MEMOIRE

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"The Shareholders' Influence on the Emissions of Companies: An Empirical Study based on the European Emissions Trading Scheme"

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Abstract

This paper examines the effectiveness of the 3 first phases of the EU ETS and explores the potential impact of the shareholders of a given entity on its level of emissions. The investigation reveals an increasingly negative correlation between the level of emissions of the studied installations and the enumerated phases above, therefore supporting the EU ETS as a tool to tackle climate change. While it is observed that listed entities on a stock exchange are not significantly better at reducing their emissions than non-listed entities, the idea that shareholders do not seem to have an influence on the level of emissions of the studied entities is therefore emitted.

1. Introduction

One of the most complicated challenges that the mankind is facing nowadays is the climate change. Given the issue, The United Nations (UN) created the Kyoto's treaty in 1997 which initiated the campaign for the reduction of Greenhouse gas (GHG) emissions in the atmosphere worldwide. In force since 2005, the treaty at hand aims at reducing the emissions of 6 greenhouse gases to approximatively 80% below 1990 levels worldwide by 2050 (European Commission, n.d.) to prevent irreversible climate damages (Britannica, 2021). Each participating country is set a specific reduction target to prove their commitment to the treaty, meaning that their emission is yearly capped to a certain amount of GHG emitted (UNFCCC, 1997). To reach these targets, numerous initiatives emerged in order to strengthen climate actions following the introduction of the agreement. One of the most important mechanisms that was introduced were Emission Trading Schemes (ETS). In essence, an ETS stems from the idea that some actors within a country are better able to reduce their emissions than other. Therefore, it leaves these low-emitting actors with the opportunity to sell their surplus of "authorized GHG emission units" (carbon credits) on a dedicated "cap and trade" market to other that do not meet their target.

This paper focuses on the most predominant ETS developed as of today; The European Emissions Trading Scheme (EU ETS). Its principal objectives aim at reducing emissions and spur low-carbon innovations by economic actors in order to reach the 2050's emissions target (The World Bank, 2021). While the EU ETS is the biggest and most developed scheme, one must understand that the scheme at hand is not a finished product as it continuously undergoes modifications and implementation of new regulations. Over the years, the European Commission started to develop the EU ETS as the main tool to reduce emissions by industrial players and tackle the climate change.

It is upon this newly introduced system that the academic literature questions its effectiveness to reduce emissions in Europe and its impact on the economic realm of the companies under the scheme. The above statement constitutes the interest of this scientific paper. Indeed, the following text elaborates first on the effectiveness of the scheme over its successive phases it went through and subsequently explores the specific influence of the shareholders on the emissions of a given company part of the EU ETS. For that matter, this research studies 2 groups of entities part of the scheme, Listed Entities on a stock exchange (LE's) and Entities that are privately held (NLE's). The latter development follows the thinking of Flammers (2013), in which the shareholders constitute an internal driver that is the most susceptible element capable of reducing the emissions of a company. On the basis of these words, this argument yields the central question of this study;

"Do shareholders have an influence on the emissions of Listed companies in Europe?"

In the following sections, a literature review provides better insights on the EU ETS and its successive phases punctuated by new reforms to understand the context of the study. After, the hypotheses are developed in concordance with the current debates of the academic literature on the effectiveness of the EU ETS and the plausible influence of the company' shareholders. Then follows the methodology of this research as well as its results. Evenly, the output of this research is put against the literature in the discussion and limitations sections.

2. Literature review

2.1. The European Union's Emission Trading Scheme

Throughout the world, there exists many ETS that vary in size, governance, and targets. They can be voluntary or mandatory, have sectoral or temporal coverage and be linked to the Kyoto's treaty or not (ex : USA) (Perdan & Azapagic, 2011). One can notice that ETS' are in general very different from one another in term of design, which stems from political motivation and geographic reach.

The present paper aims at studying the most predominant and developed ETS that currently exists, the European Union Emission Trading Scheme (EU ETS). In 2020, the European market represented nearly 90% of the record high 10,7 Giga tons of CO2 allowances traded worldwide (Refinitiv, 2021). The EU ETS operates throughout the EU countries, Iceland, Liechtenstein and Norway. It emphasizes on emissions regulations from heat and electricity generation, energy-intensive industries (steel works, oil refineries, metals production, etc…), commercial airlines within the EEA and other sectors producing toxic gases. At the moment, one can count over 14 000 installations under the EU ETS guidelines, which covers around 40% of the GHG emissions produced in the EU. It is important to notice that only companies with a relatively high level of emissions are required to follow such regulations (*European Commission*, n.d.).

Every year, the companies running their operators are required to report their emissions to an accredited verifier and ensure that their targets are respected. As explained earlier, they have the right to trade their free allowances (named EUA's is Europe) on the EU ETS or use CER's and ERU's from sustainable projects. Under the European market, it is recognized that an EUA, CER and ERU are equivalent (1 ton of CO2) (Perdan & Azapagic, 2011). In case these allowances are not surrendered, a penalty fee of 100 euro applies (indexable) per ton of CO2 that make up the gap of compliance (Environmental Protection Agency, n.d.).

2.2. The Evolution of the EU ETS

2.2.1. The successive phases

It is rather difficult to assess the CO2 emission effectiveness of the EU ETS as a whole. Indeed, throughout its implementation, the ETS has undergone a series of reforms and new implementations in a succession of phases. As a matter of fact, Phase 1 (2005-2007) constituted the pilot phase of the project, Phase 2 (2008-2012) attempted to fix the biggest issues of the juvenile scheme such as over-allocation based on historical emissions and a high level of decentralization. From Phase 3 (2013-2020) the European Commission decided to propose radical changes in the EU ETS conception. The "new" ETS of 2013 had a single EU-wide cap which linearly decreases every year by 1,74% proportionally to all participating states. Also, phase 3 initiated new core concepts that drastically changed the design of the EU ETS (presented in the next paragraph). In Phase 4 (2021-2030), the European commission set the new milestone to reduce EU's overall GHG emission by 40% compared to 2005's level in order to reach 2050's target. Therefore the previously stated 1,74% decrease in allowances distribution peaked at 2,2% for the current phase (*European*

Commission, n.d). The question of the EU ETS' efficiency is addressed with the analysis of the first 3 phases further in this paper.

2.2.2. The allowances allocation

During the first years of activity (phase 1 and 2), free carbon credits were granted to companies each year for their carbon accounting (also called grandfathering method), which at this time was the primary mean of allocation along with auctioning. While auctioning is relatively easy to implement (to produce more emissions, you must pay), grandfathering refers to a method that bases its allocation on historical emission specific to each firm. Over time, it had been shown that this practice rewarded large emitters rather than smaller firms which already efforts in improving their carbon intensive processes (Zetterberg et al., 2012). For that matter, a new allocation method called benchmarking was introduced in order to reduce the allocation inefficiencies of the first phases. Benchmarking takes the average emission efficiency of the top 10% of the listed installations and distribute carbon credits for free to companies based on their level of carbon efficiency. Indeed, the more carbon-efficient companies are, the more they receive permits, which provides them with a comparative advantage compared to big polluters. The goal is then to incentivize big polluters to review their processes if they desire more allowances (Mahringer, 2021). On another note, the auctioning method is said to take up a greater proportion of available allowance in the future years.

2.2.3. Carbon leakage

Carbon leakage describes a company's tendency to relocate its activities outside the jurisdiction of the governing ETS in response to new GHG reduction regulations. The obvious end goal is to relocate to a country with less stringent environmental policies as a mean avoid any sort of compliance costs. While Naegele & Zaklan (2019) advocate that there is no evidence that the EU ETS causes carbon leakage, the European Commission expressed its will to sustain efforts in tackling this problem in the future (Naegele & Zaklan, 2019). Intriguingly, the only solution proposed in that regard consists of extending the period of free allocations for industries that are the most likely to relocate their activities. In an effort to determine which industry is subject to 100% of free allocations, the European commission designed a framework pertaining to a quantitative evaluation of each industry (245 according to NACE scheme) under the EU ETS. The latter evaluation derives the risk of carbon leakage according to the intensity of trade with third countries, its emission intensity and the gross value added (Mahringer, 2021). In the event the risk of leakage ratio is above the threshold 0.2, the industry participants see themselves granted the totality of their necessary allocations for free.

2.2.4. Monitoring, Reporting and Verification

The lack of governance in phase 1 and 2 led the European Commission to develop a system meant to ensure that installations comply to their carbon obligations continuously. The latter system comprises monitoring, reporting and verification and is referred as MRV. Its objective is to ensure the robustness, transparency, consistency, and accuracy of the emission reported in an effort to work toward an efficient ETS. Following the introduction of this new regulation, each operator is required to have an approved monitoring plan for, obviously, monitoring and reporting their annual emissions. Subsequently, a third entity, that is recognized by European Commission is appointed to verify and validate the submitted report (European Comission, n.d.). Under certain condition, operators also have to upload an improvement report in which a series of modifications will be undertaken within a specified timeframe.

2.2.5. The market stability reserve

As one can imagine, the large accumulation of carbon credits on the market following the grandfathering approach of allocation in phase 1 and 2 underlined a significant inefficiency. As a matter of fact, the flood of allowances on the market created frequent volatility. The crisis of 2009 caused a large decrease in the permit's price and further stressed the volatility of the market. To tackle the problem of price reduction, the European Commission established the Market Stability Reserve (or MSR) in 2019, which serves two main goals; ensure the stability of the EU ETS in case of economic turmoil by controlling the supply of allowances and manage the existing surplus of carbon credits. The decision to add or remove allowances from the market is decided upon specific threshold, therefore leaving no discretion to regulators. It has been noticed that market participants planned the future scarcity of the allowances in their business plan therefore rallying up the prices recently and forcing the MSR to monitor the sharp increase. Given the complexity of the external shocks playing on the market for allowances and the strategy of the EU to reach net zero neutrality, the European Commission in considering reviewing the MSR's design and rules in the future (The World Bank, 2021).

3.Hypotheses development

The evolution of the EU ETS over the years as discussed above enlighten anyone on the complexity of the scheme's functioning. Ever since its introduction in 2005, the debates on the EU ETS' effectiveness have been fueling academic research. From the permits allocation method to its effect on EU industry's competitiveness, discussions persist on whether EU ETS has a true impact on companies and emissions in general. On the one hand, the European Environment Agency (EEA) reports a steady decrease in emission throughout European companies, showing support to the claim that the ETS is fulfilling its promises (European Environment Agency, 2021). On the other hand, it remains difficult to give credits to the EU ETS as evidences show that these emission reductions could stem from other environmental policies and change in economic drivers (increase in renewable energy, improved energy efficiency, fuel switching, etc..) (Corporate Europe Observatory, 2015).

The EU ETS has been at the center stage of many political discussions regarding the impact of the regulations on the economics of the regulated firms. Indeed, companies competing on global markets have encountered difficulties balancing emissions reduction and profitability. Theoretically, it remains unclear whether the EU ETS and its regulations have a negative impact on competition. The costs of complying with environmental directives might impact expenses (Lutz, 2016). Furthermore, surveys show that the scheme affects firm managers in their decision regarding investments in energy efficiency, although this finding is not consistent in all industries under the scheme. Also, it has been shown that companies engage in other practices such as; sly investments in clean development mechanisms (mean to obtain allowances), carbon leakages, non-optimal emission abatements in order to derive profit and take advantage of the system

(Egenhofer et al., 2011). Furthermore, a Swedish based study revealed that the EU ETS has no significant impact on firm's decision to invest in carbon reduction technologies, therefore questioning the ability of the scheme to provoke change and innovation by companies (Löfgren et al., 2014). However, Porter and Van der Linde, present a stronger hypothesis, in which properly designed environmental regulations might not only raise the motivation to develop and adopt eco-friendly technology but might even affect competitiveness in a favorable manner (Porter & van der Linde, 1995).

3.1. The effectiveness of the different EU ETS's phases

Before elaborating on the factors susceptible to influence the level of emission of a given entity, it is important to assess whether the EU ETS is actually associated with a decrease in emissions. Indeed, the recent questioning of the EU ETS relevance and the lack of academic research on its recent performance in reducing emission leaves room for this thesis to study the recent evolution of the emissions in Europe. According to the CEPS report (2016), the design problems of the EU ETS enumerated by the academic community have been solved over time, therefore arguing that the recent modifications of the EU ETS fostered emissions reduction of the concerned companies. Little to no literature gives meaningful insights regarding the recent scheme's phases performance of these last years. For that matter, the first set of hypotheses of this paper concern the investigation as to whether the subsequent phases (and therefore reforms) of the EU ETS had a significant impact on companies and their subsequent emissions. The attention of the thesis pertains to the first 3 phases (2005 to 2020) due to the availability of data. The following hypotheses each measure the impact of the phase 1, 2 and 3 respectively;

H1a : Phase 1 has no impact on the emissions level of companies part of the EU ETS.
H1b : Phase 2 has no impact on the emissions level of companies part of the EU ETS.
H1c : Phase 3 has no impact on the emissions level of companies part of the EU ETS.

3.2. The effectiveness of the EU ETS on listed entities (LE)

In order to deepen the analysis on the impact of the scheme, the attention is now brought to the entities to which the scheme applies. As a matter of fact, the academic literature barely touches upon the potential differences of emissions reduction among the type of entities within the EU ETS. According to the stakeholder theory, any structure does not solely strive for its own interest but also the interest of its stakeholders. Ultimately, differences in ownership structure will yield differences in goals, governance and most likely, differences in emissions across entities.

Regarding the motivation of bigger corporations, one can understand that economic players are less likely to spend money on emissions reductions as the cost of doing so will provide benefits to the public while directly impacting the revenues of their shareholders (Aggarwal & Dow, 2011). However, corporate initiatives (e.g. CSR) grew to a point where the need to include eco-friendly activities within the company became a genuine mean to deliver value and influence to company performance. Along with environmental regulations, political pressure and customer sensitivity to green behaviors, environmental practices by corporations are said to play a role in its valuation nowadays. Jacobs (2014) observed that the market reactions to voluntary emission reductions projects caused marginal dips in the stock price due to lower performance expectations. On the other hand, he advocates that the announcement of GHG emissions reduction has a more positive impact on the financial market compared to other emission types (B. W. Jacobs, 2014). Further on the topic of return on investment for shareholders, numerous researchers advocated a positive impact of emissions reduction on an entity's performance. Indeed, Hart and Ahuja (1996) demonstrated that the reduction of toxic gases improved return-on-equity, return-on-sales and return-on-assets (Hart & Ahuja, 1996). Similarly, other researchers present evidences that increased carbon imprint is negatively related to intangible assets' value (Matsumura et al., 2014).

From the above empirical evidences, one can wonder on the influence the shareholders can have on the board of directors, CEO and other executives' decision making regarding whether emission reductions should be pursued or not (due to firm's performance and value risks). It is upon the mixed feelings of the literature about emissions reduction within large companies that the thesis at hand elaborates on entities listed (LE) on a stock exchange that engage with the scheme. "Listed companies" are understood as companies that have their shares publicly traded. In this regard, the following hypothesis compares two groups of entities, member of the EU ETS; one group that only contains LE, and another one including entities that are not listed (NLE). In that sense, it is expected to observe a decreasing trend in the level of emissions among LE's given that most of the academic literature supports the idea that nowadays shareholders take into account the level of emissions of a company in its investment decision. Therefore, potentially explore a new a channel in which shareholders have an impact on companies' emissions;

H2: LE's are associated with a greater decrease than NLE's in their level of emissions.

While there are a few studies on the effectiveness of the EU ETS for phase 1 and 2, this study attempts to provide answers regarding the effectiveness of phase 3, as there currently exists no other studies in the academic literature on that topic. Also, Hypothesis 2 (H2) is expected to open the gates for new potential studies in the field of shareholders on the emissions of companies.

4. Methodology

The present section elaborates on the methodology adopted to answer the research question (see introduction) and subsequent hypotheses. For the sake of the analysis, a quantitative approach is adopted. Indeed, in the context of measuring the evolution of the emissions, it makes sense to gather numerical data to have a clear analysis. The latter type of data enables one to measure, evaluate and generalize findings on a population of data (Bilgin, 2017). In the below text, data and the sample construction are discussed. After, the measurement choice describes the set of variables as well as the statistical method used in answering the questions at the heart of this thesis. Evenly, the points of attentions are discussed regarding the scope and limitations of this method employed.

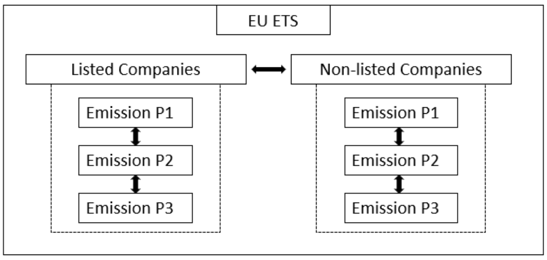

Figure 1: Research Question Model

4.1. Data and sample construction

As expected, the population of interest pertains to entities part of the EU ETS for a time span from 2005 to 2020 (or 16 years). The choice to select this time span stems from the idea that only the phase 1 to 3 are considered since phase 4 has not been completed yet. Doing so would complicate the interpretation of the results obtained for the years 2021 and 2022. To gather information on entities' emissions, one can extract information from the publicly available database of the EU ETS; The European Transaction Log (EUTL). The EUTL aggregates information on the emissions of over 14.000 installations listed on the EU ETS, to which refers a certain entity. The EUTL brings together information such as yearly granted allowances, emissions, compliances and information based on different indicators (year, country, industry, etc..) (European Commission, n.d.). Therefore, each of the observations collected in the sample refers to the emissions of a selected installation, its concurring year and evenly a certain entity of interest.

The scope of this thesis focuses on the biggest polluters in Europe since they have the biggest impact in term of emission in Europe. With that regard, the arbitrary mark of 1 million tons of emissions was set to distinguish the biggest polluters among installations to form our sample. Less than 4% of the installations listed on the EUTL produce at least 1 million tons of emissions per year. The latter are also responsible for more than 50% of the total yearly production of Emissions in Europe in 2020. Selecting this mark also facilitates the manual gathering of data for LE's, in order to answer hypothesis 2. Moreover, the initial analysis was meant to be performed for companies present in all EU ETS country members, but due to data uncompletedness and unavailability of large emitters, Bulgaria, Cyprus, Croatia, Iceland, Liechtenstein, Malta and Norway were not considered in the data sampling.

Therefore, departing from a total of more than 14 000 installations in Europe, the

Table 1
Steps of the sample selection procedure.

This table describes the procedure of the sample construction. Starting from the total amount of entities covered by the EUTL, the installations that (arbitrarily) do not reach at least 1million tons of Emissions per year are discarded from the sample selection. Only a small subset of entities (+- 4% of installations) produces more than 1Mt of emissions per year and therefore constitutes a subset with the biggest polluters of Europe. Removing incomplete observations, the final sample accounts for 5392 observations and 337 entities from which 184 are publicly traded, 44 are owned by a country's government, 43 are owned by financial companies that see installations as strategic investments and 66 privately owned entities where its ownership is defined by its private shareholders in which the operations are managed from the inside, without direct influence of investors.

	# observation	# distinct entities
Firms covered by the EUTL (2005-2020)	224.000	14.000
Less Installations below 1Mt of CO2 Emissions	7.952	497
Less Incomplete Observations	5.392	337
Final Sample		
Listed Companies on any stock exchange (LE)	2.944	184
Non-listed Entities (NLE)		
State-Owned Entities	704	44
Financial Companies	688	43
Private Shareholders Companies	1.056	66
	2.448	153
Sample	5.392	337

latter mark reduces the number of installations to 497. Further, incomplete observations are removed to ensure the relevance of the data in our sample, which decreases the sample size to 337 entities part of the EU ETS and a total of 5392 as seen in table 1. The final sample is composed of 184 LE's on a stock exchange and a remainder of 153 entities that are NLE's. Here, a LE is defined as an entity in which its ownership is distributed amongst public shareholders with the help of publicly traded stocks. It is important to stress that the sample considers entities as listed if at least 50,1% of the shares are publicly traded. Also, a company owning an installation might be a subsidiary to a bigger organization that is publicly traded or not. The analysis at hand, solely concerns ultimate parent companies, which are expected to have an influence on the emission of their installations. Further, the sample accounts for 44 predominantly state-owned entities. Once again, the sample consider an installation state-owned if at least 50,1% of the shares are owned by the state. The latter 44 installation in this case represents for the most cases large power plants used by national governments to supply energy to their regions. Henceforth, a total of 43 financial companies are observed. Here, the definition of a financial company describes an entity that sees installations as strategic investments and manage them in a way to maximize the return on investment. Evenly, the sample comprises 66 companies with a private shareholding structure. In that sense, one can understand these private structures as one or more individuals like entrepreneurs or family businesses owning shares privately that differ from financial and state-owned entities.

4.2. Descriptive Statistics and statistical model development

4.2.1. Variable selection

After gathering the data, the first step consists in turning the emissions gathered into its natural logarithmic value. The purpose of such is to reduce the skewness of the observations into a more normal distribution in an attempt to ease comparison among observations (Kenneth, 2011). Eventually, the variable "*Ln(Emissions)*" represents the value of an emissions value of a given year in a logarithmic form. Thereafter, variables unique to each installations complete the list; the country, the industry. Then an indicator variable "*Listed*" is added as a dummy to show whether the entity responsible for the installation is an LE or not. Finally, dummy variables "*Phase1*", "*Phase2*" and "*Phase3*" are added to represent the different phases in which the emissions are observed.

4.2.2. Ln(Emissions)

Table 3 presents the descriptive statistics derived from our above-mentioned variables. In panel A, one can notice the steady decrease of mean emissions values over the years, which reinforce the idea that the successive phases had an impact on installations. As previously stated, the first case of this study aims at verifying the significance of these reductions of emissions over the different phases. It is also worthy of mentioning that the variance within the sample decreases steadily before increasing again up to an all-time high in 2020. Mo et al. (2012) also noticed such a trend and qualified this phenomenon as Hysteresis, where a company needs some time to adapt and revamp its strategy of emissions over the future years. Evenly, the same panel demonstrate a strongly balanced dataset. Indeed, the completeness of yearly emissions information for the selected installations have observation for each year. In that sense, it is expected to have a better fitting statistical model

Table 2

Variable definition
This table includes the different variables selected to perform the study

Ln(Emissions)	Logarithm of the total GHG emissions of the installation measured in tons of CO2
Phase 1	Indicator variable equal to 1 if the year of the emissions at hand corresponds to Phase 1 of the EU ETS (2005-2007) and 0 otherwise
Phase 2	Indicator variable equal to 1 if the year of the emissions at hand corresponds to Phase 2 of the EU ETS (2008-2012) and 0 otherwise
Phase 3	Indicator variable equal to 1 if the year of the emissions at hand corresponds to Phase 3 of the EU ETS (2013-2020) and 0 otherwise
Listed	Indicator variable equal to 1 if the emissions are from an entity listed on a stock exchange and 0 otherwise
Country_code	Control variable representing the country of the installation at hand
Industry_code	Control variable representing the industry of the installation at hand

Table 3

Descriptive Statistics

This table reports the key statistics for the variables and observations used for the statistical test. The sample spans from 2005 to 2020 or the equivalent of the 3 first phases. Evenly, the sample is strongly balanced due to the completeness of Emissions information of the EUTL dataset.

Panel A presents a summary of the descriptive statistics of Ln(Emissions), for which the initial values were converted to ease comparability. Panel B breaks down the same Emissions observations per country. Panel C summarize the observations according to the industry of each installation.

Panel A: Key descriptive Statistics of Ln(Emissions)

	Year	Mean Emissions (ln)	P25 (ln)	Median (ln)	P75 (ln)	Variance	# Compagnies
	2005	13.83	13.23	13.81	14.58	1.47	337
Phase 1	2006	13.88	13.33	13.87	14.56	1.44	337
	2007	13.89	13.33	13.89	14.57	1.47	337
	2008	13.88	13.30	13.86	14.53	1.11	337
	2009	13.79	13.17	13.73	14.41	1.01	337
Phase 2	2010	13.81	13.19	13.79	14.44	1.0	337
	2011	13.78	13.18	13.73	14.39	1.06	337
	2012	13.73	13.06	13.66	14.32	1.09	337
	2013	13.78	13.11	13.70	14.41	1.14	337
	2014	13.72	13.04	13.66	14.37	1.17	337
	2015	13.71	13.04	13.67	14.38	1.21	337
Phase 3	2016	13.68	13.04	13.71	14.37	1.38	337
	2017	13.66	13.05	13.74	14.30	1.50	337
	2018	13.62	13.04	13.64	14.28	1.56	337
	2019	13.49	12.92	13.55	14.21	1.70	337
	2020	13.24	12.75	13.45	14.05	2.34	337

Panel B: Sample distribution of Ln(Emissions) per country

				Mean tons of CO2 (ln values)			
	# Observations	**# Entities**	**Sample %**	**Phase 1**	**Phase 2**	**Phase 3**	**Total Reduction**
AUS	144	9	2,7	13,38	13,19	13,13	0,25
BEL	224	14	4,2	13,11	13,08	12,98	0,13
CZE	368	23	6,8	13,21	13,15	13,18	0,03
DEN	128	8	2,4	14,41	14,21	13,37	1,04
EST	64	4	1,2	14,16	14,10	13,19	0,97
FIN	288	18	5,3	13,69	13,57	12,65	1,04
FRA	560	35	10,4	13,61	13,63	13,35	0,27
GER	864	54	16,0	14,04	14,01	13,86	0,19
GRC	128	8	2,4	14,19	14,07	14,35	-0,16
HUN	160	10	3,0	11,91	13,38	13,57	-1,66
IRL	128	8	2,4	13,58	13,30	13,34	0,24
ITA	576	36	10,7	13,90	13,77	13,20	0,70
LIT	64	4	1,2	12,96	12,98	13,33	-0,37
LTV	16	1	0,3	12,88	12,67	12,67	0,22
LUX	16	1	0,3	13,46	13,34	13,30	0,16
NDLS	240	15	4,5	14,21	14,10	13,82	0,39
N IRL	32	2	0,6	14,09	13,86	13,64	0,45
POL	464	29	8,6	14,09	14,07	14,00	0,09
POR	96	6	1,8	14,04	13,91	13,89	0,15
ROM	256	16	4,7	13,89	13,69	13,82	0,08
SLK	96	6	1,8	13,62	13,42	13,62	-0,01
SLO	32	2	0,6	14,47	14,40	14,18	0,29
SPA	368	23	6,8	14,02	13,74	13,54	0,48
SWE	80	5	1,5	13,22	13,50	13,28	-0,06
Sample	5.392	337	100%	13,66	13,62	13,46	0,20

Panel C : Sample distribution of Ln(Emissions) per Industry

				Mean Ln(Emissions)			
Industry	**# Observations**	**# Entities**	**Sample %**	**Phase 1**	**Phase 2**	**Phase 3**	**Total Reduction**
Production of pig iron or steel	288	18	5,34	13,81	13,77	13,55	0,26
Refining of mineral oil	832	52	15,43	13,81	13,76	13,55	0,26
Production of cement clinker	1.008	63	18,69	13,81	13,77	13,55	0,27
Production of lime, or calcination of dolomite/magnesite	176	11	3,26	13,81	13,77	13,54	0,27
Production of pulp	16	1	0,30	12,29	12,24	12,14	0,15
Combustion of fuel	2.496	156	46,29	13,81	13,77	13,55	0,26
Combustion installations with a rated thermal input exceeding 20 MW	208	13	3,86	13,77	13,65	13,20	0,57
Production of bulk chemicals	112	7	2,08	13,82	13,78	13,56	0,26
production of Coke	64	4	1,19	13,78	13,80	13,60	0,18
Production of soda ash and sodium bicarbonate	16	1	0,30	13,42	13,33	13,89	-0,47
Production of Amonia	80	5	1,48	13,74	13,76	13,62	0,12
Production or processing of ferrous metals	16	1	0,30	12,44	12,46	13,00	-0,56
Production of hydrogen and synthesis gas	16	1	0,30	12,77	12,72	12,14	0,63
Industrial plants for the production of (a) pulp from timber or other fibrous materials (b) paper and board	16	1	0,30	12,88	12,76	12,32	0,56
Production of paper or cardboard	16	1	0,30	12,86	12,79	12,65	0,21
Production of nitric acid	16	1	0,30	12,56	12,28	13,57	-1,01
Production of primary aluminium	16	1	0,30	11,13	10,87	12,86	-1,73
Sample	5.392	337	100	13,21	13,13	13,19	0,01

than merely using an unbalanced dataset (Amruthnath, 2020).

4.2.3. Country's emissions

Panel B show the distribution of emissions per country. To begin with, the sample predominantly represent the country of Germany, Italy, France, and Poland with 16%, 10,7%, 10,4% and 8,6% respectively. This observation goes along with the conclusion of Bluszcz & Kijewska (2016) that these countries dominated Europe in term of emissions up to 2016. Although it is common to see the ranking for the biggest emitters change according to the industry under investigation, it is nonetheless proven that the countries mentioned above are familiar with the top of such a ranking of emitters (Kijewska & Bluszcz, 2016). Conversely, the sample constitutes countries with a few or even single entities such as Latvia, Luxembourg, Northern Ireland, and Slovenia. Therefore, the observations or such entities exposes the overall mean of these countries to questioning given the relatively low number of emissions' observations. Looking at the last column, one can see that overall, all countries represented in the sample record a lower emission volume over the different phases with a special mention to Denmark, Estonia and Finland that report a decrease in *Ln(Emissions)* of 1,04, 0,97 and 1,04. The latter observations can be matched but not explained by the speed at which northern European countries have been laying the grounds to expand alternatives in energy productions this last decade. On the other hand, only a few countries have been backpedaling, namely; Greece (-0,16), Hungary (-1,66!), Lithuania (-0,37), Slovakia (-0,01) and Sweden (-0,06). Hungary's results concords with its enthusiasm for fossil and nuclear fuels as well as its position regarding the European objective of energetic transition. In recent years, it is said that the Hungarian government approached the question of energy and climate with a business lens with the ultimate goal of improving Hungary's economic competitiveness (Söderström, 2021). These differing observations enhance the choice of using countries as a control variable to account for the different opinions of each country on the environment.

4.2.4. Industry's emissions

The descriptive statistics carries on with the introduction of *Ln(Emissions)* per industry as shown in panel C. In first instance, it is to be stressed that 46,29% of the sample pertains to combustion of fuels, which makes sense as the latter industry is notorious for being the most polluting industry in Europe (EEA, 2021a). It is a no brainer that a bigger part of the sample is represented by this industry, therefore also influencing the potential results of the research. On the flip side, one should be careful in making conclusions about the following production industry of pulp, soda ash, sodium bicarbonate, processing of ferrous metals, hydrogen, synthesis, paper, cardboard, nitric acid, or primary aluminum since they each only consist in one entity. Therefore, misinterpretations of these means are dangerous for possible conclusions later on. The reason why this type of observations is kept for the statistical test is that it is preferable to keep as many observations as possible in order to not lose information from the data collected. For most of the industries presented in panel C, reductions throughout the phases are consistent besides the singular entity' observations; Production of soda ash and sodium bicarbonate (-0,47), production or processing of ferrous metals (-0,56), production of nitric acid (-1,01) and production of primary aluminum (-1,73). Somehow, the total reduction for the whole sample approach 0 under this angle, which is lower compared to the panel B. Therefore, it makes sense to also control for such a variable in our statistical model.

4.3. The statistical model

Based on the results obtained with the descriptive statistics, this section explores whether the reduction in emissions in natural logarithmic value of the selected installations can be first explained by the successive phases. To study such a relationship, the following model is developed using a panel data regression. Using a panel data regression method enables us to capture the dimension of time over our cross-sectional data. In comparison to static cross-sectional analyses, changes in the selected variables are directly measured repeatedly over time. Moreover, such a method takes into account the unobserved heterogeneity (unobserved dependency of other independent variables on the dependent variable) and endogeneity (correlation of error term with the observed independent variables). In other words, panel data regression controls for the effect of unobserved independent variables on other observed variables and its overall, over-arching effect on the dependent variable (Finkel, 1995).

$$Ln(Emisions)_{it} = \alpha + \beta 1 * Phase1 + \beta 2 * Phase2 + \beta \mathbf{3} * Phase3 + \varphi_1 * Country + \varphi_2 * Industry + \tau t + \delta i + \varepsilon it, \text{(H1)}$$

Where intuitively *Phase1*, *Phase2* and *Phase3* denote dummy variables equal to 1 if the observation's year matches one of the years of a given phase and 0 in the opposite case. the country and industry control variables are also added to the model. The subindexes *i* and *t* respectively represent the installation and its emission for a given year. τt and δi denote year and firm fixed effects, respectively and *εit* accounts for the error term capturing unobserved independent variables information. Finally, *β**1**,* *β**2*** and *β**3*** are parameters to be estimated along with other control variables φ_1 and φ_2.

The statistical mode is performed with a "random effect" feature because we assume that the error term "*εi"* that is specific to each phase is uncorrelated to the other independent variables of the model, namely; *β**2**,* *β**3**,* φ_1 and φ_2. It might seem counter-intuitive but the findings of the Hausman test performed at an early stage indicates that the random effect model is better suited against the fixed effect model, for the dataset at hand. In this way, it is hoped to capture trends in data over the years by controlling for endogeneity and heterogeneity (Borenstein et al., 2010).

Subsequently, an interaction term is added to the model as presented above in order to measure for the impact of the entity's structure and potentially provide new perspectives regarding hypothesis 2. The latter adjustment to the model is illustrated with equation H2 where *Listed* is the interaction term to represent whether a company is a LE that is 1 in case it is true and 0 otherwise.

$$Ln(Emisions)_{it} = \alpha + \beta 1 * Phase1 * Listed + \beta 2 * Phase2 * Listed + \beta \mathbf{3} * Phase3 * Listed + \varphi_1 * Country + \varphi_2 * Industry + -\tau t + \delta i + \varepsilon it, \text{(H2)}$$

Table 4
Emissions over the different phases
This table represents the output obtained after running the first random effect panel data regression for H1 and H2. The dependent variable Ln (Emissions) that is, the yearly emissions volume (in tons) of given installation, is put against the explanatory variables *Phase 1*, *Phase2* and *Phase3* in H1. The latter illustrate the different phases that the EU ETS underwent from 2005 to 2020. The results of "*Listed*" demonstrates the overall effect of the dummy variable on *Listed* and *Non-Listed* entities 'emissions. Further to the right, the overall effect is decomposed in the different phases and different types of entities. Below are also the results of the control variables "*Country_code*" and "*Industry_code*". t-statistics are in parentheses. *, * *, and * * * denote significance at the 10%, 5%, and 1% levels (two-tail), respectively.

	Dependent Variable: Ln (Emissions)			
	H1	H2		
	All Entities	Listed > Non-Listed	Listed	Non-Listed
Phase1	/	/	0,102 (0,116)	/
Phase2	-0,071***	0,047 (0,051)	0,053 (0,115)	-0,096*** (0,374)
Phase3	-0,256***	0,027 (0,047)	-0,141 (0,115)	-0,271*** (0,034)
Listed		0,103 (0,116)		
Controls:				
Country_code	0,013 (0,008)	0,128 (0,008)	0,128 (0,008)	0,128 (0,008)
Industry_code	0,008 (0,010)	0,006 (0,010)	0,006 (0,010)	0,006 (0,010)
Intercept	13,683*** (0,123)	13,641*** (0,133)	13,641*** (0,133)	13,641*** (0,133)
Adjusted R^2	0,015	0,018	0,018	0,018
# Observations	5.392	5.392	2.944	2.448

5. Statistical results

Based on the results of our regression analysis in table 4 one can notice the significant influence of our dummy variables *Phase2* and *Phase3* at 1% significance level advocating our case that, in the given set-up of this research, the subsequent phases of the EU ETS, as explanatory variables, had a negative impact on the emissions of the installations studied. The reason the statistical output does not specifically show significance for the first phase is because this dummy variable *Phase1* is used as a statistical baseline for the other phases. Indeed, such a practice is necessary in order to make appropriate conclusions and avoid the problem of collinearity. Hence, it is with confidence that the Hypothesis 1b and 1c is rejected, therefore fostering the idea that the phases of the EU ETS had a sustained, negative impact on emissions. Moreover, it is noticeable that that phase 3 has a bigger coefficient (-0,256) compared to phase 2 (-0,071), which makes sense as the latter was much shorter than phase 3 (4 years against 8 years).

To put these coefficients into perspective, one can understand, for example, the coefficient of the dummy variable *Phase 3* as follow; On average, an entity studied lowered its emissions 22,58% more during phase 3 compared to the reference group, phase 1.

According to table 3, the average emissions for phase 1 was 13,86 in natural logarithmic form (or 1.052.487 tons of GHG) against 13,61 (814.231 tons of GHG) for Phase 3. Comparing the 2 numbers, we indeed find a reduction of 22,63, close enough to the adjusted value calculated above. It means that, on average, an entity reduced its emissions by 238.255 tons of GHG over the 8 years of phase 3. It is important to mention that the coefficient needs to be translated from its natural logarithm to its plain form to deliver a better insight. I calculated the 22,58% given the formula of Halvorsen-Palmquist (($e^{coefficient}$ -1) x 100), 2 economists that showed how to adjust such logarithmic coefficient for interpretation. On the other hand, one can notice that the dummy variable *Listed*, when equal to 0, translated to a decrease of 23,73% more for phase 3 compared to phase 1 (using the same formula above). This also illustrates the pace at which such entities were able to further decrease their emissions in phase 3.

Turning to hypothesis H2, the goal was to observe a significant difference in the emissions level over the years between LE's and NLE's. Looking at table 5, installations that are operated by NLE's seems to have a greater reduction in their emissions compared to LE's over phase 2 and 3. It is a surprise to see the opposite of the stated hypotheses occur. Indeed, H2 attempted to prove that LE's have a greater decrease in emissions compared to NLE's given the overall findings of the literature. One can observe in this case that the emissions level of LE's and NLE's do not differ significantly (*Listed'*s coefficient = 0,103 and not significant), which prevents the hypothesis 2 to be rejected. Interestingly enough, NLE's seem to have a greater, negative reduction of emissions for phase 2 and 3 than LE's. However, one must be careful with this statement as the coefficients for LE's are not significant. The coefficients for phase 2 and 3 of NLE's still remain an interesting finding.

In an effort to deepen the analysis on the effect of NLE's on emissions over the years, a last panel data regression is carried out in order to discover the effect of different types of entities on the emissions. Following the encouraging findings developed, this thesis explores whether one type is better at decreasing its emissions than others, which could stem from the motivation of the

Table 5
Emissions over the different phases – by entity
This table represents the output obtained after running a random effect panel data regression as of H2 with an emphasis on a new interaction term: entity_*type*. The dependent variable Ln (Emissions) that is, the yearly emissions volume (in tons) of given installation, is put against the explanatory variables *Phase 1*, *Phase2* and *Phase3*. The latter illustrate the different phases that the EU ETS underwent from 2005 to 2020. The results for the interaction term entity_type is presented. Below are also the results of the control variables "*Country_code*" and "*Industry_code*". t-statistics are in parentheses. *, * *, and * * * denote significance at the 10%, 5%, and 1% levels (two-tail), respectively and the parentheses indicate the standard error of the result.

	Dependent Variable: Ln (Emissions)			
	Listed Company	State Entity	Financial Entity	Private Company
Phase1	/	0,185	-0,116	-0,272**
		(0,178)	(0,178)	(0,150)
Phase2	-0,049	0,119	-0,380	-0,381***
	(0,034)	(0,174)	(0,175)	(0,147)
Phase3	-0,244***	-0,199	-0,256	-0,553***
	(0,032)	(0,172)	(0,173)	(0,146)
Controls:				
Country_code	0,012	0,012	0,012	0,012
	(0,008)	(0,008)	(0,008)	(0,008)
Industry_code	0,008	0,008	0,008	0,008
	(0,010)	(0,010)	(0,010)	(0,010)
Intercept	13,734***	13,734***	13,734***	13,734***
	(0,123)	(0,133)	(0,133)	(0,133)
Adjusted R^2	0,029	0,029	0,029	0,029
# Entities	184	44	43	66
# Observations	2.944	704	688	1.056

shareholders of these entities. Looking at table 5, a first striking observation is the significance of all coefficients (besides control variables) of *Private Company*. To recap, a private company was defined as an entity where its ownership is defined by its private shareholders in which the operations are managed from the inside, without direct influence of investors. In this sample, it mainly refers to one or more individuals, a large company simply not listed on a stock exchange or a regular family-owned business. Looking at its numbers, it is clear that private companies have been increasingly better at reducing their emissions compared to other types of large emitters. Thanks to this last regression, it appears that the interaction term of LE's in phase 3 had a significant coefficient in this case. Moreover, the LE's in phase 3 were not better at reducing their emissions (-0,244***) compared to private companies (-0,553***), further reinforcing the finding made earlier with H2. Sadly, the deepened analysis did not pay off regarding the state and financial entities but demonstrated that the results obtained for H2 were probably mostly driven by the private companies.

Although the score of the R squared is low, we still found significant p-values. This in turn can be interpretated as having fitted line in the data plots, but with a high variability in the data above/under that same fitted line. This statement points toward the complexity to assess the emissions of a wide range of companies differing significantly from one another with a limited set of variables. However, low p-values still enables us to take away trends in the observed data, but with a low level of precision (see R squared). Furthermore, the control variables' results observed were unfortunately not significant at any point in H1 and H2. The used control variables are usually common in capturing the differences in political, geographical and industry specific constraints. Evenly, the intercept of the above models is systematically similar and significant at 1%.

6. Discussion

The study started with identifying whether entities listed on the EU ETS truly lowered their emissions following the evolution of the EU ETS over the different phases (H1). Then, this paper explored whether LE's and NLE's significantly differed in their emissions over the 3 phases (H2). Evenly, further investigations were conducted on the nature of ownerships of NLE's and their impact on emissions. Given the little academic literature, the above hypotheses opened new ways of thinking about the effect of shareholders on the emissions of European companies. This section discusses the findings of the above study and attempts to compare, understand, and emit new insights for the literature on installations' emissions in Europe.

6.1. The impact of the different EU ETS phases

To begin with, the results of phase 2 suggested that this period was significant in term of emissions reduction. This already is in line with the literature, which states that the results of phase 2 outperformed the ones predicted during phase 1 (Hu et al., 2015). That is, the GHG emissions decreased by 9,2% between 2008 and 2012 (EEA, 2021b) against the 6,3% predicted by Brown et al. (2012). In effect, the early years of phase 2 showed a larger intensity in GHG reduction as the study shows but given the set-up of the analysis (collinearity), this paper does not agree with the reduction of emissions in phase 1. According to surveys and case studies conducted by the CEPS, investments' initiatives in energy efficiency and optimization of coal-based power generation present evidences of emissions abatements around that time (Egenhofer et al., 2011). However, it should be stressed that the greater reduction than expected of phase 2 is also explained by the economic crisis of 2008-09 that hit the industrial sector. That is, the EEA (2021b) advocates that 30 to 50% of the GHG reductions can be explained by the economic recession. The above mentioned evidences foster the idea that the EU ETS was not the only reason for emissions reduction during this phase, but in the context of this research, phase 2 of the EU ETS had a significant impact on the emissions of the studied installations (Vollebergh & Corjan, 2020).

Further, the results point out that phase 3 was also significant in the reduction of emissions. While the overall observations corroborate the findings of the Eionet report that the total amount of emissions was lowered, it is important to remember that it does not mean that this statement always translate into a consistent, statistical significance across all installations. Indeed, what is observed is a tendency over all the studied installations. According to the EUTL database, the European installations decreased their emissions by 29% overall, against the 21%'s objective of 2020. Furthermore, the same report demonstrates that the main cause of GHG reduction from this period stems from the large decline in the combustion industry with -38%, which is consistent with the reduction found in my dataset (-41%). Other stationary installations (not fuel combustion industry) decreased their emissions by 9%. Combustion-related emissions depend directly on primary energy consumption and the fuel mix used in energy transformation into heat, electricity, etc… (Nissen et al., 2021). 2019 and 2020 witnessed the influence of the economic landscape on the primary energy consumption with the largest decrease in emissions (-11%) due to the covid outbreak. Also, the ever-increasing share of renewable energy in the energy mix of combustion-based industries also accounted for a significant decrease in the GHG emissions observed during phase 3 (Marcu et al., 2022). It is especially difficult to balance the findings at hand for phase 3 since no other econometric study has been performed on this phase. Given the results obtained, it is with confidence that this paper argues that phase 3 had an impact on the listed installations on the EU ETS.

6.2. NLE’s as the leaders in emissions reduction in Europe?

According to the findings concerning hypothesis 2, the overall effect of the interaction term “*Listed*” is not significant. Therefore, it induces the conclusion that the LE’s are not better at decreasing their emissions compared to NLE’s. Furthermore, it is important to realize that the opposite is not necessarily true, since it was not tested in this paper. The study here only tested for a significant and greater decrease of emissions by LE’s. The above statement concurs with the view of Aggarwal & Dow (2011), where big corporations (i.e., LE’s) are unlikely to pursue investment in emissions reductions as the cost of these practice would provide benefits to the public while directly impacting the revenues of their shareholders. From the results obtained, it seems that the governance of big corporations does not experience pressure from their shareholders to pursue decarbonization processes and that their motivation is, nowadays, still driven by economic goals only. However, a similar study conducted on the ownership structure impact on emissions in China declares that listed companies are more subject to engage in sustainability commitment (e.g. emissions reductions), since there are more exposed to environmental reporting to shareholders and authorities than unlisted companies. Indeed, in the case of policy infringement, listed companies are more exposed to punishment for environmental damages. In the study at hand, such a difference in emissions is not observed between the two groups, therefore questioning the findings of Ren et al. (2022).

Further exploring the effect of ownership structure of NLE’s proved to be a good idea as the findings for phase 3 revealed that private companies were better at reducing their emissions than LE’s. While the other structure’s coefficients (besides LE’s in phase 3) were not significant, it is still possible to observe that private companies were significantly better at reducing their emissions than the other structures. These findings indicating that such a company structure might have a specific characteristic that enables them to record such reductions. The systematic and significant reduction in private companies also present the idea that these entities strongly influenced the results obtained for H2, where it is found that NLE’s are better at reducing their emissions than LE’s.

From there, this paper confidently emits the idea that the shareholders in private companies could have a better impact than shareholders in LE's because of the results of the different ownership structures. This however should not be understood as the only reason as why a private company is better able at reducing emissions than a LE. Indeed, there could exist a long list of factors explaining why the results obtained above were discovered, the shareholder's lead is the interpretation specific to this thesis. It remains difficult to nurture this theory as the academic literature on this unique topic is nonexistent, which is why this thesis laid the ground in understanding the emissions of the largest emitters in Europe.

6.3. Control variables

The result of the country and industry control variable was expected to be significant since I have been advocating earlier in the literature review that the emissions of each participating installation in the EU ETS differs in term of its country, industry and therefore its political stance, economic model and environmental regulations. Many are the researches (Azar et al., 2021; B. Jacobs et al., 2010; Makridou et al., 2019;..) on emissions in Europe proved the significance of such a variables to reduce the inexplicable variability in the data output. The fact that these claims were not confirmed in this study leaves room to question whether the wide variety of countries and industries studied led the models developed to not appropriately capture the variation in the data, or simply indicates that such control variables fail to significantly explain emissions in Europe. This could be linked to the complexity that is unique to each country and industry and reinforcing that the idea that such studies should be carried out with a specific focus on the latter.

6.4. Future challenge of the EU ETS and its implication for the shareholders.

Looking ahead, the objectives for 2030 (phase 4) promise to be more challenging as the reduction level needs to attain 40% compared to 1990. The more ambitious emissions objective will lead the EU ETS to revise downward the EUA allocation plans, which will cause the EUA price to increase even more and increase compliance costs for companies (EEA, 2015). As a matter of fact, the price of EUA has been sky-rocketing ever since the recent energy crisis, the introduction of more stringent climate change policies and the establishment of the Market Stability Reserve (MSR), further fostering the idea that the price is unlikely to stabilize given the more ambitious goal of the EU ETS (Ampudia et al., 2022). Given these macro events on the EUA price, one would think that the risk of higher compliance cost rimes with a lower company valuation as discussed in the literature review. However, the results obtained mirror the idea that shareholders in LE's do not fear such an obstacle. In the case these macro events have an impact on entity valuation, it would have been expected to observe a significant, lower level of emissions compared to non-listed companies. I am fairly confident that a similar study including phase 4 in the future would see a significant effect of LE's on their emissions since the results of phase 3 for LE's yielded a negative, significant coefficient.

On top of the new emissions target of phase 4, the European council included a binding target that aims at increasing the share of renewable energy consumption to 32% in Europe and improve energy efficiency by at least 27%. In term of renewable energy consumption, installations met the target of phase 3 (20%) (EEA, 2022). Nevertheless, it is expected that the EU ETS will not manage to motivate R&D and innovations in the field of renewable energy by itself, therefore putting at stress the European targets cited above (Rogge et al., 2011). One can understand that there is a need to develop further renewable energy policies in order to provoke innovations by entities. The latter statement will ultimately put further pressure on entities to reinvent their operations at the expense of economic profit. However, evidences suggest that the unpredictable GHG regulatory policies of the EU cause entities to reduce their long-term investments in emissions reduction and bet on short-term investment for quick paybacks. In some cases, it is said that such investments (with mere incremental benefits) are even postponed due to the uncertainty of the transformation of GHG emissions' policies (Engau & Hoffmann, 2009).

All in all, the higher expectations of the EU ETS for the upcoming phases are likely to impact shareholders in a negative way, even though the results obtain earlier in H2 seem to go against that claim. If the price of EUA continues to increase too rapidly and companies

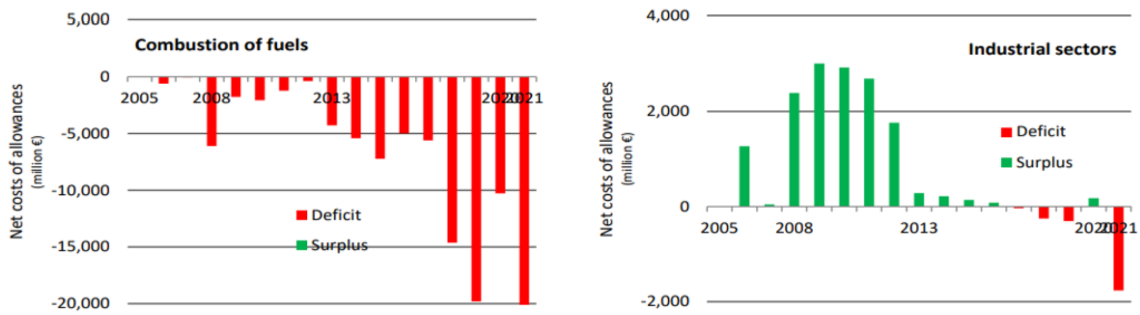

Figure 2: Net cost of Allowances (Marcu et al. 2022).

are unable to reduce emissions through innovation, it is probable to see a reduction or an elimination in industry activity instead of a sustainable decarbonization trend across installations. If LE's and NLE's do not anticipate these challenges, it is likely to observe stakeholders reviewing their investment given the increased longer-term risk of higher costs and diminished returns. The

EEA (2021) already picks up this trend of higher costs by showcasing the increasing costs of allowances over the years for the industry of fuel combustion. Looking at figure 2, the net cost of allowances bottomed to almost 0 euros in 2009 following the crisis and subsequently increased to peak at close to 20 billion euros in 2021 for the whole industry (Marcu et al., 2022). This piece of evidence is especially relevant for this study since it corroborates its findings regarding the sharp decrease of emissions for the combustion of fuel industry (the sample is composed of 46% of fuel combustion installations). The argument above should only be understood for the combustion of fuel as the industries covered by the EU ETS vary significantly in term of emissions volumes, which evenly generates different implications for shareholders committed to projects in different industries. Indeed, companies operating in industries that pollute more are exposed to a greater climate regulations, and therefore higher compliance costs evenly causing a bigger drop in market value than other industries (Chen & Montes-Sancho, 2017).

7. Limitations

The study at hand attempted to explain the level of emissions of a given set of European installations with a level of emissions over 1 million tons over a time span of 16 years, or the

3 first phases of the EU ETS. Because of the quality of the model developed (adjusted R^2), the findings explained above must be understood as sensitive and precursory. This section first explains why the results are deemed sensitive and after, why the latter are also precursory. To finish, general limitations regarding the study is addressed.

First, an obvious remark regarding the statistical model is discussed. Looking at table 4, one can see that the low R^2 serves as a prime reason why the model is sensitive. The output gathers significant coefficients with relatively low p-values and one must remember that the coefficients still explain the variability of the observations, but with a low precision. Although the dataset was carefully assembled based on information found on the EUTL, the final sample probably constitute too little explanatory variables to explain the data errors. One can think of a lack of control variables such as the financials of each entity, namely; EUA price, firms size, liquidity, etc... In the case of firm size, Birindelli & Chiappini (2020) advocate that the latter plays a role in explaining the impact of environmental policies on the value of a company's stock, which would be useful in the case of the hypothesis 2 of the study at hand. Findings reveal that the larger the size of the company, the higher the spike of the stock's price following a climate policy commitment. In this sense, investors seem to believe that the larger firms will be able to endure the costs of more stringent environmental regulation and probably develop efficient and innovative processes that will procure competitive advantages (Porter & van der Linde, 1995). Regarding the price of the allowance and the liquidity, it could further indicate the financial position of a company and its ability to comply with its carbon fees. The lack of such variables in the model is a consequence of my position as a student. Unfortunately, such information is not readily available online since a great part of the entities studied do not disclose it.

Secondly, the research at hand can be understood as precursory for the following reasons. In a first instance, there is currently no panel data regression analyzing the emissions of the biggest polluters in Europe over such a period. More specifically, there is no other statistical research on the efficiency of the EU ETS' phase 3 in the academic literature. At last, the main reason this research is precursory is because the findings presented in this work open the way for potential new channels of explanations regarding the emissions observed in Europe. Indeed, this thesis approached the matter of emissions given the shareholding structure of an entity, and subsequently asked whether the governance of the entity could influence emissions. As a matter of facts, there currently exists no other study on the relationship between the ownership structure of an entity and its related level of emissions in Europe. The relatively elementary model developed above could be the subject for further studies with the end goal of understanding the emissions in Europe and possibly help policy makers in adapting and developing new regulations to tackle climate change according to the type of entity. With that regard, focusing on a distinct industry, country, or entity type as the next step seems more adequate since each of these components are a complexity in itself. As mentioned before, there are multiple layers in the EU ETS that pertain to geographical, political, and industry-specific matters, which tangle the causes of a higher/lower level of emissions of a given installation. To that end, it might be more relevant to explain drivers of emissions on a micro level first, and evenly generalize findings on a macro level.

Lastly, the regression performed in this study cannot conclude causation of the presented explanatory variables with emissions levels but can however, induce correlation for now. One could think of adding the effect of environmental policies as mentioned in the discussion in the model by some means. Thereafter, a comparison using difference in difference method could be carried out between a group that endured the reforms against another that did not endure such reforms in order to see a potential causation of the different phases and the ownership structure on the emissions of observed entities.

8. Conclusion

This study attempted to observe a potential channel of influence of the shareholders on their company's level of emissions. To that end, the dataset of the EUTL was used as a basis to provide resources to this empirical research. For the record, the emphasis of this research pertained to the biggest polluters of Europe part of the EU ETS.

In a first instance, it was important to first test for the effectiveness of the first 3 phases of the EU ETS before addressing the potential role of shareholders on the emission reduction. The results obtained in this paper point out a significant and negative correlation between the successive phases and the level of emissions of the installations studied. While it remains challenging to untangle the true effect of the EU ETS on these firms with other environmental regulations, one can safely assume that the studied installations all report encouraging decreases in their emissions. From that finding, emissions of LE's and NLE's were compared and, surprisingly, LE's did not prove to be better at reducing their emissions compared to NLE's therefore emitting the idea that shareholders do not have a significance influence on the operations of their company. On the contrary, a last analysis revealed that NLE's recorded bigger decreases in emissions compared to LE's entities. Further on the ownership structure of these NLE's, it is observed that the above finding is mostly influenced by privately held companies, which showed tremendous decreases in their emissions compared to other type of entities over the different phases.

As discussed in the limitations of this paper, one should keep in mind that the low R squared of the model does not necessarily discredit the choice of the indicators selected but rather motivate anyone to improve the model by implementing more meaningful variables into the model as mentioned before. Along with a richer dataset, more indicators would for sure help the model in better explaining the variability of the data observed. Moreover, I believe that this precursory research could play a role in inspiring the academic literature in further exploring the role of shareholders in the emissions reduction in Europe. As a matter of fact, there exists no other study as such in the scientific world. This research has the potential to unveil new researches in that field, which in turn could help policy makers across Europe to better regulate and evenly, help the cause against climate change.

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