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Deciphering the effect of the EU Emissions Trading System:
A panel data study on EU member states' FDI outflows

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Abstract
This paper examines the effect of the European Union Emissions Trading System (EU ETS) on foreign direct investment outflows of European Union member states. A panel data set on FDI outflows for 33 countries ranging from the year 1995 to 2019 and the empirical methods of multiple linear regression, difference-in-differences, and triple difference are used to examine the effect. This paper contributes to the research on the EU ETS by expanding the scope to a cross-country setting and studying the first three phases of the policy. Moreover, our study sheds light on some econometric difficulties associated with research on the relationship between environmental regulation and firms' investment decisions. Building on previous research on the EU ETS, carbon leakage, and the pollution haven effect, we hypothesize that the policy had a positive effect on EU member states' FDI outflows. The study fails to obtain any evidence of whether EU ETS had an effect on EU member states' FDI outflows.

Keywords: EU ETS, FDI outflows, Panel data analysis, Carbon leakage, Pollution haven hypothesis

JEL: F23, Q52, Q56, Q58

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1 Introduction

Environmental regulation and policy-making are increasingly at the forefront of the political agenda. Today, policy objectives are often directed towards reducing emissions and policy tools such as carbon taxes are becoming widely implemented (OECD, 2019). The European Union Emissions Trading System (EU ETS), implemented in 2005, was the world's first major carbon market. For the EU, it is a key component of their strategy for facing current climate challenges by reducing greenhouse gas emissions. To this day, it has remained the biggest carbon market in the world (European Commission, n.d.,a). There has been a debate regarding what costs environmental regulation carries. For example, it has been discussed whether environmental regulation could encourage domestic firms to relocate in order to save costs or hamper domestic firms' international competitiveness to the extent that they relocate to countries with less stringent regulation.

As the EU ETS is a unilateral policy, affecting the entire European Union market, one consideration is how it affects firms' investment decisions at large, including their foreign direct investment (FDI). Foreign direct investment is defined as "an investment reflecting a lasting interest and control by a foreign direct investor, resident in one economy, in an enterprise resident in another economy (foreign affiliate)" (UNCTAD, 2020). An important concern for the EU is to safeguard the competitiveness of the European Single Market. Therefore, the EU member states' FDI flows are of great concern when implementing environmental regulation. However, the empirical findings on the relationship between firms' investment flows and environmental regulation are diverse and to date, there is no conclusive empirical evidence of its bearing and significance.

In this paper, we examine if the EU ETS had an impact on the EU member states' FDI outflows. Our methodology is inspired by the study of Jayachandran et al. (2010) that investigates how the introduction of sulfa drugs affected mortality rates in the twentieth century. We mirror their use of a multiple linear regression model to search for a trend break in FDI outflows at the time of the adoption of the EU ETS and their use of a difference-in-differences analysis with a continuous year variable to investigate a possible causal relationship while controlling for a linear time trend. For this, we use a panel data set on country level FDI outflows from the year

1995 to 2019. First, we perform two multiple linear regression (MLR) analyses to examine whether the policy had an effect on EU member states' FDI outflows. These regressions will give us some idea if there was a break in the trends of FDI outflows when the EU ETS was implemented. Second, we employ a difference-in-differences (DID) analysis that allows us to compare EU member states' FDI outflows to non-EU OECD member states'[1] FDI outflows and thereby examines if the EU ETS affected EU member states' FDI outflows. Third, by developing an extension that allows us to categorize all countries based on their emissions and thereby their potential degree of exposure to the policy, we will perform a triple difference (TD) analysis to investigate whether the EU ETS had an extra effect on high emitting EU member state's FDI outflow. We fail to obtain any evidence of an effect on EU member states' FDI outflows as a result of the EU ETS. Furthermore, we fail to obtain any evidence of an extra effect on high emitting EU member states' FDI outflows as a result of the EU ETS.

Several studies have been conducted on the existence and effect of carbon leakage,[2] the pollution haven hypothesis,[3] and to what extent environmental stringency affects company investment decisions. In this paper, we will try to broaden the scope of the research done on the EU ETS and its effect on FDI outflows in individual countries (see Wagner & Timmins, 2009, Borghesi et al., 2020). While these studies are limited to one specific country and firm level data, we will expand the scope by including all countries regulated under the EU ETS to examine any potential cross-country wide effects. There has been, to our knowledge, no research on how a single environmental policy with EU ETS magnitude affects FDI outflows on a cross-country basis. Our results contribute to the understanding of how single policy decisions can affect FDI outflows and therefore the competitiveness of domestic firms, the relocation of firms and their production, and to what extent policymakers need to take this into consideration when implementing such policies. This is of interest both to policy makers, but further, to the general public as climate challenges and the tools used to combat them are growing in significance.

[1] Some countries are both EU member states and OECD member states. We will hereby, for simplicity, refer to OECD member states who are not EU member states as "OECD member states" or "control group"
[2] Carbon leakage refers to the phenomena of emissions that shift from a country with relatively stringent environmental regulations to another country with less stringent regulations. Further explained in Section 2.
[3] The pollution haven hypothesis refers to the phenomena that more stringent environmental policies or higher energy prices undermine competitiveness. Further explained in Section 2.

This paper is structured as follows: Section 2 reviews the relevant literature relating both to carbon leakage, the pollution haven hypothesis, the relationship between environmental regulation and FDI as well as EU ETS specific studies; Section 3 presents the policy background to the EU ETS; Section 4 describes our quantitative research design, presents our data and empirical methods; Section 5 presents our empirical results for all three analyses; Section 6 discusses our findings, the potential limitations of our study as well as presents some suggestions on further research; Section 7 summarizes and concludes our findings.

2 Previous research

How companies make investment decisions is a well-studied subject in many different fields of academia, not least within economics and policy-making. In general, these decisions are attributed to the wish to create shareholder value by maximizing revenues and minimizing costs. Companies face domestic regulations and policies and have to take this into consideration in their strategic decision-making. Such a strategic decision could be to take advantage of other countries' regulations and policies, for example, by setting up foreign subsidiaries. One type of domestic regulation that may differ between countries is environmental regulations. The relationship between firms' investment decisions and environmental regulation has been subject to previous research.

A potential limitation of environmental regulation directed at reducing emissions is that emissions would move to another country with less stringent regulation (European Commission, n.d.,b). This notion has been referred to as carbon leakage and has been extensively studied. Naegele and Zaklan (2019) describe the theoretical foundations of carbon leakage as two effects. One effect is that domestic firms relocate their production to countries with less stringent emissions constraints in order to lower their costs. The other effect is a loss in competitiveness of domestic firms to unregulated foreign competitors who do not face the same costly regulation, ultimately resulting in a loss of market shares of domestic firms. The notion of carbon leakage is similar to the pollution haven effect and furthermore the pollution haven hypothesis. The pollution haven effect describes how high environmental regulatory stringency in advanced countries shifts polluting industries to developing countries (Levinson & Taylor, 2004). OECD work on environment (2017) states precisely this about the pollution haven hypothesis (PHH): "..more stringent environmental policies or higher energy prices undermine competitiveness and lead to the erosion of industrial activity to the benefit of countries with laxer regulations." The PHH assumes that the shift of emissions is generated by FDI inflows to countries with less stringent environmental regulations (Singhania & Saini, 2021).

Although the PHH and carbon leakage are relatively well-studied subjects, the empirical evidence remains inconclusive. Furthermore, very few researchers have analyzed the relationship between FDI outflows and the EU ETS even though FDI outflows can work well as a measurement for determining the existence of pollution havens and carbon leakage.

Koch and Basse Mama (2019) investigated if the EU ETS had an effect on outward FDI decisions for German multinational firms using a matched difference-in-differences approach and found evidence for investment leakage, detected through FDI, for a small number of firms regulated under the EU ETS. Contrary to prior belief, these results were almost exclusively driven by a small number of firms, not operating in the most carbon-intensive industries, but instead in industries with low fixed costs associated with setting up production abroad. Borghesi et al. (2020) found that the EU ETS caused a significant increase in FDI outflows from Italian manufactures to their already active foreign subsidiaries, suggesting a production displacement effect. Using the number of foreign industrial subsidiaries and the sales of foreign industrial subsidiaries as proxies, the effect was most prevalent in trade-intensive firms. Their study also found that the costs of opening up a new subsidiary to shift production were prohibitively large compared to the costs incurred by the EU ETS. Verde (2020) looked at previous econometric literature on the EU ETS and FDI and found no general positive nor negative support for competitiveness effects and carbon leakage. However, the author also acknowledged the econometric difficulties that are associated with analyzing this subject and that more data is needed in order to make any conclusive remarks. In a review of the existing empirical work within this field, Joltreau and Sommerfeld (2019) set out to explain why the EU ETS did not have a concurrent negative effect on the competitiveness of domestic firms. Focusing primarily on phases 1 and 2 of the policy (2005 - 2012) they found that the large over-allocation of emissions allowances is a core explanation. Furthermore, they found that the fact that firms in some sectors are able to pass on costs to their end consumers left firms largely unphased by the EU ETS. They also conclude that there is no significant empirical evidence of carbon leakage as a result of the EU ETS.

The studies above all examine the EU ETS and its relation to FDI flows, either by performing new analyses or by reviewing previous research on the field. There is also research on the EU ETS and its relation to the pollution haven hypothesis and carbon leakage but not FDI flows specifically. All of these relate to FDI flows in the sense that their dependent variables, used to measure the pollution haven hypothesis and carbon leakage, are highly associated with FDI flows.

Naegele and Zaklan (2019) investigated if compliance costs incurred by the EU ETS on European manufacturing industries cause carbon leakage. Focusing on phases 1 and 2 (2004 - 2011) and by using trade flows of embodied carbon as a measurement for leakage they found no such effect. Their results suggest that the costs incurred by the EU ETS are smaller than the costs (e.g. transportation costs) and risks (e.g. political risk) associated with leakage. Dechezleprêtre et al. (2021) examined carbon emission data on 1122 companies whereof 261 were regulated under the EU ETS during the years 2007 - 2014. They found no significant carbon emission movement for these companies, including movement towards countries with much less stringent environmental policies. Instead, they concluded that the firms that are subject to the EU ETS reduce their emissions both within and outside the EU. Boutabba and Lardic (2017) explored if the EU ETS caused competitive losses or carbon leakage in the cement and steel industries of Europe and found negligible effects. Martin et al. (2014a) took on a dataset of 400 qualitative interviews with managers at companies that were subject to the EU ETS and found that trade exposure is not a determining factor in explaining to what extent the companies risk engaging in carbon leakage. Instead, they found that carbon intensity is heavily correlated with carbon leakage. Martin et al. (2014b) performed a meta-analysis on the literature on the impacts of the EU ETS on the industrial and power sectors. They found a robust causal sector-level effect on emissions in firms regulated under the EU ETS, a decline relative to estimated business-as-usual emission levels within these industries during phases 1 and 2 of the policy. Furthermore, they found a similar, but larger, effect on firm level data for studies within specific countries (Germany and France) during phase 2 of the policy.

A number of studies examine environmental regulation and its relation to FDI flows, the pollution haven effect, and carbon leakage by measuring environmental stringency instead of using specific policies like the EU ETS.

Controlling for industry agglomeration effects, Wagner & Timmins (2009) examined the pollution haven hypothesis and found economically significant evidence of the pollution haven effect for the German chemical industry. Kellenberg (2009) studied the pollution haven effect in a cross-country setting and found a statistically significant effect on U.S. outward multinational affiliate production during 1999 - 2003. Furthermore, the study found that the enforcement of environmental policies is usually more powerful in deterring firms than the regulatory stringency. Ben-David et al. (2020) used self-reported firm level data on carbon emission to analyze if strict domestic environmental policies lead to greater carbon emission in countries with less strict environmental policies. They found that the environmental policy stringency is correlated with both a larger share and a larger total amount of carbon emission in the country with less stringent policies. However, for the same companies, the overall carbon emissions are smaller on a global scale.

While the theoretical aspects of the field are clear, all studies on the empirical evidence suffer from a variety of problems. Some of these are hard to avoid due to the mere complexity of the field, but others are econometric-specific complications that can be accounted for by advancing or altering the econometric methods. A noteworthy aspect of the existing literature is that it primarily focuses on the two first phases of the EU ETS. As noted by Verde (2020), a majority of the literature, examined by the author, uses data up until 2010, meaning it only captures phase 1 and parts of phase 2, and only one study uses data up until 2015. The author also highlights the extensive use of the DID approach within the field and notes that it poses a risk of bias stemming from unobserved time-variant differences between treatment and control groups. The risk of bias is present when performing econometric methods such as multiple linear regression as well. Martin et al. (2014b) found that most of the available literature within the field focuses on correlations instead of robust causal inference. Moreover, much of the literature focuses on one specific country and industry level data where the country is chosen because the country-specific attributes are likely to be sensitive to such environmental policies.

Our study seeks to solve some of the econometric problems associated with the research field as well as focus on the EU ETS as a single policy decision instead of environmental stringency overall. Furthermore, our study seeks to expand the focus area of the EU ETS-specific studies by including as many countries, regulated under the EU ETS, as possible. Lastly, our study seeks to solely examine FDI outflows and not primarily evaluate the existence of carbon leakage or the pollution haven hypothesis in general.

3 Policy background

3.1 European Union Emissions Trading System

The initial ideas of the EU ETS were first presented in the year 2000 by the EU Commission with the objective to initiate a discussion with stakeholders on how emissions trading could be implemented within the European Union. The EU defines emissions trading as: "Emissions trading is a scheme whereby companies are allocated allowances for their emissions of greenhouse gases according to the overall environmental ambitions of their government, which they can trade subsequently with each other" (European Commission, 2000). Stakeholder discussions encompassed issues such as the objective of the freedom of establishment principle, relating to market conditions on the internal European market. A driving force behind the policy was also the commitment to emissions reduction set out in the Kyoto Protocol, signed by all EU member states in 1997 and ratified in 2002. In 2003 the European Parliament and Council adopted the EU ETS directive and the first phase of the system was scheduled to be in action in 2005 (European Parliament 2003/87/EC, 2003).

Phase 1 of the policy, stretching from 2005 - 2007, consisted of several measures such as the establishment of National Allocation Plans (NAPs), meaning that each EU member state decided on an allocation of emission allowances that in total summed up to a decentralized total cap on emissions allowances. The decisions on the NAPs were issued in 2004 - 2005. Phase 1 of the EU ETS covered only CO2 emissions from power generators and energy-intensive industries. The firms regulated under the policy were given nearly all allowances for free. In phase 1 the penalty for non-compliance was €40 per tonne of emissions (European Commission, n.d.,c). During phase 1, allowances exceeded the current levels of emissions, and thus the supply of allowances greatly exceeded the demand of emission-emitting industries. However, phase 1 succeeded in establishing "a price for carbon, free trade in emission allowances across the EU and the infrastructure needed to monitor, report and verify emissions from the businesses covered" (European Commission, n.d.,c). In phase 2 (2007 - 2012), free allocation of emissions rights fell to 90%, the penalty for non-compliance was increased to €100 per tonne and a lower cap on allowances was introduced (European Commission, n.d.,c). Phase 3 (2012 - 2020) included more industries and greenhouse gases and introduced a new cap on allowances with a yearly linear reduction (EU ETS Handbook, 2015). Today, in phase

4 (2021 - 2030), the system imposes more restrictive measures and the yearly reduction of allowances has been increased (European Commission, n.d.,d).

In the development of the EU ETS, policy makers were devoted to ensuring that current environmental regulations such as energy taxes or environmental agreements were reinforced by the EU ETS, rather than weakened. An important objective was to safeguard the mechanisms of the internal market and to minimize market distortions. For example, the EU ETS initially made specific exceptions to industries with the aim to maintain the competitiveness of EU ETS-affected industries and to reduce the risk of carbon leakage. Based on a number of criteria related to direct- and indirect costs and trade intensity, sectors that were deemed to be at risk of carbon leakage were given 100% free allowances up to a certain benchmark (Joltreau & Sommerfeld, 2019).

4 Quantitative research design

In this section, we first describe our quantitative data, explain the dependent variable and samples, explain the model extension that will be used in the triple difference model as well as discuss data issues. Second, we describe our hypothesis. Lastly, we specify the econometric models and variables that will be used to answer our research question and discuss the limitations of these models.

4.1 Quantitative data

4.1.1 Sources and basic facts

Our data set consists of panel data for 33 countries covering the years 1995 - 2019. Data on Foreign direct investment, net outflows (% of GDP) has been drawn from World Bank, World Development Indicators.

The data that is used for the extension in the triple difference analysis is data on total CO2 emissions from electricity and heat production as a percentage of total fuel combustion and total CO2 emissions from manufacturing industries and construction as a percentage of total fuel combustion. This data has been drawn from World Bank, World Development Indicators.

4.1.2 Dependent variable

Our dependent variable, FDI outflow, refers to "the net outflows of the sum of equity capital, reinvestment of earnings and other capital from the reporting economy to the rest of the world, as a percentage of the country's GDP" (World Bank, World Development Indicators, n.d.). This definition of FDI outflow is consistent for all econometric methods used. It is important to note that as our variable is constructed as the ratio between a country's FDI outflows and GDP, changes in the dependent variable depends on both changes in FDI outflows and GDP. As we are interested in whether FDI outflows grow in significance for a country relative to the countries' economic well-being, using FDI outflows as a percentage of GDP is preferable to an absolute measurement of FDI outflows. Furthermore, we will control for fixed effects to account for changes between countries and changes over time. This is discussed further in Section 4.3.2. It should be noted that international investments made by a country cannot be summarized as foreign direct investment. Among other things, the measurement excludes locally raised capital and non-equity transactions.

For the remainder of this paper, we will refer to our dependent variable as "FDI outflows". However, when interpreting the results and when clarification is helpful, we will refer to our dependent variable as "FDI outflows as a percentage of GDP".

4.1.3 Samples

The treatment group consists of the member states of the European Union in 2003 when the European Parliament and Council adopted the EU ETS directive (European Parliament, 2003). In addition to these countries, we have included the eight countries of central- and eastern Europe that joined the EU in the 2004 expansion. This is justified as negotiations underpinning EU expansion of 2004 were initiated prior to the official accessions and the EU ETS directive had been adopted prior to the accessions. As the United Kingdom was an EU member during the full sample period, the country is included in the treatment group.

The control group consists of the OECD member states, excluding all EU member states. Even though all countries in our control group were not members of OECD in 2003, we have chosen to include them as the membership is not important in itself but rather the common characteristics that make the countries a suitable control group. Similar to the EU member states, OECD member states are developed and established economies.

Mexico and Luxembourg are not included in our dataset due to missing values before the treatment year 2003. Even though Iceland and Norway are not member states of the EU, they could be included in the treatment group as they participate in the EU ETS. However, their participation started in the second trade period of the EU ETS (2008 - 2012) and are, therefore, in order to avoid different treatment dates, excluded from the treatment group. Cyprus and Malta are both considered outliers in our dataset and are therefore excluded. Furthermore, Bulgaria and Romania are excluded as they joined the EU in 2007 and Croatia is excluded as it joined the EU in 2013.

All in all, the data set on the 33 countries over the years 1995 - 2019 consists of 825 unique observations. 22 countries and thereby 550 observations are part of the treatment group and 11 countries and thereby 275 observations are part of the control group.

4.1.4 Extension

To conduct the triple difference analysis, we also use data on CO2 emissions. The data is used to create an extension that consists of the two dummy variables Hemi (high emission) and Lemi (low emission). The variables are constructed using the sum of two measurements of total CO2 emissions, namely, CO2 emissions from electricity and heat production as a percentage of total fuel combustion and total CO2 emissions from manufacturing industries and construction as a percentage of total fuel combustion. The two measurements of CO2 are chosen as they, as closely as the data allows, reflect the emissions regulated under the EU ETS (European Commission, n.d.,a). The variables are used to categorize the countries based on their emissions levels and to split the countries into two groups. Hemi denotes the 16 countries with the highest emissions and Lemi the 17 countries with the lowest emissions. The reason for constructing such a categorization is to describe to what extent a country is affected by the EU ETS. We assume that a country with high CO2 emissions from electricity and heat production as well as from manufacturing industries are more affected by the EU ETS than a country with low CO2 emissions from electricity and heat production as well as from manufacturing industries. Although a country from the control group is not regulated under the EU ETS, they are included in the categorization as this is necessary to perform our analysis.

Hemi consists of 10 countries from the treatment group and 6 countries from the control group. Lemi consists of 12 countries from the treatment group and 5 from the control group. The countries and the categorization are summarized in Table 7 in Appendix.

4.1.5 Limitations

Our choice of data was partially governed by public availability. One advantage of using data from World Bank, World Development Indicators database is that they are extensively used and established in the research community. However, there are some limitations to our data.

Our dependent variable, FDI outflows, consists of the net outflows of the sum of equity capital, reinvestment of earnings, and other capital from the reporting economy to the rest of the world. Hence, both FDI outflows from an EU member state to another EU member state and FDI outflows from an EU member state to a non-member state are included in the measurement. This is a limitation of our study as changes in FDI outflows cannot be distinguished as changes in FDI outflows within the EU or otherwise. As the purpose of this thesis is to examine the effect of the policy on EU member states' FDI outflows, this could limit our possibility of determining the true effect of the policy. Ideally, we would have liked to examine data on FDI outflows defined as the net outflows of the sum of equity capital, reinvestment of earnings, and other capital from the reporting economy to non-EU-member states.

There are several characteristics of the EU member states' total FDI outflows that affect the precision of our estimates. The outward FDI stock from EU member states consists of FDI in a number of different industries such as financial intermediation, business services, trade & repairs, electricity, gas & water, etc. These industries represent different portions of the total stock of outward FDI. In 2005, the financial intermediation sector represented 35% of the total value of outward FDI and the business services sector represented approximately 30% (European Union foreign direct investment yearbook, 2008). In 2014, the service industry at large represented 59% of outward FDI, whereof financial services represented 66%. Meanwhile, the manufacturing industry represented 27% of outward FDI stock with petroleum, chemical, and pharmaceutical products representing 40% of that (Eurostat, 2017). This is relevant as these industries vary in their emissions intensity. The manufacturing industry is relatively more emissions-intensive than, for example, the financial services industry. We assume that an industry, less dependent on emissions-intensive production, is less affected by environmental regulation targeting emissions. Thus, when studying the effect of a policy directed at emissions, the abundance of FDI stock value attributed to non-emissions-intensive industries might make it more difficult to capture the effect of the policy.

4.2 Research question and hypothesis

The question we seek to answer is: did the EU ETS have an effect on EU member states FDI outflows? Our hypothesis is that the EU ETS had positive effects on FDI outflows for EU member states. We will also divide the effect into an intercept effect and a slope effect. We expect both of these effects to be positive. This hypothesis will be tested with a multiple linear regression and a difference-in-difference analysis.

To answer our research question we also seek to answer: did the EU ETS have an extra effect on high emitting EU member states' FDI outflows? Our hypothesis is that there will be an extra effect on high emitting EU member states' FDI outflows. This hypothesis will be tested with a triple difference analysis.

Our hypotheses are based on the research presented in our literature review. While the effect of environmental regulation on FDI outflows is not exhaustively mapped, it does seem to have explanatory power on a national level and for high emitting industries. We expected this to expand to a cross-country level.

We expect that the EU ETS has deterred OECD member states from investing in the EU. Either OECD member states might have reduced FDI outflows in total or they have, as we expect is the case for the EU member states, shifted FDI directed towards the EU towards countries not participating in the EU ETS. In any case, this implies that when we compare the FDI outflows of EU member states and OECD member states, we are studying the differential effect of the policy, or in other words, the composite effect.

4.3 Econometric specification

4.3.1 Trend-break models

To test our hypothesis, we have constructed a number of different regression models. First of all, we have performed two multiple linear regression analyses that we call trend-break models

1 and 2. With these models, we investigate whether the EU ETS had an impact on the treatment group's FDI outflows. These regressions will give us some idea as to whether there was a trend break around the time of the treatment. The trend-break models are specified below, where the first one allows for an intercept change and the second one allows for an intercept- and slope change. We estimate the following regressions:

Trend-break models

$$FDIoutflowEU_{it} = \beta_0 + \beta_1 CenYear_t + \delta_0 CenPost2003_t + e1_{it} \quad (1)$$

$$+ \delta_1 (CenPost2003_t \ x \ CenYear_t) + e2_{it} \quad (2)$$

where $FDIoutflowEU_{it}$ is FDI outflows as a percentage of GDP for EU member state i in year t, $CenYear_t$ is a continuous year variable centered on 2003, $CenPost2003_t$ is a dummy variable equal to one for the year 2003 and after, $CenPost2003_t \, x \, CenYear_t$ is an interaction term between $CenPost2003_t$ and $CenYear_t$. As for the coefficients, β_1 represents the average change of FDIoutflowEU in percentage points for every year, δ_0 represents the mean difference in percentage points of FDIoutflowEU between the post-treatment period and pre-treatment period, and δ_1 represents the mean difference in percentage points of the average yearly change in FDIoutflowEU between the post-treatment period and pre-treatment period. In model 1, we are interested in δ_0 and in model 2, we are interested in δ_0 and δ_1. The continuous year variable CenYear and the dummy variable CenPost2003 are centered on 2003 to ease the interpretation of the intercept. We use cluster robust standard errors on country level to account for possible correlation in our model's unexplained variation.

We have decided to examine the effect of the EU ETS using the year of the adoption of the directive, 2003, as the policy implementation date. In other words, we use 2003 as the treatment year. There are two reasons for choosing this date rather than 2005, the beginning of phase 1. Firstly, the directive of 2003 set out the conditions of the system and the policy measures started to form. Already in 2004, the decisions of the NAPs were issued, for example. Secondly, discussions with stakeholders regarding the policy began already in 2000. Thus, any effect on companies' investment decisions might be visible before the beginning of phase 1.

There are some limitations to the MLR analysis. In the MLR models, we have not included all variables that have explanatory power for the variation in FDI outflow, and thus, our regressions suffer from omitted variable bias. For instance, there are a number of determinants of FDI that explain the variation in FDI outflows that have been excluded. For example, the size of the country's population and infrastructure (Onder & Karal, 2013). A solution to this would be to control for more omitted variables. However, this would raise other issues. As more explanatory variables are added to the regression, the standard errors increase if explanatory variables are highly correlated with each other. Thus, the option of adding controls to eliminate our bias is constrained by the trade-off between increasing the variance and obtaining unbiased estimates. Moreover, because of the mere complexity of the determinants of FDI, their inclusion in a MLR model is simply not feasible. Due to these issues, we will also perform difference-in-differences analyses.

4.3.2 Difference-in-differences models

Second, we have performed a generalized difference-in-differences analysis. The DID analyses allow us to compare the FDI outflows of the EU member states to the OECD member states and examine if the EU ETS had an effect on FDI outflow. The first DID model allows for an intercept change and the second allows for an intercept- and slope change.

Difference-in-differences intercept model

$$FDIoutflow_{it} = \beta_0 + \beta_1(Treat_i \ x \ CenPost2003_t) + \beta_2(Treat_i \ x \ CenYear_t) + \beta_3 Treat_i +$$

$$\beta_4 CenYear_t + \beta_5 CenPost2003_t + e1_{it} \tag{1}$$

$$+ F_y + e2_{it} \tag{2}$$

$$+ F_c + e3_{it} \tag{3}$$

$$+ (-) \ F_y + e4_{it} \tag{4}$$

To the DID intercept model above and the DID intercept- and slope model below, we have constructed three alternative versions using fixed effects on yearly level (DID intercept model 2 and DID intercept- and slope model 2), on yearly- and country level (DID intercept model 3 and DID intercept- and slope model 3), and on country level (DID intercept model 4 and DID intercept- and slope model 4). In all specifications of the DID models, we control for a linear time trend by including a continuous year variable.

In the DID intercept model, $FDIoutflow_{it}$ is the FDI outflows as a percentage of GDP for country i in year t, $Treat_i$ is a dummy variable equal to one for all EU member states, $CenYear_t$ is a continuous year variable centered on 2003, $CenPost2003_t$ is a dummy variable equal to one for the year 2003 and after, $Treat_i$ x $CenPost2003_t$ is an interaction term between $Treat_i$ and $CenPost2003_t$, $Treat_i$ x $CenYear_t$ is an interaction term between $Treat_i$ and $CenYear_t$, F_y is a vector representing a dummy variable for each year and F_c is a vector representing a dummy variable for each country. As for the coefficients, β_1 measures whether the increase in FDIoutflow, post-treatment, was larger for the treatment group compared to the control group, β_2 represents the mean difference in percentage points of the average yearly change in FDIoutflow between our treatment and control group, β_3 represents the mean difference in percentage points of FDIoutflow between our treatment- and control group, β_4 represents the average change of FDIoutflow in percentage points for every year, and β_5 represents the mean difference of FDIoutflow in percentage points between the post- and pre-treatment period. In all specifications of the model, we are interested in β_1. We use cluster robust standard errors on country level to account for possible correlation in our model's unexplained variation.

Difference-in-differences intercept- and slope model

$$FDIoutflow_{it} = \beta_0 + \beta_1(Treat_i \text{ x } CenPost2003_t \text{ x } CenYear_t) + \beta_2(Treat_i \text{ x } CenPost2003_t) +$$

$$\beta_3(Treat_i \text{ x } CenYear_t) + \beta_4 Treat_i + \beta_5 CenYear_t + \beta_6 CenPost2003_t + e1_{it} \quad (1)$$

$$+ F_y + e2_{it} \quad (2)$$

$$+ F_c + e3_{it} \quad (3)$$

$$+ (-)\ F_y + e4_{it} \quad (4)$$

where all variables and their respective coefficients are defined as for DID intercept model 1 - 4 with the addition of the interaction term $Treat_i$ x $CenPost2003_t$ x $CenYear_t$ that represents the slope variable. As for the coefficient of the interaction term added, β_1 measures whether the increase in FDIoutflow, post-treatment, was larger for the treatment group compared to the control group. In all specifications of the model, we are interested in whether β_1 and β_2 are jointly significant. We use cluster robust standard errors on country level to account for possible correlation in our model's unexplained variation.

For the DID estimators to be reliable, it is necessary that the identifying assumption, the parallel trend assumption, holds. The assumption states that the treatment and control group would experience the same trends in FDIoutflow in absence of the policy. If the assumption is violated, the DID estimators will be biased. We will discuss this identifying assumption together with our results in Section 6.

The difference-in-differences analyses allow us to mitigate the bias of our regressions. Some of the omitted variables only vary across time, such as global economic cycles, and some only vary across countries, such as countries' natural resources, and therefore have country invariant or time invariant effects on FDI outflows. This bias can be dealt with by controlling for time-specific and country-specific variation. We do this in the three variations of the DID models by controlling for fixed effects on yearly level, yearly- and country level, and country level. However, our DID models could potentially still suffers from bias as the error term also consists of an idiosyncratic effect generated by explanatory variables that vary both with time and countries. It is difficult to perfectly control for all potential idiosyncratic effects in regards to FDI outflows and thus our regressions could still suffer from some bias.

Our treatment group consists of EU member states that share many common characteristics. For instance, all EU member states are regulated under EU law and are part of the EU single market. Thus, there might be variables that vary over time and between our treatment- and control group. An example of such a factor that varies over time and between the treatment- and control group, is one of the fundamental freedoms of the EU single market, free movement of capital. This was first specified in the Treaty of Maastricht on European Union (later on in the Treaty on the Functioning of the European Union, TFEU). The treaty was implemented in order to prohibit all forms of restriction of capital movement and thereby work towards enabling an open European financial market (European Commission, n.d.,e). As it was implemented in 1994, the regulation could be considered to not have an effect on FDI flows in the EU that is varying over time (since we study the effect of FDI outflows between 1995 - 2019 and therefore after the treaty was implemented). However, the notion of free movement of capital within the EU has changed over the years. Various exceptions, described in Article 65 of TFEU, have been given to countries for different reasons. For example, in order to prevent an excessive outflow of capital as a result of the European sovereign debt crisis that began in late 2009, Cyprus announced capital controls in 2013 and Greece in 2015. These restrictions were removed from Cyprus in 2015 and from Greece in 2019. Moreover, in September 2015, the European Commission introduced the Capital Markets Union (CMU). The aim of this is to further foster a single market for capital in the European Union and remove regulatory barriers that hinder free movement of capital (European Commission, n.d.,f).

Overall, the EU single market is an important factor when it comes to understanding FDI flows for its member states. The free movement of goods and services provides an incentive for member states to favor trade and investments within the EU. As described above, there have been changes and developments in terms of the strength and meaning of important aspects of capital movement in the EU and these changes and developments are expandable to the European single market as a whole.

Even though exceptions as the ones described above for Cyprus and Greece hinder foreign investments, we can conclude that the European Union is becoming increasingly integrated in terms of working as one single market. When it comes to if and how this will affect our results, there is some uncertainty. A more open and integrated market in the EU provides an incentive for our treatment group to increase their FDI outflow. Not being able to control for these changes could potentially lead to a slightly upward biased effect. However, it is also not unreasonable to think that there could be a substitution effect. Companies in EU member states who previously invested in non-EU countries could change their investment flows towards the European single market. In this case, this would lower the FDI outflows towards control countries and thereby have a downward bias effect. However, such a downward bias effect would, in the case of its existence, not reveal itself in our results as we cannot distinguish whether FDI outflows from the treatment group are directed towards EU member states or otherwise (see discussion in Section 4.1.6).

Another important factor to take into consideration is whether there were other events or changes around the time of the treatment. When introducing a new policy, one possible consequence, besides what follows from the regulation itself, could be a domestic shift in public opinion. If the EU ETS contributed to an increased awareness of climate issues, such a change could have an impact on firms' investment decisions. If for example, increased awareness resulted in increased customer demands on sustainable practices, this could force companies to relocate or reinvent their production. Increased awareness of climate issues could therefore have an upward or downward bias effect on our estimates.

As previously stated, these are biases we cannot remove using fixed effects on a yearly- nor country level and constructing an econometric approach to dealing with such factors is beyond the scope of this paper. However, we have yet not found a similar policy or event that could have a large impact on FDI outflows at the time of the treatment.

4.3.3 Triple difference model

Lastly, we have performed a triple difference analysis. By turning to our extension and the categorization of all countries into Hemi and Lemi, we can perform a TD analysis with a less strict identifying assumption. The identifying assumption for the triple difference model states that the relative FDI outflows of the high emission countries and low emission countries in the treatment group trend in the same way as the relative FDI outflows of the high emission countries and low emission countries in the control group, in absence of the EU ETS. Essentially, we are assuming that the effect of the policy cannot be seen for the group of countries included in Lemi as they have relatively lower emissions regulated under the EU ETS, while the effect might be prevalent for the group of countries included by Hemi as they have relatively higher emissions regulated under the EU ETS. In other words, we are examining whether there was an extra effect in FDIoutflow for the EU Hemi countries relative to the FDIoutflow of the EU Lemi group. We do this by taking the difference of two difference-in-differences. This can be described using the TD estimator below:

$$\hat{\beta} = \Big((\bar{Y}_{Treat,Hemi,Post2003} - \bar{Y}_{Treat,Hemi,Post2003}) - (\bar{Y}_{Control,Hemi,Post2003} - \bar{Y}_{Control,Hemi,Pre2003}) \Big) - ((\bar{Y}_{Treat,Lemi,Post2003} - \bar{Y}_{Treat,Lemi,Pre2003}) - (\bar{Y}_{Control,Lemi,Post2003} - \bar{Y}_{Control,Lemi,Pre2003}))$$

Triple difference model

$$FDIoutflow_{it} = \beta_0 + \beta_1(Treat_i \times CenPost2003_t \times Hemi_i) + \beta_2(Treat_i \times CenPost2003_t) + \beta_3(Treat_i \times Hemi_i) + \beta_4(CenPost2003_t \times Hemi_i) + \beta_5 Treat_i + \beta_6 Hemi_i + \beta_7 CenPost2003_t + e_{it}$$

where all variables are defined as in the DID regressions above and in Section 4.1.1. We use cluster robust standard errors on country level to account for possible correlation in our model's unexplained variation.

The TD estimator, $Treat_i \times CenPost2003_t \times Hemi_i$, can be interpreted as the extra effect in FDIoutflow for the EU Hemi countries relative to the change in FDIoutflow for the EU Lemi countries after the treatment.

The triple difference analysis is more robust compared to the difference-in-differences models and allows us to control for a lot of potential biases. However, a TD analysis might also be biased. Another event, occurring simultaneously as the treatment, could affect our regression results. Therefore, the discussion regarding other events and changes at the time of the treatment, in Section 4.3.2, is relevant to take into consideration for the triple difference analysis as well. However, as previously stated, we have yet not found a similar policy or event that could have a large impact on FDI outflows at the time of the treatment.

4.3.4 List of variables

Table 1: List of variables

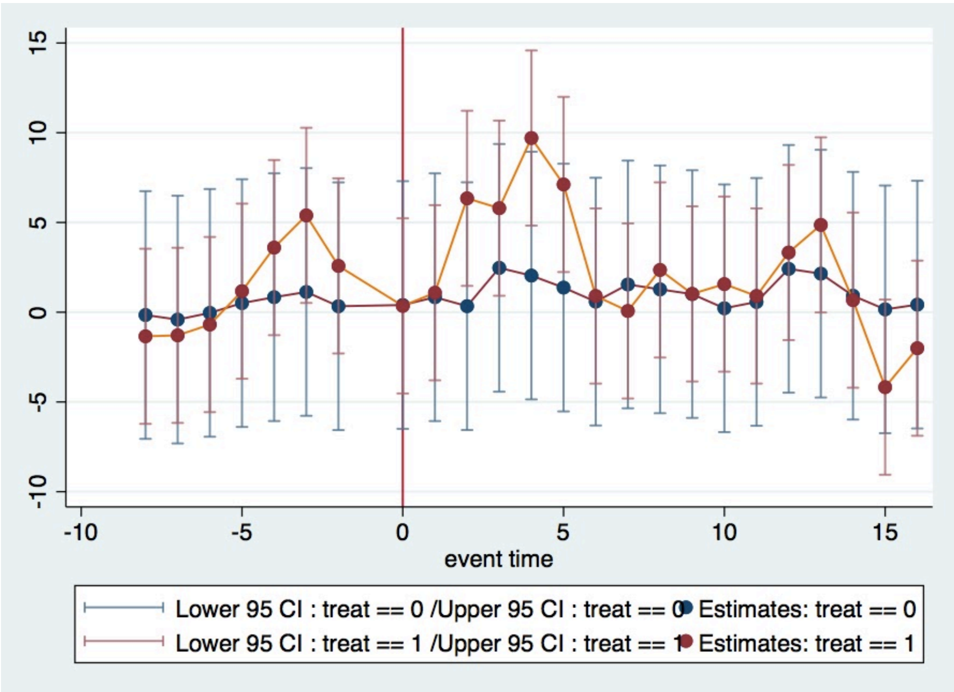
Variable	Description	Type of variable	Source
FDIoutflow	FDI outflows from treatment- and control group (% of GDP)	Dependent	World Bank, WDI
FDIoutflowEU	FDI outflows from treatment group (% of GDP)	Dependent	World Bank, WDI
CenYear	Continuous year variable centered on 2003	Independent	
CenPost2003	Dummy variable: 1 for year 2003 and afterwards, 0 otherwise	Independent dummy	EU
Treat	Dummy variable: 1 if country is in the treatment group, 0 otherwise	Independent dummy	EU
F_y	Dummy variables for each year between 1995 and 2019 (fixed effects on yearly level)	Independent dummy	
F_c	Dummy variables for each country (fixed effects on country level)	Independent dummy	
Hemi	Dummy variable: 1 if country is in the category "high emission", 0 otherwise	Independent dummy	World Bank, WDI
Lemi	Dummy variable: 1 if country is in the category "low emission", 0 otherwise	Independent dummy	World Bank, WDI

5 Empirical results

5.1 Graphical evidence of trend break

To investigate a potential trend break in FDI outflows, we have constructed a graph using all countries. The graph will not be used for any statistical inference but is rather a visual aid to see if there seems to be a trend break for the treatment group compared to the control group around the time of the treatment year. The graph has the average FDI outflows as a percentage of GDP for the treatment group (red) and the control group (blue) on the y-axis and the years centered on 2003 on the x-axis.

Figure 1: Time series of FDI outflows for all countries



Note: FDI outflow is measured as a percentage of GDP. Event time "0" refers to the treatment year, 2003. Data source: World Bank, World Bank Development Indicators.

5.2 Results from trend-break models

Below are the regression results from trend-break models 1 and 2 as specified in Section 4.3.1.

Table 2: Regression results from trend-break models

	(1)	(2)
VARIABLES	FDI outflow EU	FDI outflow EU
CenPost2003	4.268*	1.193
	(2.096)	(2.008)
CenPost2003 x CenYear		-0.922***
		(0.254)
CenYear	-0.248***	0.588***
	(0.0870)	(0.183)
Constant	2.622***	6.385***
	(0.877)	(1.765)
Observations	550	550
R-squared	0.014	0.027

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. FDI outflow EU is measured as a percentage of GDP. CenYear is the continuous year variable centered on 2003. CenPost2003 is the post-treatment dummy.

In model 1, the coefficient of interest, CenPost2003, tells us that for the treatment group, the predicted effect of the mean difference in FDI outflows as a percentage of GDP between the post-treatment period and pre-treatment period is 4.268 percentage points. The coefficient is statistically significant at a 10% level.

In model 2, the first coefficient of interest, CenPost2003, tells us that for the treatment group, the predicted effect of the mean difference in FDI outflows as a percentage of GDP between the post-treatment period and pre-treatment period is 1.193 percentage points. The coefficient is not statistically significant. The second coefficient of interest, CenPost2003 x CenYear, tells us that for the treatment group, the mean difference of the average yearly change in FDI outflows as a percentage of GDP between the post-treatment period and pre-treatment period is -0.922 percentage points. These results tells us that in 2004, the slope for EU member states' FDI flow as a percentage of GDP decreased by 0.922 percentage points, in 2005 it decreased by 1.1844 percentage points[4], and in 2010 it decreased by 6.454 percentage points[5]. The coefficient is statistically significant at a 1% level.

5.3 Results from difference-in-differences models

Below are the regression results from the difference-in-differences intercept specifications 1 – 4 as specified in Section 4.3.2.

Table 3: Regression results from difference-in-differences models

	(1)	(2)	(3)	(4)
VARIABLES	FDI outflow	FDI outflow	FDI outflow	FDI outflow
Treat x CenPost2003	3.426	3.426	3.426	3.426
	(2.127)	(2.156)	(2.199)	(2.168)
Treat x CenYear	-0.247**	-0.247**	-0.247**	-0.247**
	(0.0912)	(0.0924)	(0.0943)	(0.0930)
Treat	0.875	0.875		
	(1.089)	(1.104)		
CenYear	-0.00123			-0.00123
	(0.0291)			(0.0297)
CenPost2003	0.842*			0.842*
	(0.435)			(0.444)
Constant	1.746**	2.314***	2.898***	2.330***
	(0.653)	(0.722)	(0.803)	(0.782)
Fixed effects (yearly)		Y	Y	
Fixed effects (country)			Y	Y
Observations	825	825	825	825
R-squared	0.029	0.090	0.370	0.309

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. FDI outflow is measured as a percentage of GDP. CenYear is the continuous year variable centered on 2003. CenPost2003 is the post-treatment dummy. Y is an indication of whether fixed effects is employed.

In all specifications of the model, the DID estimator, Treat x CenPost2003, tells us that after the treatment year, the predicted effect for the treatment group is a 3.426 percentage points

[4] 2 x 0.922 = 1.1844
[5] 7 x 0.922 = 6.454

larger increase in FDI outflows as a percentage of GDP compared to the control group. The result is not statistically significant.

In specification 1, we include the post-treatment dummy, CenPost2003, and the treatment group dummy, Treat, and in specification 2 - 4 we control for fixed effects on yearly level, yearly- and country level, and country level respectively. As we can see in our results, controlling for fixed effects does not have a large impact on our coefficients. This is expected as we already control for a linear combination of the fixed effects with the CenPost2003- and Treat dummy. Controlling for fixed effects simply increased the standard errors. As expected, CenPost2003 and CenYear are both dropped from the regression for specification 2 and 3 when using fixed effects on yearly level and Treat is dropped from the regression for specification 3 and 4 when controlling for fixed effects on country level. This is due to multicollinearity between the variables.

Below are the regression results from the difference-in-differences intercept- and slope specifications 1 – 4 as specified in Section 4.3.2.

Table 4: Regression results from difference-in-differences intercept- and slope model

	(1)	(2)	(3)	(4)
VARIABLES	FDI outflow	FDI outflow	FDI outflow	FDI outflow
Treat x CenPost2003 x CenYear	-0.922***	-0.808***	-0.808***	-0.922***
	(0.252)	(0.267)	(0.273)	(0.257)
Treat x CenPost2003	0.351	0.734	0.734	0.351
	(2.041)	(2.060)	(2.101)	(2.081)
Treat x CenYear	0.590***	0.486**	0.486**	0.590***
	(0.184)	(0.193)	(0.197)	(0.187)
Treat	4.639**	4.171**		
	(1.871)	(2.014)		
CenYear	-0.00123			-0.00123
	(0.0291)			(0.0297)
CenPost2003	0.842*			0.842*
	(0.436)			(0.444)
Constant	1.746**	2.314***	5.095***	4.839***
	(0.654)	(0.722)	(0.991)	(0.956)
Fixed effects (yearly)		Y	Y	
Fixed effects (country)			Y	Y
Observations	825	825	825	825
R-squared	0.041	0.093	0.373	0.321

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. FDI outflow is measured as a percentage of GDP. CenYear is the continuous year variable centered on 2003. CenPost2003 is the post-treatment dummy. Y is an indication of whether fixed effects is employed.

In all specifications of the model, we are interested in whether Treat x CenPost2003 x CenYear and Treat x CenPost2003 are jointly significant. Below is a summary of the F-statistics and P-values for these two variables.

Table 5: F-statistics and P-values for intercept-and slope specification 1 - 4

Specification	(1)	(2)	(3)	(4)
F-statistics	6.84	4.80	4.61	6.58
P-values	0.0034	0.0151	0.0174	0.0040

In specification 1, the DID estimator is jointly significant at a 1% level, in specification 2, the DID estimator is jointly significant at a 5% level, in specification 3, the DID estimator is jointly significant at a 5% level and in specification 4, the DID estimator is jointly significant at a 1% level.

Specification 1 tells us that, in 2003, the predicted effect for the treatment group was an increase of 0.351 percentage points in FDI outflows as a percentage of GDP compared to the control group. In 2004, the DID estimator, Treat x CenPost2003 x CenYear and Treat x CenPost2003 equals -0.571. Thus, after the treatment year, in 2004, the treatment group had a 0.571 percentage points[6] lower change in FDI outflows as a percentage of GDP compared to the control group. Following the same interpretation, in 2005, the predicted effect is -1.493 percentage points[7] and in 2010, the predicted effect is -6.103 percentage points[8].

Following the same reasoning as in our DID intercept model, the inclusion of fixed effects on yearly level, yearly- and country level, and country level, should not have a large impact on our DID estimator but increase the standard errors. As we see in the results for specifications 2 - 4, this is the case. Furthermore, following the same reasoning as in our DID intercept model, the variables CenPost2003, CenYear, and Treat are dropped when using fixed effects.

[6] (-0.922) + 0.351 = -0.571
[7] (-0.922x2) + 0.351 = -1.493
[8] (-0.922x7) + 0.351 = -6.103

5.4 Results from triple difference model

Below is the regression result from the triple difference model as specified in Section 4.3.3.

Table 6: Regression results from the triple difference model

	(1)
VARIABLES	FDI outflow
Treat x CenPost2003 x Hemi	-2.630
	(2.483)
Treat x CenPost2003	1.568
	(2.343)
Treat x Hemi	-1.787
	(2.195)
CenPost2003 x Hemi	0.334
	(0.462)
Treat	2.651
	(2.002)
Hemi	-1.616
	(1.386)
CenPost2003	0.645**
	(0.291)
Constant	2.633*
	(1.360)
Observations	825
R-squared	0.080

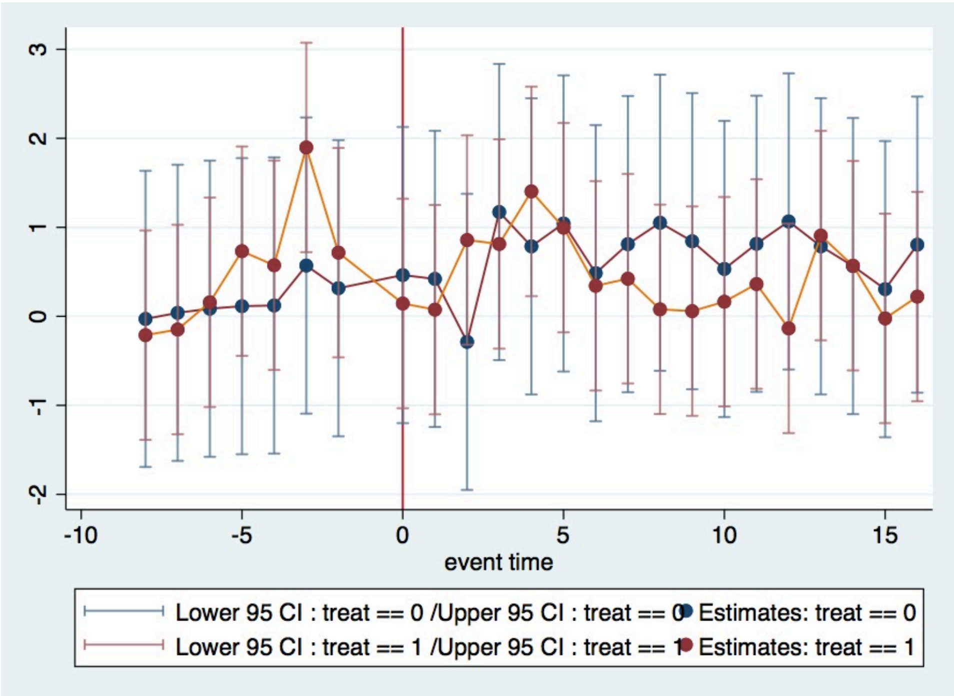
Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. FDI outflow is measured as a percentage of GDP. CenPost2003 is the post-treatment dummy. Hemi is the dummy for high emission countries.

The triple difference estimator, Treat x CenPost2003 x Hemi tells us that, after the treatment year, the treatment Hemi group had a 2.630 percentage points lower change in FDI outflows as a percentage of GDP compared to the treatment Lemi countries. The result is not statistically significant.

To study the identifying assumption for the triple difference model, we have constructed three graphs. The graphs in Figure 2 and Figure 3 have the average FDI outflows as a percentage of

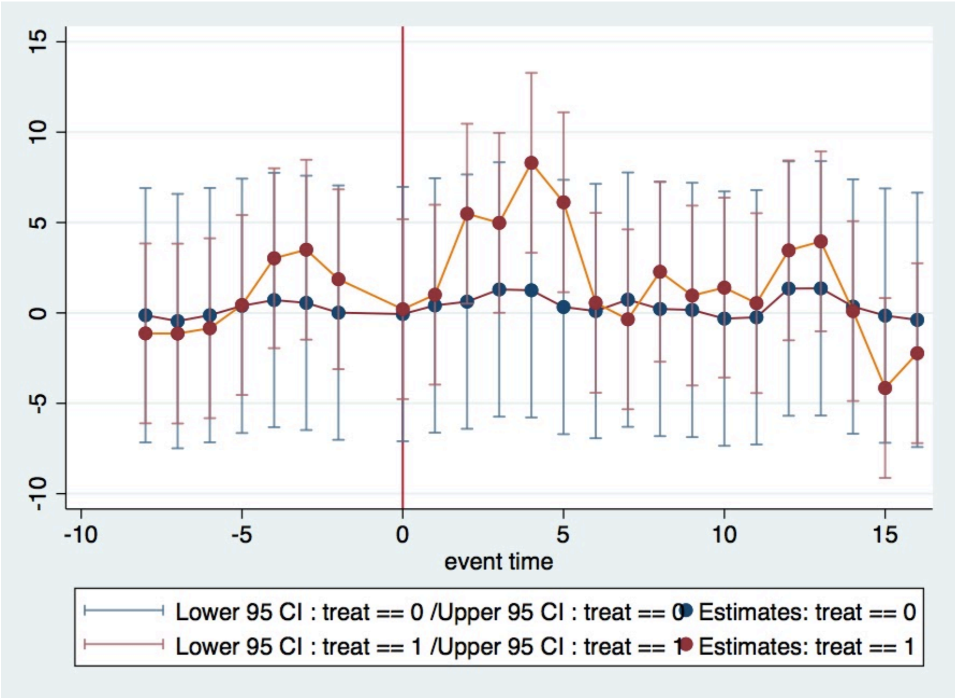
GDP for the treatment group (red) and the control group (blue) on the y-axis and the years centered on 2003 on the x-axis. The graph in Figure 2 displays the trend in FDI outflows for the high emission countries. The graph in Figure 3 displays the trend in FDI outflows for the low emission countries. The graph in Figure 4 displays the difference in FDI outflows as a percentage of GDP between countries categorized as Hemi and Lemi. In Figure 4, the red line represents the EU member states and the blue line represents the OECD member states. We will discuss the identifying assumption together with these results in our discussion, section 6.

Figure 2: Time series of FDI outflow for all countries categorized as "high emission"



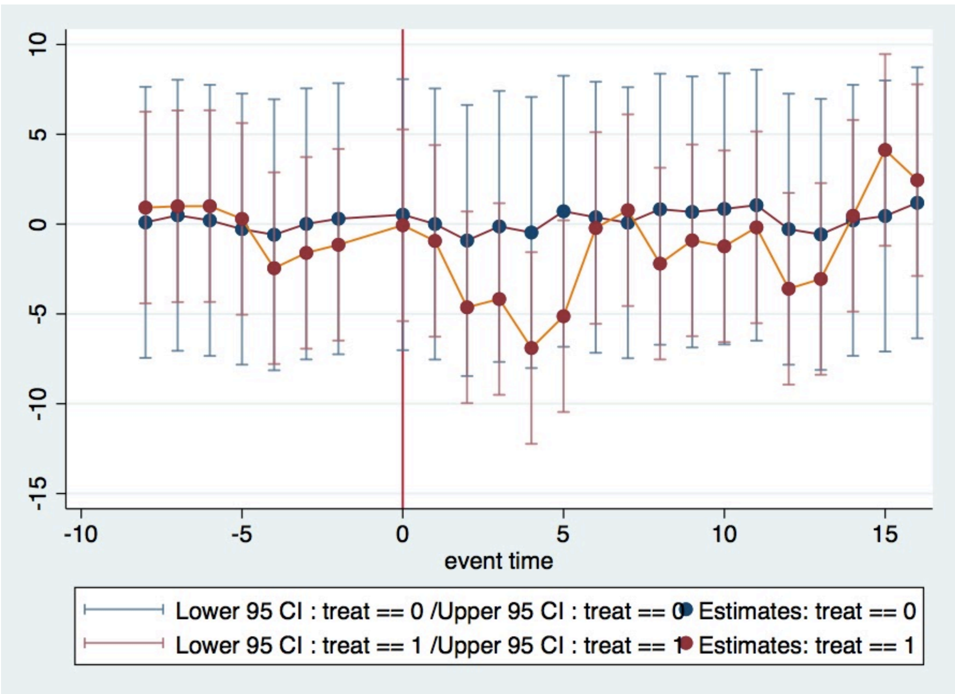
Note: FDI outflow is measured as a percentage of GDP. Event time "0" refers to the treatment year, 2003. Data source: World Bank, World Bank Development Indicators.

Figure 3: Time series of FDI outflow for all countries categorized as "low emission"



Note: FDI outflow is measured as a percentage of GDP. Event time "0" refers to the treatment year, 2003. Data source: World Bank, World Bank Development Indicators.

Figure 4: Time series of the difference in FDI outflow between countries categorized as "high emission" and "low emission"



Note: FDI outflow is measured as a percentage of GDP. Event time "0" refers to the treatment year, 2003. Data source: World Bank, World Bank Development Indicators.

6 Discussion

We hypothesized that the EU ETS would have had positive effects on FDI outflows for EU member states and that both the intercept- and slope coefficients would be positive. We tested this with a multiple linear regression analysis and a difference-in-differences analysis. Furthermore, we hypothesized that there would have been an extra effect on high emitting EU member states' FDI outflows. We tested this with a triple difference analysis.

With the graphical evidence and the trend-break models, we can simply conclude that there seems to be a trend break at the time of the treatment. However, as previously stated, this analysis cannot be used for any causal inference due to the many econometric difficulties that are associated with such an analysis. Employing difference-in-differences analyses and allowing for both a change in intercept and slope, we find a small but significant impact of the EU ETS on FDI outflows for EU member states.

For the DID analyses to be reliable, it is necessary that the parallel trend assumption holds. The assumption states that the treatment- and control group would experience the same trends in FDI outflows in absence of the policy. If the assumption is violated the DID results will be biased. We tested this by looking at the graphical evidence for all countries before the treatment date, presented in Section 5.1. We can see that the treatment- and control group do not follow parallel trends prior to the policy and the identifying assumption is therefore violated. The graph shows that an increase in FDI outflows for treated countries is accompanied by an increase in FDI outflows for the control countries and vice versa. However, the magnitudes of these changes are substantially different between the treatment- and control group.

In addition to relying on the graphical evidence, looking at the regression results can also provide some valuable insights into the reliability of the identifying assumption. First and foremost, the results of the DID intercept model show that the interaction term, Treat x CenYear, is the only statistically significant variable. This could mean a few different things. It could be the case that the FDI outflows trends for the treatment- and control group are different before the treatment date. This would violate the parallel trend assumption. Furthermore, it could be the case that they follow different trends in FDI outflows after the treatment. It could also be a combination of these two scenarios. However, if they would follow statistically significant different trends after the treatment, this would have been reflected in the DID estimator, Treat x CenPost2003. Since the DID estimator was not statistically significant, we can conclude that the trends differed before the treatment and the parallel trend assumption is thereby violated.

The problem with the parallel trend assumption as described above is also prevalent in the DID intercept- and slope model. The DID estimator could simply be capturing the different trends between the treatment- and control group before the actual treatment. Since we now understand that the parallel trend assumption is violated, we conclude that the joint significance of the DID estimator, Treat x CenPost2003 x CenYear and Post2003 x Treat, is simply a result of underlying different time trends.

When interpreting the results from the DID models, it is also important to note that our standard errors are quite large and that the large confidence intervals, therefore, display an imprecise estimate of the policy effect. This reveals a somewhat low power of our analysis and it is important to keep this in mind when interpreting both the results from the regressions as well as the analysis of the parallel trend assumption. Thus, there could be a policy effect that we fail to capture.

The triple difference analysis shows no significant results. To draw any causal inference from the TD analysis, the identifying assumption must hold. The identifying assumption states that the relative FDI outflows of the high emission countries and low emission countries in the treatment group trend in the same way as the relative FDI outflows of the high emission countries and low emission countries in the control group, in absence of the EU ETS. Examining the graphs in Figure 2 - 4 in Section 5.4, we can conclude that the assumption holds quite well. The lines seem to follow parallel trends but with a small difference in magnitude, especially between the years 1998 and 1999. Between these years, the lines cross each other. However, the confidential intervals do not. Caution is advised since the trends differ a little bit in magnitude, but as a whole, it seems like the identifying assumption holds.

Further examining the graphs in Figure 2 and Figure 3 in Section 5.4, we can see that, after the treatment year, it seems as the Lemi treatment group had a relatively larger increase in FDI outflows as a percentage of GDP compared to the Hemi treatment group. This can also be seen in the graph in Figure 4 where the red line that reflects the difference in FDI outflows between the Hemi treatment group and the Lemi treatment group decreases after the treatment. This contradicts our hypothesis that Hemi countries would experience a larger effect of the policy than Lemi countries. However, it is important to note that the results from the TD analysis that measures the extra effect for the Hemi treatment group showed no statistically significant effect. What further amplifies the uncertainty of our results relates to the conclusion that was drawn for the DID analysis, namely, that the standard errors are large and the confidence intervals, therefore, display an imprecise estimate of the policy effect. Therefore, it could be the case that FDI outflows as a percentage of GDP for the Lemi treatment group did not increase more than the Hemi treatment group and that there actually is a policy effect that we fail to capture in our analysis.

As the parallel trend assumption is violated in the difference-in-differences analysis, we fail to obtain any evidence of whether the EU ETS had an impact on the EU member states' FDI outflows as a percentage of GDP. Furthermore, due to the insignificant result and large confidence intervals in the triple difference analysis, we fail to obtain any evidence of whether the EU ETS had an extra effect on the high emitting EU member states' FDI outflows as a percentage of GDP.

This paper set out to examine the EU ETS' effect on FDI outflows and to broaden the scope from a national level to a cross-country level. In light of the different findings and methods in previous research within this field, our results could be seen as both expected and unexpected. The most closely related studies done on country level reveals an increase in FDI outflows due to the EU ETS (see Koch & Basse Mama, 2019, Borghesi et al., 2020). However, as previously stated, these results were discovered for specific countries and industries with high sensitivity to such environmental policies. Expanding these results to a cross-country level, it could very well be the case that a similar trend does not exist. Countries and firms with different preconditions are probably not affected in the same way or to the same extent by a given policy. When studying the effects of the EU ETS in a cross-country setting, it is, therefore, possible that significant effects of the policy on certain countries (e.g. Germany and Italy) are not uncovered as the policy might have insignificant effects on other countries. Extending the comparison to Verde (2020) and Joltreau and Sommerfeld (2019) and therefore to carbon leakage in general, our findings are somewhat less surprising. Both of these papers found no overall evidence of the relationship between the EU ETS and investment flows. Furthermore, they pointed out several associated econometric difficulties within this field. This was apparent in our study as well.

Our study has several limitations that might not allow us to identify the true effect of the policy. The fact that we use total outward FDI stock creates noise in our study as an abundance of FDI stock value is attributable to non-emissions-intensive industries. Therefore, our study might not be able to detect the total effect of the policy on emissions-intensive industries in our sample countries. Another implication of looking at countries' total FDI outflows is that we cannot distinguish between changes in FDI outflows as changes within the EU or otherwise. Hence, it is not possible to isolate the FDI outflows to countries not participating in the EU ETS. However, before performing our empirical analysis, we could not exclude the possibility that the policy had an effect on total FDI outflows. When performing the triple difference analysis, the method used to categorize to what extent countries were affected by the EU ETS, is not unproblematic. We assume that countries with relatively higher carbon emissions (as measured in our extension) would be more affected by the EU ETS. However, there might be other more important factors that determine how sensitive countries are to the EU ETS. One such factor could be trade-intensity. For example, companies who operate in trade-intensive international markets are more likely to react to the EU ETS by increasing their FDI outflows since their fixed costs associated with setting up new factories and offices abroad are lower.

While we fail to obtain any evidence on whether the EU ETS affected EU member states' FDI outflows, our research question is of relevance to policy makers as a key concern of the policy was to not negatively impact the European single market. Our study contributes to the research by introducing a cross-country analysis and a triple difference method in studying the relationship between the EU ETS and FDI outflow. Moreover, our study sheds light on some econometric difficulties associated with research on the relationship between environmental regulation and firms' investment decisions. Further research within this field is important to allow policymakers to better grasp the effects of environmental regulation directed at emissions as well as enhance proper environmental policy evaluation.

6.1 Suggestions for further research

For policy makers to truly understand the global impact of cross-country policies like the EU ETS, it is relevant to understand how individual countries and firms react to the policy but also to realize how the EU or other unions react as a whole. One suggestion for further research would therefore be to study the effects of the EU ETS at a cross-country level but to use data that more easily allows for a potential effect to be revealed. For example, sorting the data on FDI based on the host country would allow for a more detailed clearer view to be presented. Furthermore, research on what country-specific attributes determines a country's sensitivity to environmental regulation could contribute to the field. Our paper could also be expanded by using different ways to categorize to what degree countries are affected by the EU ETS.

7 Concluding remarks

This paper considers whether the implementation of the EU ETS had an effect on EU member states' FDI outflows by using panel data on 33 countries between the years 1995 – 2019.

By first approaching the question with two multiple linear regressions, called trend-break models and graphical evidence of a trend break, we could identify a trend break of FDI outflows at the time of the treatment. However, this cannot be used for any causal inferences due to the many associated econometric issues.

The causal relationship is later on tested using two different difference-in-differences models. One that allows for a change in intercept and one that allows for a change in intercept and slope. Both of these difference-in-differences models are extended by using fixed effects on yearly level, country level, and yearly- and country level. The DID intercept model showed no significant results. The DID intercept- and slope model had a small positive significant result. However, as the parallel trend assumption was violated in the analysis, the statistically significant result could not be used for any causal inference.

Lastly, we employed a triple difference analysis that made use of an extension based on the countries' carbon emissions, working as a proxy for the degree to which the countries should be affected by the EU ETS. The triple difference analysis showed no significant result.

In conclusion, we fail to obtain any evidence of whether the EU ETS had a significant effect on EU member states' FDI outflows. Furthermore, we fail to obtain any evidence of whether the EU ETS had an extra effect on the high emitting EU member states' FDI outflows. There are many econometric difficulties associated with our research question and while a policy effect is theoretically sound, the empirical findings of it are ambiguous, including the findings of this paper.

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Appendix

Table 7: Countries in the treatment- and control group and their categorization

EU member states	**OECD member states**
Categorized as Lemi	**Categorized as Lemi**
Austria	Austria
Belgium	Chile
France	Israel
Germany	Japan
Hungary	Korea, Rep.
Ireland	Turkey
Italy	
Netherlands	
Slovenia	
Spain	
Sweden	
United Kingdom	
Categorized as Hemi	**Categorized as Hemi**
Czech Republic	Canada
Denmark	Colombia
Estonia	New Zealand
Finland	Switzerland
Greece	United States
Latvia	
Lithuania	
Poland	
Portugal	
Slovak Republic	