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The Impact of the European Union Emissions Trading System (EU ETS) on CO2 Emissions and Firm Performance

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ABSTRACT (ENGLISH)

This paper evaluates the effectiveness of the European Union Emissions Trading System (EU ETS) in reducing CO_2 emissions and its impact on firms' economic performance. The study is based on installation- and firm-level data from Denmark and Spain over the period 2001–2019 and applies a quasi-experimental approach combining matching techniques and a difference-in-differences (DiD) framework.

The results show that the introduction of the EU ETS led to a reduction in CO_2 emissions among regulated installations. The effect is particularly pronounced for large installations. No negative impact on employment is found, while firms' financial indicators, such as assets and revenue, exhibit neutral or positive effects.

Overall, the findings suggest that the EU ETS is an effective climate policy instrument that reduces emissions without imposing significant adverse effects on firms' economic performance.

ABSTRACT (DEUTSCH)

Diese Studie untersucht die Wirksamkeit des Emissionshandelssystems der Europäischen Union (EU ETS) bei der Reduzierung von CO_2-Emissionen sowie dessen Auswirkungen auf die wirtschaftliche Leistungsfähigkeit von Unternehmen. Die Untersuchung basiert auf Anlagen- und Unternehmensdaten aus Dänemark und Spanien für den Zeitraum 2001–2019 und verwendet einen quasi-experimentellen Ansatz, der Matching-Methoden mit einem Difference-in-Differences-(DiD)-Framework kombiniert.

Die Ergebnisse zeigen, dass die Einführung des EU ETS zu einer Reduktion der CO_2-Emissionen bei regulierten Anlagen geführt hat. Dieser Effekt ist besonders ausgeprägt bei großen Anlagen. Es wird kein negativer Einfluss auf die Beschäftigung festgestellt, während finanzielle Kennzahlen der Unternehmen, wie Vermögenswerte und Umsätze, neutrale oder positive Effekte aufweisen.

Insgesamt deuten die Ergebnisse darauf hin, dass das EU ETS ein wirksames klimapolitisches Instrument ist, das Emissionen reduziert, ohne erhebliche negative Auswirkungen auf die wirtschaftliche Leistungsfähigkeit der Unternehmen zu verursachen.

CONTENTS

1. INTRODUCTION

The greenhouse effect has remained one of the most significant global environmental problems in recent decades. The greenhouse effect is a phenomenon in which the atmosphere retains part of the heat radiation emitted from the planet's surface due to the presence of greenhouse gases. The main greenhouse gases include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), and ozone (O_3). In recent decades, an increase in the concentration of carbon dioxide in the atmosphere has been observed, and according to scientists, the main cause of this is anthropogenic activity (Intergovernmental Panel on Climate Change, 2021).

In recent years, global warming has accelerated significantly: the period from 2015 to 2024 has been the warmest on record, and temperatures have already exceeded pre-industrial levels by approximately 1.55°C. If warming reaches 2°C, it will lead to serious consequences for both nature and people, which is why countries are striving to limit it to 1.5°C (European Commission, 2026). To slow down climate change, it is necessary to reduce emissions: every ton of CO_2 avoided decreases the rate of warming, and to stop it completely, net-zero emissions must be achieved. That is why, as a response measure, the European Union Emissions Trading System (EU ETS) has been in operation since 2005. It is a market-based climate policy instrument built on the "cap-and-trade" principle. Its main objective is to reduce greenhouse gas emissions in a cost-effective way by setting a gradually decreasing overall emissions cap and creating a market for emission allowances.

Over the past 20 years of its operation, the EU ETS has faced various challenges and has been subject to criticism. By 2023, the European Union Emissions Trading System had helped reduce emissions from European power plants and industrial facilities by approximately 47% compared to 2005 levels (European Commission, 2026). However, these emission reductions cannot necessarily be attributed solely to the EU ETS, as other factors have also influenced their dynamics, such as the 2008 economic crisis, fluctuations in fuel prices, and natural changes in industrial activity. Combined with relatively low carbon prices within the EU ETS, this has led many researchers to question whether emissions would have been higher in the absence of this policy.

In this regard, the aim of this study is to assess, over a horizon of nearly a quarter of a century, to what extent the implementation of this system has proven effective, whether it has had a positive impact on the environmental situation and whether it has avoided negative effects on companies' economic performance. The paper analyzes the impact of the EU ETS on carbon emissions and firms' economic outcomes. The study is based on a matching approach that accounts for the criteria determining the inclusion of installations in the EU ETS, as well as the application of the difference-in-differences method. The empirical analysis uses installation-level data from Danish and Spanish national emissions registries for the period 2001–2019, as well as firm-level economic indicators for companies in Denmark and Spain over the corresponding period.

The first chapter of this paper examines the historical development of the EU ETS, along with its main principles and mechanisms of operation. It also analyzes the key challenges faced by the system and the main directions of its criticism.

1.1 History of EU ETS.

In 1997, the Kyoto Protocol was adopted for 37 industrialized countries. Its main objective was to stabilize the concentration of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic influence on the climate system. The principle of common but differentiated responsibility was recognized, meaning that different countries have different capacities to address climate change. Each country was assigned an emissions quota. If a country emitted less than its allocated limit, it could transfer or sell its excess allowances to other countries. In this way, the Kyoto Protocol became the first environmental agreement based on a market-based regulatory mechanism.

Phase I (2005–2007): The EU ETS was launched in 2005 as a pilot phase, covering only CO_2 emissions from power plants and energy-intensive industries. Due to inaccurate emissions data, most allowances were allocated for free, which led to an oversupply and caused the carbon price to fall to zero by 2007. Nevertheless, Phase I enabled the establishment of emissions trading in the EU, the emergence of a carbon price, and the creation of a monitoring and reporting system.

Phase II (2008–2012): The emissions cap was reduced by 6.5%, additional gases were included, and the use of international carbon credits was allowed. Auctions for allowances were also introduced, and the aviation sector was included starting in 2012. However, the 2008 financial crisis led to a decline in production, causing emissions to fall more than expected. This resulted in an oversupply of allowances and lower carbon prices.

Phase III (2013–2020): A single EU-wide emissions cap was introduced, replacing national caps. Auctioning became the main method of allocating allowances instead of free allocation. The scope of the system was also significantly expanded to cover more sectors and gases.

Phase IV (2021–2030): The current phase includes a higher linear reduction factor, accelerating the decline in the overall cap. From 2024, maritime transport has also been included in the system. In addition, the EU introduced the Carbon Border Adjustment Mechanism (CBAM), which entered its transitional phase in 2023 and came into full force in 2026. The policy imposes a carbon cost on imports of selected goods to prevent carbon leakage and ensure fair competition between imported products and EU producers (European Commission, 2026).

In 2024, the EU ETS achieved a 4.8% reduction in emissions, demonstrating recovery after the energy crisis. More than 50% of the Phase IV target, a 62% reduction by 2030, has already been reached, mainly driven by the energy sector and the transition to renewable energy sources. However, in industry, part of the emissions reduction is attributable to decreased production levels. Auction revenues from the EU ETS reached €32 billion in 2023, an increase of 9.8% compared to 2022. Of these revenues, 76% went to EU Member States, while the remainder was allocated to the Modernization Fund (13%), the Recovery and Resilience Facility (6%), the Innovation Fund (4%), and EFTA countries and Northern Ireland (less than 1%). For the first time, countries were required to report how these funds were spent: 43% was directed to the energy sector (generation, grids, storage), and 21% to public transport and mobility. From a market perspective, the system functioned effectively in 2024, with 9.7 billion emission allowances sold (EUAs) (European Commission, 2026). In 2026, the EU ETS remains the largest “cap-and-trade” system in the world in terms of trading value. In 2027, the EU plans to introduce ETS2. This will be a separate system from the existing EU ETS and will cover CO_2 emissions from fuel combustion in buildings, road transport, and other sectors, primarily targeting small businesses not currently included in the existing system.

1.2 Mechanism of EU ETS.

The functioning of the EU ETS begins with the establishment of an overall emissions cap for the covered sectors of the economy, including power generation, energy-intensive industries, aviation, and maritime transport. This cap is set at the EU level and is reduced annually in line with long-term climate targets. As a result, a scarcity of allowances is created, which is a key driver of carbon pricing. Within this cap, emission allowances are issued, each granting the right to emit one ton of CO_2 equivalent. These allowances are distributed through two main mechanisms: auctions, which represent the dominant method, and free allocation, which is mainly applied to sectors exposed to the risk of carbon leakage. Auctions are conducted, among other platforms, on specialized exchanges such as the European Energy Exchange. Companies covered by the system are required to monitor, report, and verify their emissions. At the end of each reporting period, they must surrender several allowances equal to their actual emissions. Failure to comply results in penalties (€100 per ton of CO_2), while the obligation to surrender the missing allowances remains in force.

A key feature of the system is the ability to trade allowances. Companies that reduce their emissions below their allocated allowances can sell their surplus on the market. Conversely, firms that exceed their limits must purchase additional allowances. This mechanism ensures that emission reduction efforts are redistributed toward those participants for whom such measures are least costly. As a result, the overall environmental objective is achieved while minimizing total economic costs. The market price of allowances is determined by supply and demand. Changes in the overall cap, economic activity, technological developments, and regulatory interventions all influence price dynamics.

Thus, the EU ETS operates as an integrated system combining administrative regulation (setting the cap and allocation rules) with market mechanisms (trading and price formation). Its effectiveness is based on creating economic incentives for emission reductions, directing investment toward low-carbon technologies, and ensuring the achievement of climate goals at the lowest possible cost (Marcu et al., 2025).

In academic literature, criticism of the EU ETS focuses on both its economic efficiency and its design. One of the key issues is the low level of carbon prices, especially during the early years of the system's operation, which significantly weakened incentives for companies to reduce emissions and invest in low-carbon technologies. Closely related to this is the problem of overallocation in the initial phases, when firms received an excessive number of free allowances, leading to market oversupply and reduced effectiveness.

A significant part of the criticism is also linked to concerns about the competitiveness of European companies (Dechezleprêtre & Sato, 2017). In the context of more lenient climate policies in other countries, there is a risk of production being relocated outside the EU, leading to so-called carbon leakage (Levinson & Taylor, 2008). Furthermore, in certain sectors, a redistribution effect has been observed, where companies passed the cost of allowances on to consumers and generated windfall profits.

1.3 Research Objectives and Structure.

The aim of this study is to assess the impact of the EU ETS on CO_2 emissions at the installation level and on the economic performance of regulated firms. The analysis is based on data from Denmark and Spain over the period 2001–2019. The empirical approach combines matching methods with a difference-in-differences (DiD) aproach. To achieve this objective, the following tasks are addressed:

1. collection and merging of data from national PRTR registries, E-PRTR, EUTL, and the ORBIS database;
2. construction of a comparable sample of regulated and non-regulated installations and firms using matching techniques;
3. estimation of the impact of the EU ETS on CO_2 emissions at the installation level;
4. estimation of the impact of the EU ETS on firms' economic outcomes, including total assets, operating revenue, and number of employees.

The main hypothesis of the study is that the introduction of the EU ETS leads to a reduction in CO_2 emissions without a significant negative effect on firms' economic performance. In addition, it is expected that the effect of regulation may vary depending on the size of installations.

Empirical results show that the introduction of the EU ETS led to a statistically significant reduction in CO_2 emissions among regulated installations compared to the control group. In the baseline specifications, the estimated effect is around 25–30%, while in the most conservative specification with fixed effects it is approximately 15%, which is consistent with findings from previous studies across other countries and periods. Regarding economic outcomes, the results are mixed: the impact of the EU ETS on employment is statistically insignificant in most specifications. At the same time, for financial indicators, the effect is neutral or slightly positive.

2. LITERATURE REVIEW

In recent years, there has been a marked increase in interest in the EU ETS. Several factors have contributed to this trend: tighter EU climate policies, rising carbon prices, the EU ETS expansion to new sectors, and the introduction of the Carbon Border Adjustment Mechanism (CBAM) from 2026, which seeks to prevent carbon leakage. This section reviews the most relevant and recent studies on the EU ETS, including three review articles, and highlights the research gap addressed by this study.

2.1 Overview of literature review papers.

In Martin et al. (2016), the authors provide a review and meta-analysis of empirical studies assessing the effects of the first two phases of the EU ETS. Most of the studies considered conclude that the introduction of the EU ETS led to a reduction in CO_2 emissions, with the most pronounced effects observed during Phase II of the system. At the same time, the EU ETS generally has little impact on firms' economic performance, with no significant negative effects on profitability or employment on average. Similarly, the overall competitiveness of European firms appears to have been largely preserved, although this does not hold uniformly across all sectors. The authors also note that the EU ETS has contributed to the adoption of cleaner technologies and innovation. However, this effect remains modest and depends on the allocation of allowances and the presence of complementary policies. Authors claims that reductions in air pollutants cannot be attributed solely to the EU ETS. In a few countries, a trend toward emissions reduction was observed even before the introduction of this policy, and emissions dynamics may also depend on other factors, in particular economic cycles. Therefore, when evaluating the effectiveness of the EU ETS, it is necessary to establish that the actual level of emissions is lower than the level that would have been observed in the absence of this policy. The authors emphasize that researchers face two methodological challenges in such analyses: the lack of detailed installation-level emissions data prior to 2005, and the need to construct a counterfactual scenario reflecting the trajectory of emissions without the impact of the EU ETS. In addition, the authors note that country-level studies provide only a general picture but do not allow for a precise identification of causal relationships. More reliable estimates can be obtained using micro-level data at the firm or installation level, which allows for comparisons between regulated and unregulated entities before and after the introduction of the policy.

In the work of Sean Healy et al. (2015), are presented a literature review and an analysis of gaps in the evaluation of EU ETS policy. The authors show that the existing literature mainly focuses on several key areas: the assessment of the environmental effectiveness of the system, the analysis of its economic efficiency, and the study of its impact on firms' competitiveness. The main methodological approaches are mostly econometric and statistical analysis, data analysis, and modeling.

In a later study, Cristiano Salvagnin (2024) presents a bibliometric analysis of articles published between 2004 and 2024. The analysis identifies several key practical problems in the functioning of the EU ETS: over-allocation of allowances, low carbon prices, and the possible relocation of investment and production. In addition, the author highlights several scientific and methodological challenges, including limited available data, insufficient use of modern analytical methods, a lack of studies on macroeconomic effects, and limited research on the impact of exchange rates and the links between the EU ETS and financial markets.

2.2 Overview of existing studies on EU ETS effectiveness.

The following discussion focuses on the key empirical studies that evaluate the effectiveness of the EU ETS. Francesco Biancalani et al. (2024) analyze changes in CO_2 emissions at the country level. For the empirical analysis, the authors use a machine learning method called Matrix Completion with Fixed Effects (MCFE), which includes fixed effects for countries and time. This approach makes it possible to estimate the effect of the policy by comparing it with a counterfactual scenario in which the EU ETS had not been introduced. The treated group consists of 17 EU countries, while the control group includes 7 developed countries outside the EU where such a policy was not implemented. The main result of the study is that the introduction of the EU ETS led to an average reduction in CO_2 emissions of about 15,4%.

Bayer and Aklin (2020) investigate whether the introduction of the EU ETS resulted in a real reduction in CO_2 emissions in regulated sectors of the economy. The analysis uses panel data on emissions at the sector level in EU countries for the period 1990–2016, which allows comparing emission trends before and after the introduction of the ETS. The authors examine four main regulated sectors: power generation, metallurgy, mineral products, and the chemical industry. To estimate the causal effect of the policy, they apply the Generalized Synthetic Control Method (GSCM), which makes it possible to construct a counterfactual path of emissions. The results show that the introduction of the EU ETS led to a reduction in emissions in regulated sectors by about 8–12% over the period 2008–2016, which corresponds to a decrease of around 1,2 billion tons of CO_2.

The study by A. Dechezleprêtre et al. (2023) examines the effectiveness of the EU ETS system. The authors use a quasi-experimental approach to assess whether the introduction of the ETS led to changes in CO_2 emissions and how it affected firms' economic performance. Since the EU ETS regulates emissions only for large installations, a natural experiment arises with installations whose emissions are below the threshold and are therefore not regulated. These installations can be in the same country and industry and can be similar in size to regulated ones, which makes them a suitable control group. The study uses data on installations from France, the Netherlands, Norway, and the United Kingdom, as these countries have low reporting thresholds, allowing the inclusion of smaller installations. For empirical analysis, the authors apply the Difference-in-Differences (DiD) method and matching techniques. The results show that during the first two phases of the EU ETS, CO_2 emissions decreased by about 10%. At the same time, no negative effect on company profits is observed, while revenue and the value of fixed assets show an increase.

Piero Basaglia et al. (2024) explore the impact of the ETS policy not only on CO_2 emissions but also on emissions of other air pollutants. The study uses panel data on emissions at the country level for the period from 1990 to 2021. To estimate the causal effect of the policy, the authors apply the GSCM. They compare regulated industries covered by the ETS with sectors that are not included in the system, estimating the average effect of the policy for regulated industries relative to those not covered by the ETS. The results show that, due to the introduction of the ETS, more than 20 million tons of pollutants such as SO_2, PM2.5, and NO_x were avoided over the period studied.

Kalantzis et al. (2024) take a different approach by using a broader measure, the Environmental Policy Stringency (EPS) index, instead of focusing only on the ETS system. The dataset includes about 1 million firms from 12 European countries over the period 1995–2020. As a control group, the authors use firms that are not covered by the EU ETS, while firms with ETS-regulated installations form the treatment group. The empirical analysis is carried out using panel regression with fixed effects at the firm level, sector level, and across economic cycles. The authors examine whether the effects of EPS differ across periods with high and low carbon prices. The results show that some ETS-regulated firms, when carbon prices are high, experience higher turnover. The authors also do not find evidence that stricter environmental policy has a negative effect on firm profitability.

Georgia Makridou et al. (2019) focus on how participation in the EU ETS affects firms' financial performance. The study uses panel data on companies from 19 EU countries over the period 2006–2014, including firms' financial indicators, data on emissions and allowance allocation, as well as macroeconomic variables. The analysis is carried out using Hierarchical Linear Modelling (HLM), which allows considering the multi-level structure of the data (firm, industry, country, and time). The results show that firms' profitability is mainly determined by their financial characteristics and economic conditions. However, ETS-related factors also have a statistically significant effect: higher carbon intensity is associated with lower profitability, while improvements in energy efficiency and the development of energy policy can have a positive impact on firms' financial performance.

The impact of the EU ETS can be assessed at multiple levels, including country-level, sector-level, and firm-level analyses. Moreover, the effects of the EU ETS may differ across its policy phases: Phase I (2005–2007), Phase II (2008–2012), Phase III (2013–2020), and Phase IV (2021–2030). Effectiveness can be measured both in terms of economic performance indicators and reductions in emissions. Table 1 below is presented to summarize the empirical studies discussed above and to highlight the research areas that are currently most relevant.

Author(s) / Year	Scope			Period				Assessment		Methodology
	Region	*Sector*	*Firm*	*I*	*II*	*III*	*IV*	*Emissions*	*Economic*	
Biancalani et al. (2024)	✓			✓	✓	✓		✓		MCFE
Bayer & Aklin (2020)		✓		✓	✓	✓		✓		GSCM
Dechezleprêtre et al. (2023)			✓	✓	✓			✓	✓	DiD
Basaglia et al. (2024)	✓			✓	✓	✓		✓		GSCM
Kalantzis et al. (2024)			✓	✓	✓	✓			✓	Panel data
Makridou et al. (2019)			✓	✓	✓				✓	HLM
This study			✓	✓	✓	✓		✓	✓	DiD

Table 1. *Overview of recent empirical studies on the EU ETS.*

The literature review shows that the effectiveness of the EU ETS has been studied at different levels and across various policy phases. Most research has focused on Phases I–II, evaluating both environmental and economic outcomes. Evidence indicates that the EU ETS contributed to reductions in CO_2 emissions, with estimates ranging from approximately 8 to 15%, depending on the level of analysis and methodology used. At the same time, the economic impact on firms appears to be moderate: the higher the emissions associated with production, the lower the firm's profitability, whereas improvements in energy efficiency and policy measures support stronger financial performance.

2.3 Research gap.

While the EU ETS has been widely studied, Phase III (2013–2020) remains underexplored. Furthermore, as the review shows, firm-level analysis is particularly relevant for understanding the microeconomic effects of the EU ETS under current market conditions. Building on this gap, the present study will focus on Phases I - III of the EU ETS, assessing its economic effects at a firm level. The analysis will be conducted using a Difference-in-Differences approach combined with matching techniques, allowing for a robust comparison between firms affected by the policy and a control group. This study focuses on the analysis of data from Denmark and Spain, countries that, unlike in most previous research, have not been central subjects of empirical investigation. While existing studies typically concentrate on a limited set of countries (such as the Netherlands, Norway, France, and the United Kingdom), this paper aims to test whether previously established findings hold in a new national context. The empirical analysis is based on installation-level data from Danish and Spanish national emissions registries covering the period 2001–2019. To assess the impact on economic outcomes, firm-level data from Denmark and Spain are additionally employed. The presence of low reporting thresholds, together with the availability of pre-ETS data, makes it possible to identify installations that are not regulated under the EU ETS. This, in turn, enables the application of a quasi-experimental Difference-in-Differences approach. In this way, the study not only contributes to existing literature by incorporating previously underexplored countries but also tests the robustness of earlier findings in a different institutional and economic setting. By focusing on the most recent policy phase and conducting the analysis at the firm level, the paper aims to provide new insights into the current economic and ecological effects of the EU ETS.

3. DATA

This chapter describes the data used in the empirical analysis and their sources, as well as the process of constructing the final dataset. It first discusses the different emissions registries and financial databases used in the study. It then explains how installations and firms are matched and how the final comparable samples are constructed. Finally, the chapter presents the econometric strategy, including the DiD approach, its key assumptions, and the model specification.

3.1 Data description.

To assess the impact of the introduction of the ETS, installation-level emissions data are required. In general, there are three types of emissions registries. The E-PRTR (European Pollutant Release and Transfer Register) is a pan-European emissions register that has been in operation since 2007 and covers greenhouse gas emissions, heavy metals, and other pollutants from more than 34000 installations across 30 countries. Large installations in these countries that fall under the regulatory scope are required to self-report their emissions to this registry. Since 2024, it has been gradually replaced by a new system – the Industrial Emissions Portal (IEP), which will cover more than 60000 installations. In addition, there is the European Union Transaction Log (EUTL), which is the registry of allowance trading transactions under the EU ETS. It includes data on approximately 15000 stationary installations. In addition, there are national PRTR (Pollutant Release and Transfer Register) systems, which were introduced in different countries at different points in time and have varying reporting thresholds and covered sectors. There are no harmonized rules governing the operation of national registries. Therefore, they may differ significantly across countries. These systems were developed independently and primarily for monitoring emissions of various pollutants into air, soil, and water.

To identify the causal effect of the EU ETS on CO_2 emissions, it is necessary to use installation-level data for both regulated installations and those not subject to regulation. In this study, the analysis of the impact of the EU ETS on changes in installation-level emissions is based on national PRTR data and information on regulated installations from the E-PRTR registry. Both the E-PRTR and the EUTL include data only on large installations with high capacity. At the same time, the inclusion thresholds in national registries are often lower, resulting in a larger number of installations being covered, including those that fall under EU ETS regulation. This feature allows the construction of a natural experimental setting, where installations with similar emission levels can be divided into a treatment group (those subject to EU ETS regulation) and a control group (those not regulated).

An analysis of reporting requirements in national registries of EU ETS countries identifies six countries with low reporting thresholds: Denmark, Spain, the Netherlands, Norway, France, and the UK (see Table 2). However, Dechezleprêtre et al. (2023) already examine the Netherlands, Norway, France, and the UK using a similar approach. Denmark and Spain, therefore, remain less explored in this context, which is why they are the focus of the present study. While results for these two countries alone cannot be considered fully representative on their own, when combined with evidence from other studies they contribute to a more comprehensive and representative picture of the overall effects for countries covered by the EU ETS.

Country	Reporting threshold	Country	Reporting threshold
Austria	high	Malta	*NA*
Belgium	high	Netherlands	low
Bulgaria	high	Norway	low
Hungary	high	Poland	high
Germany	high	Portugal	*NA*
Greece	*NA*	Slovakia	*NA*
Denmark	low	Romania	*NA*
Sweden	high	Finland	high
Ireland	high	Slovenia	*NA*
Italy	high	Switzerland	high
Spain	low	Croatia	*NA*
Cyprus	*NA*	France	low
Latvia	high	Czechia	high
Lithuania	*NA*	Estonia	high
Luxembourg	high	United Kingdom	low

Table 2. *Reporting thresholds of national PRTR datasets across European countries. (Grey-shaded denote low reporting threshold)*

National PRTRs datasets for Denmark and Spain contain an installation identification number, installation name, address, postal code, and annual emissions for the corresponding year. Since national PRTRs do not include information on whether an installation is covered by the EU ETS, this study matches installations from national PRTRs with those in the E-PRTR to determine which installations are subject to ETS regulation and from which year onwards. This is done using fuzzy matching algorithms based on installation name, postal code, and address, as well as manual matching and validation procedures to improve accuracy.

The final dataset used to estimate the effect of the EU ETS on installation-level CO_2 emissions includes the following variables:

1. A unique company identifier (for Denmark, this is the CVR number, which is the unique registration number of a company in the Danish Central Business Register; for Spain, this is the corresponding installation number in the national PRTR database).
2. Company size: very large, large, medium, or small. Firm size is determined according to the ORBIS classification.
3. Information on whether the installation is covered by the EU ETS.
4. The country in which the installation operates.
5. The amount of CO_2 emissions for a given year and installation. The sample includes data from 2001 to 2019.

Table 3 provides an overview of the number of installations and observations for the two countries.

Country	Number of installations		Number of observations	
	ETS installations	Non-ETS installations	ETS installations	Non-ETS installations
Denmark	120	286	802	1692
Spain	710	1703	5311	11474

Table 3. *Analytical sample of installations for estimation effects on emissions.*

After estimating the effect of the EU ETS on emission levels, the next step is to assess how it has affected the competitiveness of participating firms. To identify the causal impact of the EU ETS on firms' economic performance, firm-level data are required, as well as information on which companies are covered by the system. In this part of the analysis, Denmark and Spain are again considered over the same time periods as in the emissions analysis, which makes the results more comparable and consistent.

For matching, the EUTL database is combined with financial data from the ORBIS database provided by Bureau Van Dijk. The same approach is used as in the emissions dataset: fuzzy matching algorithms based on company name, postcode, longitude and latitude, and address are used, along with manual matching procedures to check validity. ORBIS data are extracted for the period 2003 to 2019, including both ETS-covered firms and non-ETS firms. The financial variables include total assets, operating revenue, and number of employees. After matching the two datasets, firms covered by the EU ETS are identified.

The final dataset used to estimate the effect of the EU ETS on firms' financial performance includes the following variables:

1. A unique company identifier (for Denmark, the CVR number, which is the unique registration number in the Danish Central Business Register; for Spain, the corresponding company identifier in the ORBIS database).
2. Firm size: very large, large, medium, or small. Firm size is defined according to ORBIS classification.
3. An indicator of whether the company is covered by the EU ETS.
4. The country in which the company operates.
5. A set of financial indicators, including total assets, operating revenue, and number of employees, for each company-year observation.

The sample includes all firms from Denmark and Spain with available data over the period 2003–2019. Firms with clear measurement or data entry errors were excluded from the dataset. Table 4 provides an overview of the number of firms and observations for the two countries.

Country	Number of companies		Number of observations	
	ETS companies	Non-ETS companies	ETS companies	Non-ETS companies
Denmark	25	31	440	527
Spain	183	375	3045	6573

Table 4. *Analytical sample of companies for estimation effects on economic performance.*

3.2 Matching.

To estimate the causal impact of the EU ETS on both environmental and economic outcomes, a matching approach is employed. The main objective is to construct treatment and control groups that are as similar as possible in terms of observable characteristics prior to the introduction of the ETS. This is largely facilitated by the institutional design of the system. The EU ETS covers installations that exceed certain capacity or output thresholds depending on the sector. As a result, installations included in the system are often very similar to those just below the threshold, differing mainly in whether they fall under the EU ETS regulation. Under this setup, differences in emissions or economic outcomes can be more credibly attributed to the effect of the ETS. In this study, two datasets are used: installation-level CO_2 emissions data and firm-level financial data. For each dataset, a separate matching procedure is implemented.

For the emissions analysis, regulated and non-regulated installations are matched based on industry (NACE code) and country. This ensures that the units of analysis operate under similar institutional and market conditions. Matching is also performed using firm size categories. In addition, pre-treatment characteristics are included, namely the average level of emissions and the emissions trend prior to the introduction of the EU ETS. The average emissions level is used as a proxy for installation capacity and production intensity, while the emissions trend captures differences in dynamics before treatment.

For the analysis of economic outcomes, a similar matching procedure is applied at the firm level. To ensure comparability in external conditions, firms are matched based on NACE industry codes and country. Pre-treatment characteristics also include the trend and average level of the relevant outcome variables prior to the introduction of the EU ETS. The financial indicators considered are total assets, operating revenue, and number of employees.

To improve the robustness of the results, observations with extreme values in levels or trends are excluded from the sample. Similarity between units is measured using Euclidean distance computed on standardized variables, ensuring comparability across variables measured in different units. Nearest-neighbour matching is then applied, where for each treated unit the closest untreated unit is selected. Matching is performed one-to-one with replacement, allowing a control unit to serve as a match for multiple treated units.

As a result, a matched sample of comparable firms and installations is obtained, consisting of both ETS-regulated and non-regulated units. This approach improves the credibility of the estimated causal effects.

3.3 Difference-in-Differences.

After constructing the matched sample, the impact of the EU ETS is estimated using a difference-in-differences (DiD) approach. The purpose of this method is to compare changes in relevant outcomes for ETS-regulated units with those of a comparable group of non-regulated units after the introduction of the system. The main idea is that, in the absence of the policy, both groups would have followed similar trends over time. Therefore, any difference in outcomes after the introduction of the EU ETS can be interpreted as a causal effect.

For the validity of the DiD approach, several key assumptions must hold. First, the parallel trends assumption requires that, in the absence of the EU ETS, the treatment and control groups would have evolved in a similar way over time. In other words, the pre-treatment trends in the outcomes should be comparable across groups. This study addresses this assumption by matching firms with similar countries, sectors, and pre-treatment trends. The validity of this assumption will be assessed through a formal test of pre-treatment parallel trends. Second, compositional stability implies that the composition of the treatment and control groups should not change systematically over time. Third, there should be no spillover effects, meaning that the introduction of the EU ETS should not indirectly affect non-regulated units. In practice, this assumption may be difficult to fully satisfy, as market-wide effects such as changes in energy prices may influence both groups. Finally, the no-anticipation assumption requires that firms do not systematically adjust their behavior in anticipation of the policy. By accounting for pre-treatment trends before the introduction of the EU ETS, the matching procedure helps reduce potential anticipation effects. If these assumptions hold, the difference-in-differences estimator can be interpreted as the causal effect of the introduction of the EU ETS on the outcomes of interest.

The effect is estimated using the following model:

$$Y_{it} = \beta(Treated_i \times Post_i) + \sigma_i + \theta_t + \varepsilon_{it} \qquad (1)$$

- Y_{it} – is the outcome variable for unit *i* in year *t*;
- $Treated_i$ – is a binary variable equal to 1 for units that are covered by the EU ETS, and 0 otherwise;
- $Post_i$ – is a binary variable equal to 1 for the period after the introduction of the ETS, and 0 for the pre-treatment period;
- σ_i – represents unit fixed effects;
- θ_t – represents time fixed effects;
- ε_{it} – is the error term.

Individual fixed effects are used to control time-invariant unobserved characteristics of firms and installations, such as production technologies, organizational structure, and other stable factors. Time fixed effects, in turn, capture common shocks that affect all units in a given year, such as macroeconomic changes or other economy-wide influences. For a more convenient interpretation of the estimated coefficients in the analysis of emissions and economic outcomes, the dependent variable is specified as: $\ln\left(1 + Indicator_{it}\right)$, where $Indicator_{it}$ – the outcome variable depending on the specific analysis.

The parameters of the model are estimated using ordinary least squares (OLS). Since observations for the same unit over time are not independent, standard errors are clustered at the installation or firm level to allow for within-unit correlation over time. This approach improves the reliability of statistical inference. The coefficient β represents the average treatment effect on the treated (ATT), measuring the effect of EU ETS participation on regulated units compared with the matched control group.

4. RESULTS

Before presenting the empirical results, it is important to briefly summarize the construction of the final matched samples and the main data sources used in the analysis. The emission dataset combines installation-level CO_2 data with information on ETS coverage, while the economic dataset is built at the firm level using ORBIS financial indicators merged with the EUTL registry. In both cases, treated and control units are constructed using a matching procedure based on sector, country, firm size, and pre-treatment trends in outcomes. This ensures that the groups are comparable prior to the introduction of the EU ETS and allows for a more credible evaluation of causal effects within a difference-in-differences framework.

The following sections present the main empirical results. Section 4.1 focuses on the impact of the EU ETS on CO_2 emissions at the installation level, while Section 4.2 examines its effect on firms' economic performance.

4.1 Effect on emissions.

Table A.1 in the Appendix provides a brief overview of the descriptive statistics of the CO_2 emissions sample used in the analysis.

As a result of the matching procedure based on NACE codes, country, installation size category, average pre-ETS emission levels, and emission trends in the years prior to the introduction of the system, the final dataset presented in Table 5 is obtained. This allows for a sample of comparable installations across multiple dimensions, with some units regulated under the EU ETS and others not.

Country	Number of installations		Number of observations	
	ETS installations	Non-ETS installations	ETS installations	Non-ETS installations
Denmark	51	52	377	297
Spain	87	40	701	248

Table 5. *Matched sample: number of installations and observations.*

After the matching procedure, it can be concluded that the pre-treatment characteristics of installations covered by the EU ETS and those not covered are very similar. At the same time, ETS installations generally exhibit higher emission levels, which is largely driven by the design of the system and the threshold values that determine inclusion in the EU ETS. Figure 1 compares the distribution of emissions between ETS and non-ETS groups prior to the introduction of the policy. The closeness of the points to the diagonal indicates that both groups have similar characteristics and can be used for further comparison within the DiD framework.

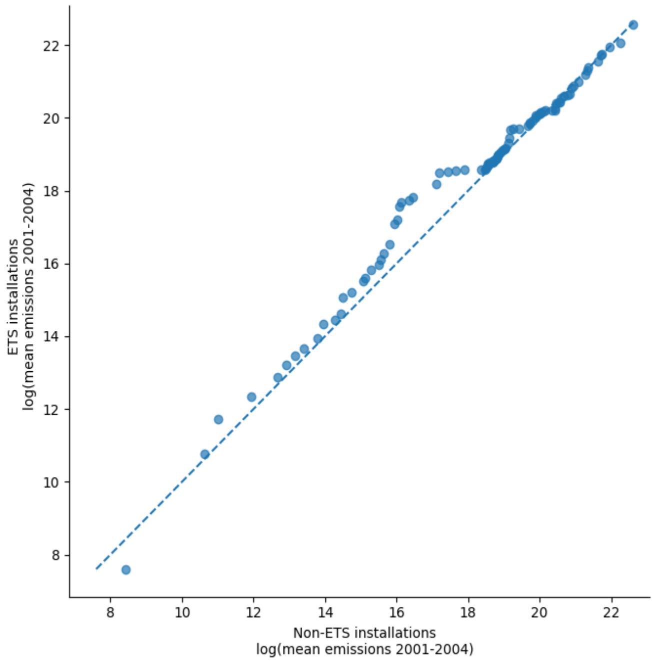

Fig. 1. *Empirical Q–Q plot of CO_2 emissions (pre-treatment period) in a matched sample.*

Figure 2 shows the dynamics of emissions after the matching procedure for ETS and non-ETS installations. The graph indicates that before the introduction of the EU ETS, both groups exhibited almost identical trends, which further supports the parallel trends assumption. After the introduction of the system in 2005, it becomes visible that the decline in emissions is steeper for ETS installations compared to non-ETS ones, particularly during Phase II of the ETS

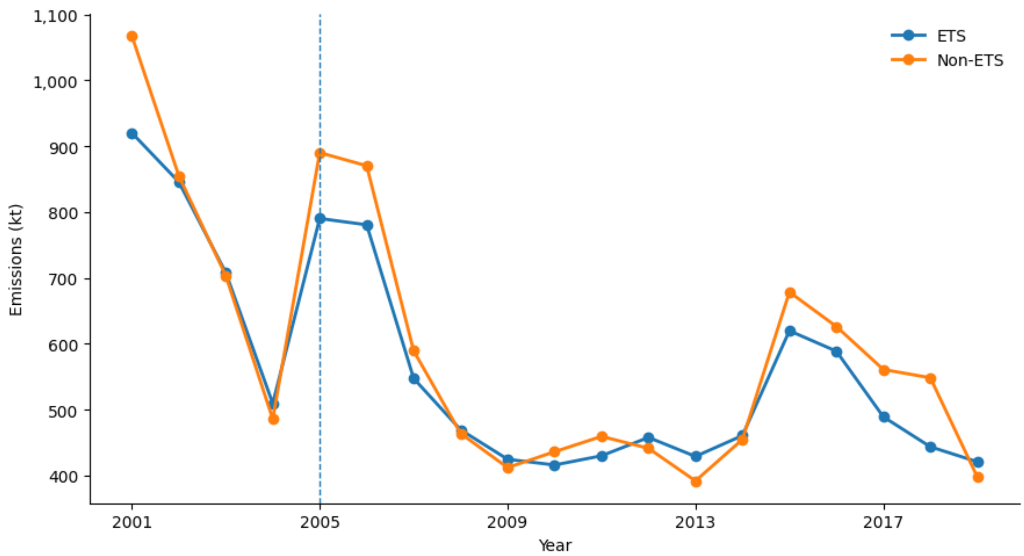

Fig. 2. *CO_2 emissions trends before and after the EU ETS (matched sample).*

Table 6 shows that the matching procedure was successful. There are no statistically significant differences between ETS and non-ETS installations in either pre-treatment emission levels or pre-treatment emission trends, indicating that the two groups were comparable before the introduction of the EU ETS.

Variable	ETS mean	Non-ETS mean	Difference	p-value
Pre-ETS emissions	521,60 kt	521,57 kt	0,03 kt	0,99
Pre-ETS trend	0,02	0,04	-0,02	0,17

Table 6. *Balance test for pre-treatment emissions and trends.*

Further analysis is conducted using panel data and a DiD approach. The dependent variable is the logarithm of emissions. Equation (1) is applied to the previously constructed sample. The model parameters are estimated using ordinary least squares (OLS). The estimation is conducted using four specifications with a gradually increasing set of fixed effects. In the first specification, no fixed effects are included. In the second specification, only unit-level fixed effects are included. In the third specification, only year fixed effects are included, which allows controlling for common macroeconomic shocks and time trends. In the fourth specification, both unit and year fixed effects are included.

Variable	First specification	Second specification	Third specification	Fourth specification
$Treated_i \times Post_i$	-0,289*	-0,372**	-0,230	-0,162
Standard Errors	(0,173)	(0,096)	(0,253)	(0,116)
t-stat	-1,671	2,170	-0,910	-1,394
p-value	0,095	0,031	0,363	0,165
F-stat	27,09	32,33	27,82	46,39
R^2	55%	57%	59%	60%
Installation Fixed Effects	-	✓	-	✓
Year Fixed Effects	-	-	✓	✓

Table 7. OLS DiD results for CO_2 emissions

In the first and second specifications, the results are statistically significant. The estimated effect is (−25%) in the first specification and (−31%) in the second one. While in the fourth specification, which includes both unit and year fixed effects, the result is close to statistical significance. In this model, the estimated effect corresponds to a 15% reduction in CO_2 emissions, which is in line with results found in previous studies, although for other countries.

In Dechezleprêtre et al. (2023), it is suggested that since emissions monitoring and compliance require substantial financial resources and involve significant fixed costs, larger installations may respond more strongly to regulation. One possible explanation is that larger firms can spread the costs of adopting new technologies over a larger output, thereby reducing the relative burden per unit of production. To test this hypothesis, an additional analysis is conducted where installation size is defined based on pre-treatment emission levels.

Figure 3 presents the estimated treatment effects across four groups of installations, divided according to the quartiles of the emissions distribution. The results show clear differences across installation sizes. The largest installations (Q4) have a strong and statistically significant drop in emissions compared to the control group ($p < 0{,}01$). Smaller installations do not show significant changes: Q1 has a small positive but insignificant effect ($p = 0{,}51$), while Q2 and Q3 show small negative effects that are also not statistically significant (see Table A.2 in the Appendix).

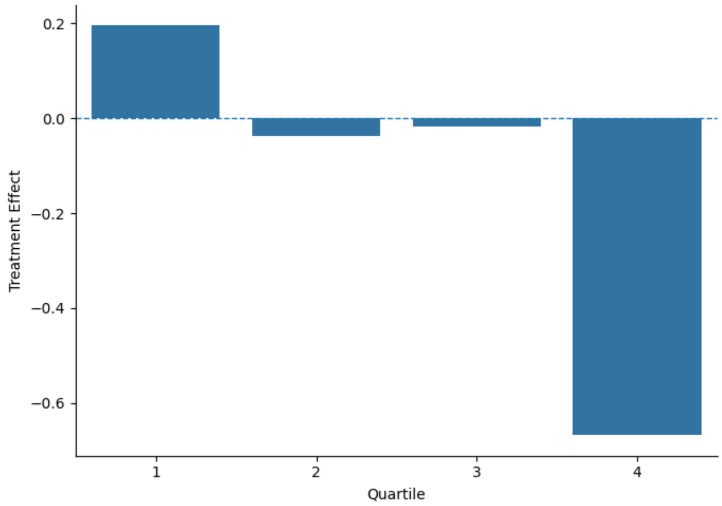

Fig. 3. *Treatment effects of EU ETS across emission size quartiles.*

Overall, emissions reductions under the ETS are mainly driven by the largest installations, while smaller ones show little to no response to the policy.

4.2 Effect on economic performance.

This section of the study examines the impact of the EU ETS on firms' economic performance. In the related literature, there is an ongoing discussion about the competitiveness of firms that are subject to emission regulation compared to those whose emissions are not associated with additional compliance costs. There is a concern that production may be relocated to regions outside EU ETS countries, where environmental regulation is less strict. Therefore, this part of the analysis focuses on the potential effects of the EU ETS on firms' economic performance.

The analysis is also based on a matching approach, but this time the data are constructed at the firm level rather than at the installation level. A company is considered to be covered by the EU ETS if at least one of its installations is subject to the regulation.

As a result of the matching procedure based on NACE codes, country, firm size category, average pre-ETS values of total assets, number of employees, and operating revenue, as well as the pre-treatment trends of these indicators, the final dataset presented in Table 8 is obtained. This allows for a sample of comparable firms across multiple dimensions, with some firms covered by the EU ETS and others not.

Country	Number of companies		Number of observations	
	ETS companies	Non-ETS companies	ETS companies	Non-ETS companies
Denmark	17	9	272	148
Spain	148	88	2220	1452

Table 8. *Matched sample: number of companies and observations.*

The results of the matching procedure indicate a high degree of comparability between firms covered by the EU ETS and the control group prior to the introduction of the regulation. The key characteristics: total assets, number of employees, and operating revenue differ only slightly in the pre-treatment period, which suggests that the matching procedure was successful.

Figure 4 shows a comparison of the distributions of key variables between ETS and non-ETS firms before the introduction of the policy. The closeness of the observations to the equality line indicates that, after matching, the groups become comparable in terms of pre-treatment characteristics, making them suitable for further analysis within the DiD framework.

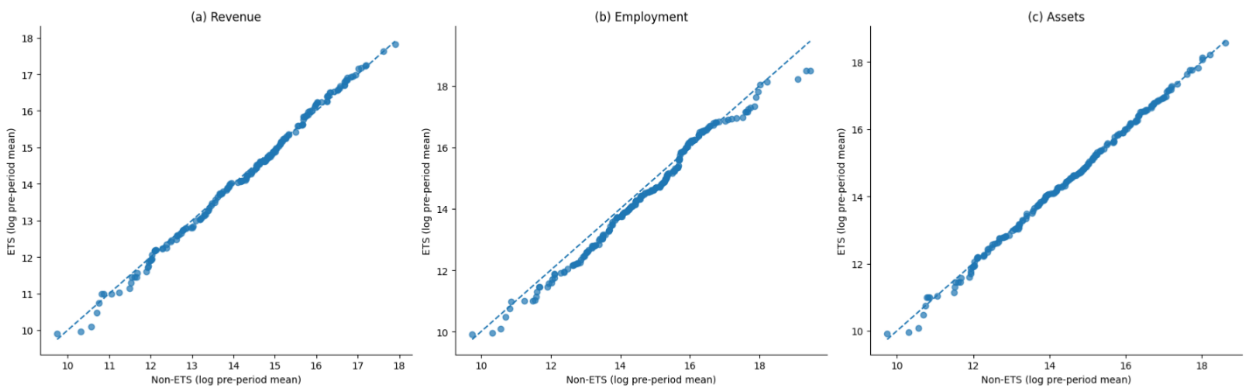

Fig. 4. *Empirical Q–Q plots of key firm-level variables (pre-treatment period) in a matched sample.*

Figure 5 (a – c) shows how the indicators evolve after matching for ETS and non-ETS firms. Before the EU ETS was introduced, both groups moved in a very similar way, which supports the idea of parallel trends. After 2005, when the system started, the differences become clearer: ETS firms show stronger growth compared to non-ETS firms.

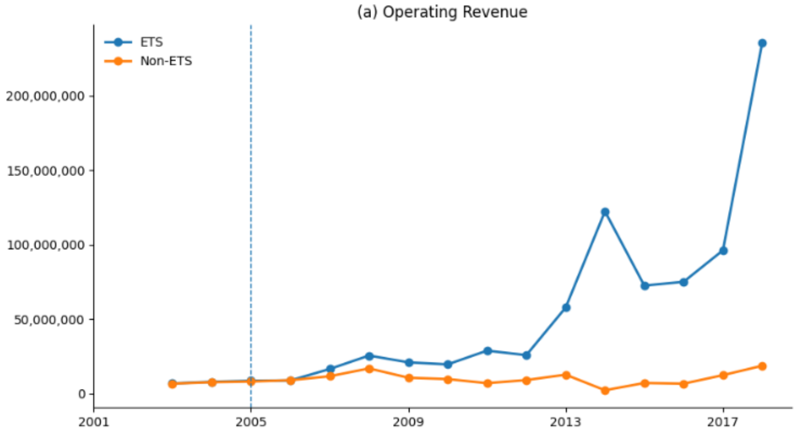

Fig. 5.a *Operating revenue trends before and after the EU ETS (matched sample).*

Fig. 5.b *Number of employees trends before and after the EU ETS (matched sample).*

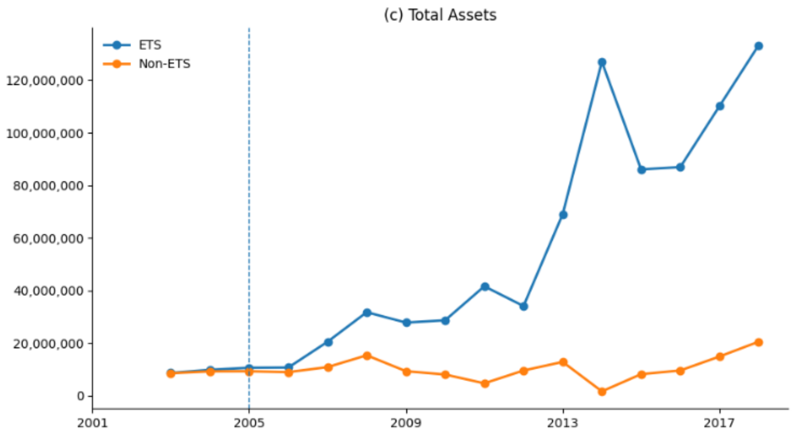

Fig. 5.c *Total assets trends before and after the EU ETS (matched sample).*

The results in Table 9 indicate that there are no statistically significant differences between ETS and non-ETS firms in pre-treatment levels or trends of operating revenue, number of employees, and total assets. This suggests that the matching procedure successfully produced comparable groups prior to the introduction of the EU ETS.

Parameter	Variable	ETS mean	Non-ETS mean	Difference	p-value
Operating revenue	Pre-ETS emissions	7 489 383	7 386 720	102 662	0,48
	Pre-ETS trend	0,216	0,256	-0,04	0,15
Number of employees	Pre-ETS emissions	13,21	12,65	0,56	0,36
	Pre-ETS trend	0,212	0,234	-0,02	0,27
Total assets	Pre-ETS emissions	9 226 781	9 044 744	182 036	0,28
	Pre-ETS trend	0,205	0,205	0,00009	0,99

Table 9*. Balance test for pre-treatment economic indicators and trends.*

After the matching procedure, further analysis is carried out using panel data and a DiD approach. The dependent variable is the logarithm of the selected firm-level indicator. Estimation is based on equation (1), applied to the previously constructed sample of firms. The model parameters are estimated using OLS.

The analysis is conducted in four sequential specifications that differ in the set of fixed effects included. In the first model, no fixed effects are included. In the second specification, firm-level fixed effects are added, which allows controlling for unobserved differences between firms. In the third specification, only year fixed effects are included, which control for macroeconomic shocks and time trends. In the fourth specification, both firm and year fixed effects are included, providing the most complete specification.

Variable	Number of employees				Total assets				Operating revenue			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
$Treated_i \times Post_i$	0,003	-0,005	-0,001	-0,04*	0,76	0,18	0,50*	0,08***	0,77	0,176	0,659	0,19**
Standard Errors	(0,120)	(0,047)	(0,01)	(0,02)	(0,635)	(0,121)	(0,269)	(0,04)	(0,150)	(0,28)	(0,9)	(0,106)
t-stat	0,025	-1,25	-0,97	-1,70	1,20	1,50	1,88	2,10	0,670	0,63	0,733	1,82
p-value	0,98	0,21	0,33	0,09	0,23	0,134	0,05	0,03	0,50	0,53	0,463	0,06
F-stat	14,2	165,33	28,7	190,5	13,67	32,33	11,83	3409	15,13	4353	7,66	889
R^2	55%	90%	62%	91%	2%	94%	7%	94%	2%	89%	6%	89%
Company FE	-	✓	-	✓	-	✓	-	✓	-	✓	-	✓
Year FE	-	-	✓	✓	-	-	✓	✓	-	-	✓	✓

Table 10. *OLS DiD results for economic performance of companies.*

The results show different levels of robustness of the EU ETS effect depending on the outcome variable. For the number of employees, the estimated effect is statistically insignificant in most specifications, except for the fourth model, where a weak negative effect (−4%) is observed, significant at the 10% level. For total assets, the effect is more pronounced and, in several specifications, statistically significant. In particular, a positive and significant effect is found in the third model. In the most complete specification, the effect remains positive and significant at the 1% level (+8%), which indicates the stability of this result. A similar pattern is observed for operating revenue, where the EU ETS effect is also positive and, in the fourth specification, statistically significant.

Overall, the results suggest a heterogeneous impact of the EU ETS on different economic indicators. While employment shows low sensitivity to the regulation, total assets and revenue exhibit a more stable positive response among firms covered by the system.

4.3 Robustness check.

The analysis includes three main robustness checks: (I) an alternative matching method based on Mahalanobis distance, (II) the exclusion of extreme values, and (III) the exclusion of one of the countries from the sample.

In the main specification, nearest-neighbour matching based on Euclidean distance over standardized variables is used to build a comparable sample. As a robustness check, Mahalanobis distance matching is also applied. This choice is motivated by Dechezleprêtre et al. (2023), where Mahalanobis distance matching is used as the main baseline specification for constructing a comparable control group of EU ETS installations. This method is similar but additionally accounts for the covariance structure of the variables. The second robustness check involves excluding extreme observations from the distribution of pre-ETS characteristics. Specifically, the sample is sequentially trimmed by removing the top 5% of installations/companies in terms of pre-ETS emissions or financial indicators, as well as the bottom 5% of installations/companies according to the same measures. The third robustness check consists of excluding one country from the analysis, namely Denmark, which may differ from Spain in terms of structural economic characteristics. This exclusion allows testing whether the results are driven by country-specific features of a single economy.

The results of the robustness checks are reported in Table 11. Overall, the main conclusions remain unchanged, although the magnitude of the effect varies slightly across specifications.

Variable	Specification	Effect, %	Standard Errors	T-stat	p-value	F-stat	R^2
Emissions	I	-4,99	0,13	-0,373	0,70	77,396	63%
	II	-12,22*	0,07	-1,75	0,08	3,06	81%
	III	-13,8**	0,07	-1,91	0,05	3,84	69%
Number of employees	I	6,18	0,09	0,65	0,52	1,42	66%
	II	0,2	0,08	0,03	0,97	0,01	62%
	III	3,05	0,07	1,62	0,11	2,11	68%
Total assets	I	38,02	0,15	1,05	0,29	4,10	74%
	II	9,42*	0,09	1,75	0,08	2,48	69%
	III	24,60	0,11	0,92	0,36	3,85	77%
Operating revenue	I	18,32	0,14	0,62	0,54	3,90	72%
	II	7,90	0,09	0,41	0,68	2,35	68%
	III	11,37*	0,1	1,67	0,09	2,80	70%

Table 11. *Robustness check.*

For emissions, in specification I the estimated effect is −5%. In specifications II and III, the effect becomes stronger (−12% and −13%) and is statistically significant in both cases. This indicates that the result is robust and does not depend on the estimation method. For the number of employees, no statistically significant effect is found in any of the three specifications, as the coefficient is not significantly different from zero. For total assets and operating revenue, specifications II and III show a statistically significant positive effect, respectively.

Overall, the results are consistent across all specifications and outcomes, and the sign of the estimated effect remains the same. The results also match those obtained in Sections 4.1 and 4.2, which confirms the robustness of the findings regardless of the specification used.

5. CONCLUSION

This study examined the effects of the EU ETS on CO_2 emissions and firms' economic performance. To achieve this objective, a quasi-experimental approach was applied, combining matching techniques with a DiD methodology. The empirical analysis was based on installation- and firm-level data from Denmark and Spain covering the period 2001–2019.

The results indicate that the introduction of the EU ETS contributed to a reduction in CO_2 emissions among regulated installations. Depending on the model specification, the estimated effect ranges from 15% to 30%. In the most conservative specification, including both installation and year fixed effects, emissions decreased by approximately 15%. These estimates are consistent with previous studies and provide further evidence of the environmental effectiveness of the EU ETS.

The analysis also showed that the effect differs across installations of different sizes. Large installations achieved a greater reduction in emissions compared to the control group, while the effect for smaller installations was less pronounced. This finding supports the argument that larger firms have greater capacity to adopt low-carbon technologies and to spread the costs of environmental investments over a larger scale of production.

The results on economic performance indicate that the EU ETS did not have a significant negative impact on firms. No statistically significant effect was found for employment in most model specifications, except for a weak negative effect in one specification. At the same time, positive effects were observed for financial indicators. In the most comprehensive specification, participation in the EU ETS was associated with an increase in total assets of about 8% and an increase in operating revenue of approximately 19%. Overall, the results support the main hypothesis of this study. The EU ETS appears to have reduced emissions while not causing a significant decline in the economic performance of regulated firms.

At the same time, the study has several limitations. First, the analysis covers only two countries, Denmark and Spain, and therefore the results cannot be directly generalized to all EU ETS members. Second, the identification of regulated installations is based on matching information from different registries, which may lead to some classification errors. Third, the DiD methodology relies on the assumptions of parallel trends and the absence of spillover effects, which cannot be fully tested.

The results are also robust to a range of alternative specifications, including different matching approaches, sample trimming, and country exclusion, confirming the stability of the main findings.

A direction for future research is the analysis of Phase IV of the EU ETS (2021–2030), which is characterized by much higher carbon prices and more ambitious climate targets. It would also be useful to study the interaction between the EU ETS, the CBAM, and the new ETS2 system, which from 2027 will cover emissions from buildings, road transport, and several other sectors.

Overall, the results show that the EU ETS is an effective climate policy instrument. The system helps reduce greenhouse gas emissions without causing major negative effects on the economic performance of regulated firms. This shows that environmental goals can be achieved while maintaining economic growth and business activity.

APPENDIX

Variable	Spain	Denmark	Both countries
Emissions, kt			
Mean per installation	725	144	459
Median installation	387	5	132
Share of emissions by sectors, %			
Manufacturing	39,8	22,3	38,5
Electricity, Gas and Steam	59,7	26,8	57,2
Water and Waste Management	0,5	2,2	0,6
Others	0,0	48,7	3,7
Share of installations by sectors, %			
Manufacturing	57,3	53,8	55,7
Electricity, Gas and Steam	40,5	10,3	26,7
Water and Waste Management	1,6	4,5	2,9
Others	0,6	31,4	14,7
Mean emissions by sectors, kt			
Manufacturing	494	47	296
Electricity, Gas and Steam	1 078	362	952
Water and Waste Management	262	38	105
Median emissions by sectors, kt			
Manufacturing	274	5	115
Electricity, Gas and Steam	563	37	499
Water and Waste Management	225	0,5	58

Table A.1. *Descriptive statistics of the CO_2 emissions sample.*

	Q1	Q2	Q3	Q4
Effect	0,195	-0,037	-0,017	-0,668***
p-value	0,509	0,811	0,927	0,005

Table A.2. *Heterogeneous treatment effects of the EU ETS by emission quartiles.*

Variable	ETS	Non-ETS
Number of employees		
Mean per company	152	107
Median company	24	20
Total assets, EUR		
Mean per company	50 210 518	19 249 910
Median company	3 082 417	2 947 894
Operating revenue, EUR		
Mean per company	64 092 509	25 454 884
Median company	3 338 962	3 893 437

Table A.3. *Descriptive statistics of the companies' performances sample.*

Declaration of Authorship: This thesis was primarily created by the author. AI was used as a language-support tool for stylistic editing, including improvements to structure, wording, clarity, grammar, and English-language formatting. It was also used to assist with citation management. All AI-generated suggestions were carefully reviewed, edited where necessary, and approved by the author. In accordance with the University of Vienna's AI policy, all scientific content, analysis, interpretation of results, and final decisions regarding the text remain the sole responsibility of the author.

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