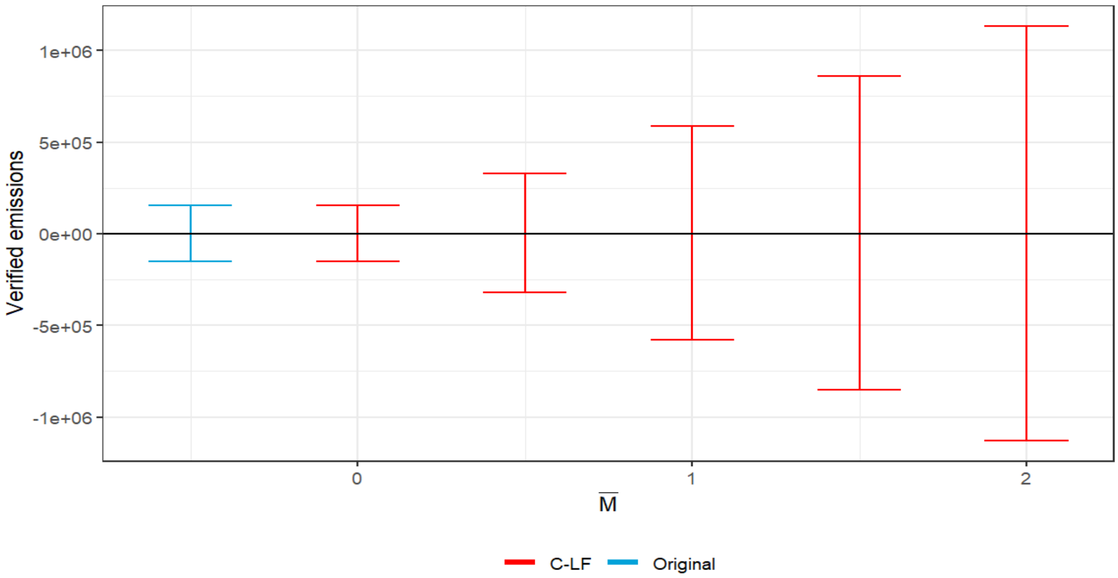


Figure A6: Robustness on the parallel trends assumption of the matching sample performed in Section 5.1. We employ the *createSensitivityResults_relativeMagnitudes* function of the *HonestDiD* package of R (see Rambachan and Roth 2023). The post-treatment effect is estimated as the average over 2021-2023.

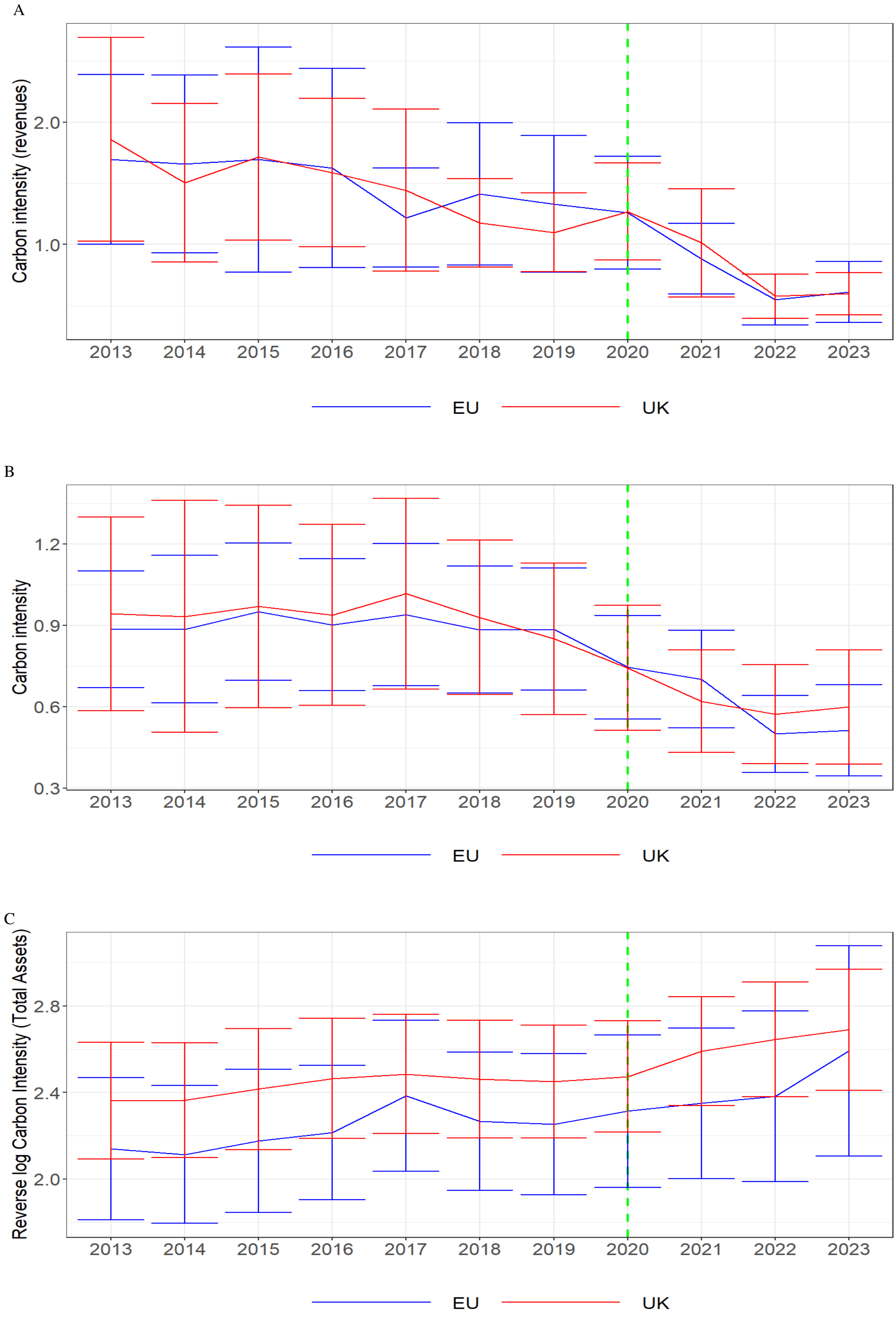


Figure A7: Robustness on the outcome variable of the PSM performed in Section 5.1. Error bars represent 95% confidence intervals. Labels A, B, and C represent, respectively, the carbon intensity based on revenues, the carbon intensity based on total assets, and the reverse log transformation of the carbon intensity (based on total assets) of the matched firms.

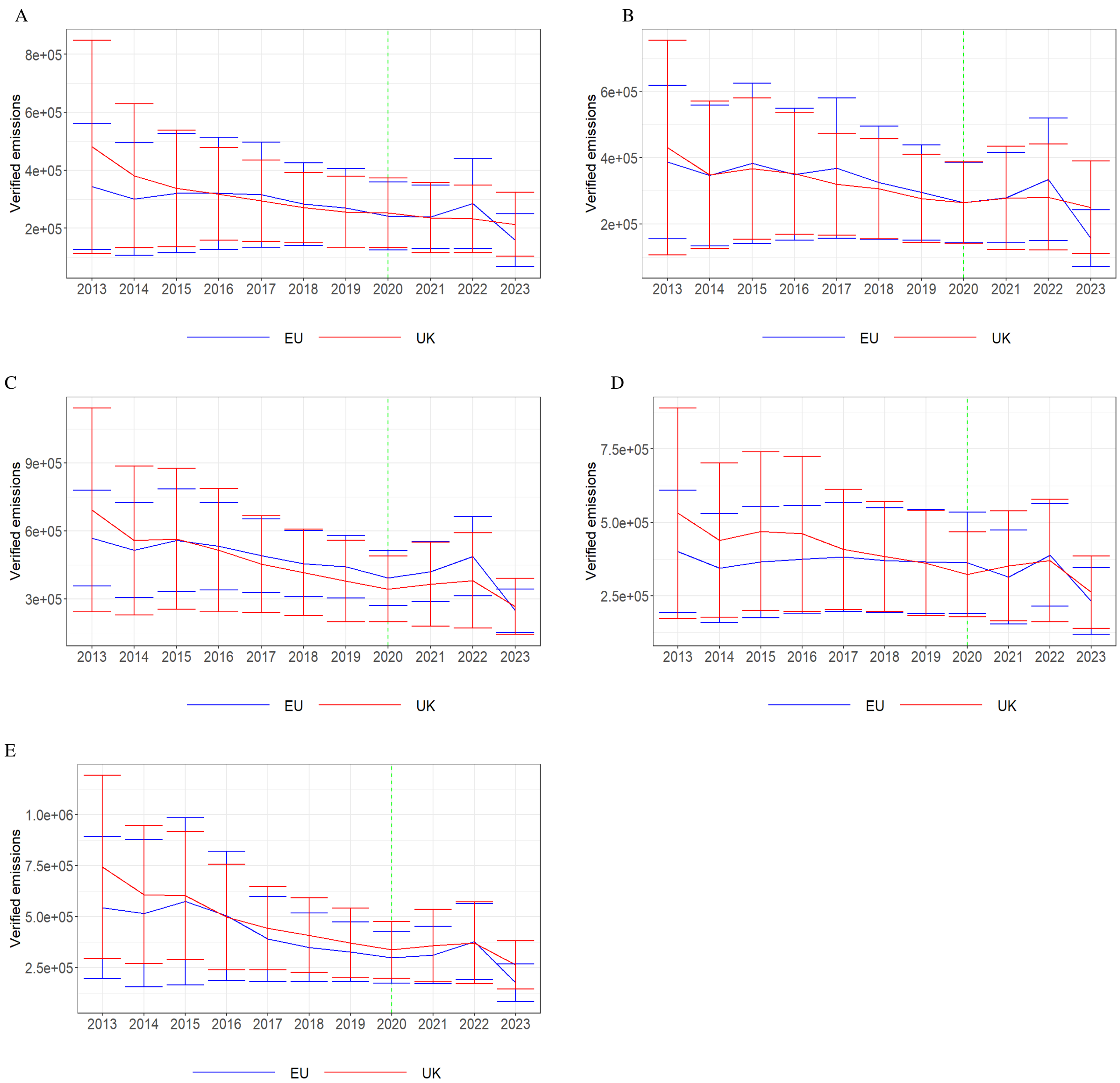


Figure A8: Robustness on the parameters of the PSM performed in Section 5.1. Error bars represent 95% confidence intervals. Labels A and B correspond to matching with a caliper of 0.1 and 0.2, respectively. Label C represents matching with a 1:2 ratio, while Label D is based on Mahalanobis distance. Lastly, Label E corresponds to matching with replacement.

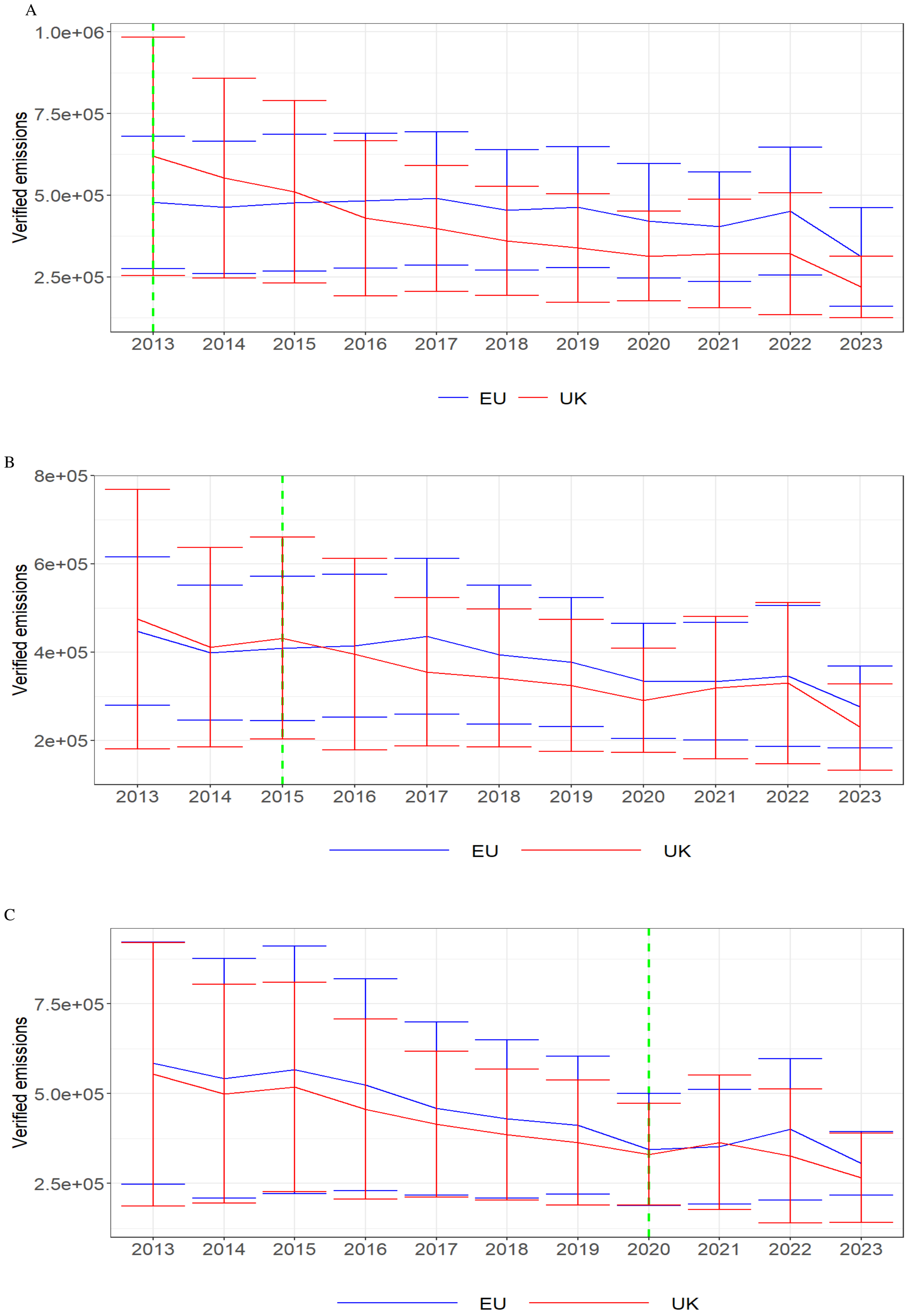


Figure A9: Robustness on the period of the PSM performed in Section 5.1. Error bars represent 95% confidence intervals. Labels A, B, and C refer to matching periods covering 2013, 2013–2015, and 2016-2020, respectively. The dashed vertical green lines indicate the corresponding treatment year in each specification.

A

B

Figure A10: Robustness on the variables of the PSM performed in Section 5.1. Error bars represent 95% confidence intervals. Labels A and B correspond to matching with more and fewer variables employed for matching, respectively.