Impacts of free allocation on emissions between phases II and III of the EU ETS

Lappeenranta–Lahti University of Technology LUT
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Examiner: Postdoctoral researcher, Ekaterina Albats

ABSTRACT

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The European Union's long term strategy and the goal of being climate-neutral by the year 2050 can only be reached by making substantial reductions to emissions. This is why it is crucially important to study the performance of the EU ETS and to evaluate it.

The goal of this bachelor's thesis is to compare emission amounts in phases II (2008-2012) and III (2013-2020) of the European Union Emissions trading system and to study whether or not the amount of emission allowances given for free to companies by the EU had an impact on said emission amounts. The study is conducted using data from the European Union Transaction Log. This data is used to generate two linear regression analyses – one for phase II and another for phase III of the EU ETS. The results of the aforementioned regression analyses indicate that in phase II of the EU ETS, the amount of free allocation had no impact on verified emission amounts. This is most likely due to the fact that the EU ETS was still new and finding the best way to allocate allowances and to operate. In phase III, however, the regression analysis results suggest that a decrease in the amount of free allocation decreases the amount of verified emissions.

TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT

LUT-kauppakorkeakoulu

Kauppatieteet

Oona Lahtinen

Ilmaiseksi myönnettyjen päästöoikeuksien vaikutus päästöihin EU:n päästökauppajärjestelmän vaiheissa II ja III

Kauppatieteiden kandidaatintutkielma

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Euroopan unionin pitkän aikavälin strategia ja tavoite olla ilmastoneutraali vuoteen 2050 mennessä voidaan saavuttaa vain vähentämällä päästöjä merkittävästi. Tästä syystä on erittäin tärkeää tutkia EU:n päästökauppajärjestelmän suorituskykyä ja arvioida sitä.
Tämän kandidaatintyön tavoitteena on verrata päästömääriä Euroopan unionin päästökauppajärjestelmän vaiheissa II (2008-2012) ja III (2013-2020) ja selvittää, onko yrityksille ilmaiseksi myönnettyjen päästöoikeuksien määrällä vaikutusta päästömääriin. Tutkimus on tehty käyttämällä Euroopan unionin tapahtumalokin tietoja. Näitä tietoja käytetään kahden lineaarisen regressioanalyysin luomiseen – toinen EU:n päästökauppajärjestelmän vaiheelle II ja toinen vaiheelle III. Edellä mainittujen regressioanalyysien tuloksista voidaan nähdä, että EU:n päästökauppajärjestelmän vaiheessa II, ilmaisten päästöoikeuksien määrällä ei ollut vaikutusta todennettuihin päästömääriin. Tämä johtuu todennäköisesti siitä, että EU:n päästökauppajärjestelmä oli vielä uusi ja etsi parasta tapaa jakaa päästöoikeuksia ja toimia. Vaiheessa III regressioanalyysin tulokset viittaavat taas siihen, että ilmaisten päästöoikeuksien määrän pienentäminen vähentää myös todennettujen päästöjen määrää.

TABLE OF CONTENTS

1. Introduction

This Bachelor's thesis will examine the differences in emissions between the phases II and III of the European Union Emissions trading system. In the current state of the climate, it is important now more than ever to study and re-examine the ways that we are combatting carbon emissions. The European Union decided in 2003 to launch an emissions trading system, to encourage greenhouse gas reductions in an "economically efficient manner". (European parliament, 2003)

To motivate companies to reduce their emissions, the EU has a way of allocating emissions allowances for free to firms. At first, almost all allowances were given to companies for free, however, the proportion of freely allocated allowances decreases each year, as the European Union makes auctioning the preferred method of allocating allowances. (European Commission, 2020)

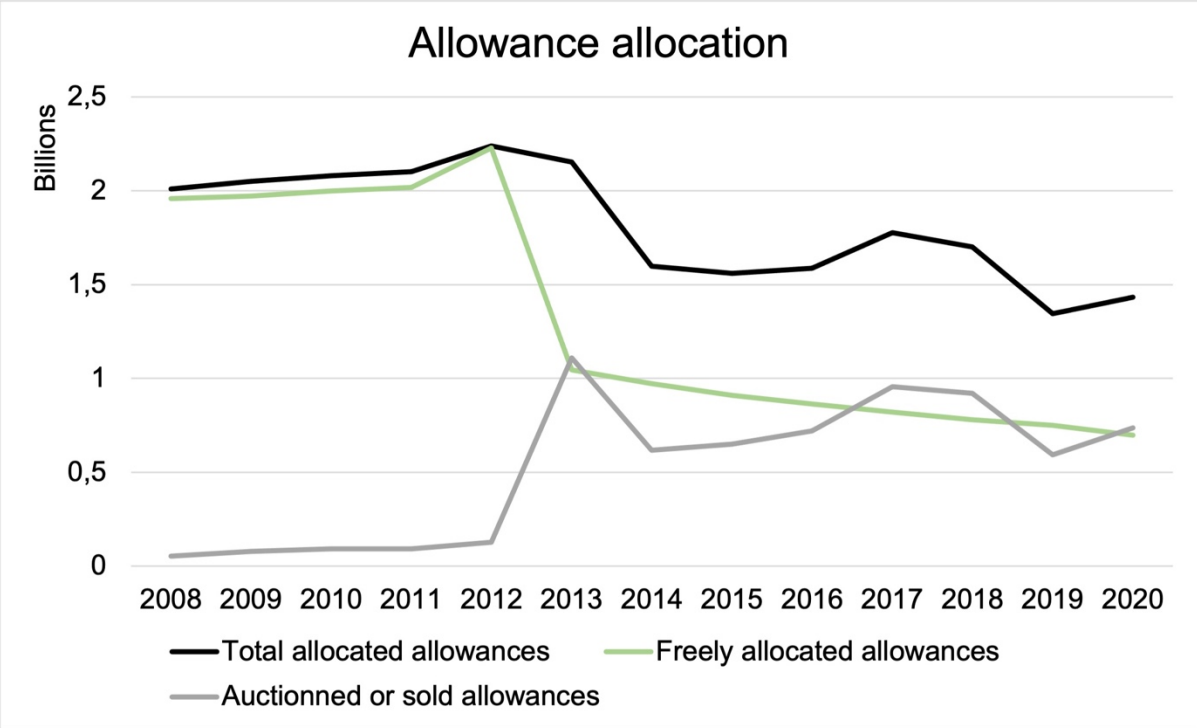

Figure 1. Allowance allocation. Allowance amounts on y-axis and years on x-axis. (data from data.europa.eu database)

In phases I and II, the European Union used a method of free allocation called grandfathering, where the free allowances are given to the companies based on past emissions. This changed in phase III when the European Union started using the new method, benchmarking. In this method, the free allowances are issued based on performance indicators. (European commission, 2015)

The European Union's commitment to a carbon neutral EU by the year 2050 can only be reached by making profound reductions to the carbon emissions cap as well as the amount of free allocation of allowances in the EU ETS. These reductions are supposed to inspire companies to reduce their greenhouse gas emissions. It is, however, possible for affluent companies to simply buy more allowances instead of reducing emissions, if they are not given the allowances for free. (European Commission, 2021a)

1.1 Goals of the study

My goal in this thesis, is to examine whether the aforementioned reductions in the free allocation have made an impact on emissions. I will do this using the following research question:

1. Has the reduction of free allocation had an effect on emissions?

It would be easy to assume that when free allocation amounts are reduced, emission amounts go down as well. However, because of the fact that companies are also able to buy allowances to cover their emissions, it is not a given that emissions are reduced when free allocation is reduced. For this reason, it is important to study whether or not there is a connection between free allocation amounts and emission amounts.

1.2 Limitations

Although many emissions trading systems are currently operating all over the world, in this Bachelor's thesis I will limit my research to the EU ETS. This is due to the fact that the EU ETS is the biggest cap-and-trade system in the world, and as such, it has the largest amounts of data available. I will also not be focusing on the first phase of the EU ETS because of the fact that is was a trial period and as such it is not as relevant to the topic at hand.

The EU ETS is a well researched topic. However, due to phase III ending just recently in 2020, even the most recent literature hasn't yet focused much on the differences between phases II and III.

1.3 Structure of the study

This bachelor's thesis consists of five parts: introduction, theoretical framework, data and methods, results and conclusions. The first part focuses on presenting the subject as a whole as well as discussing the goals and background of the study. The first chapter will also include the limitations of the study.

The second part of the thesis is the theoretical framework. This part includes relevant theoretical information about the subject and provides more detailed information about the background of the EU ETS. In addition, the second part takes a look at previous studies on the subject.

The third part presents the data and methods used in the study. There will be two analyses, one for each of the two phases of the EU ETS studied in this thesis. The fourth part contains the results of the study and discusses possible contributing factors as well as compares the two analyses' result with each other.

The last part, conclusions, contains a summary of the findings and results of the study and presents future research propositions.

2. History of the EU ETS and relevant theories

The first steps toward regulating greenhouse gasses were taken in 1992 when the United Nations had a convention called the United Nations Framework Convention on Climate Change, UNFCCC for short. The convention was first ratified by 154 countries. However, currently the convention is ratified by 197 countries. The eventual goal of the UNFCCC is to stop dangerous human encroachment to the climate system. (UNFCCC 2022)

The parties of the UNFCCC are divided into Annex I, Annex II and non-annex countries based on how developed these countries are according to the UN. All parties of the UNFCCC have certain commitments that they have to follow, however, the Annex I and II countries have additional obligations. Annex I includes 43 parties that are industrialized nations. The Annex II includes 24 countries that are, in addition to the general obligations given to all parties, obligated to provide financial support to developing nations to help the countries fulfill their obligations. (United Nations, 1992)

2.1 Kyoto protocol

In 1997 the United Nations adopted the Kyoto Protocol as a means to operationalize the United Nations Framework Convention on Climate Change. The goal of the Kyoto protocol is to commit industrialized countries to reducing and regulating their emissions. (United Nations 1997)

The protocol came into effect in 2005 and included emission limitation commitments to the aforementioned Annex I countries as well as obligations to create national policies that promote sustainability. The first commitment period of the Kyoto protocol, 2008 – 2012, had an overall target of a 5 % decrease in emissions compared to the levels in 1990. (UNFCCC 2022)

The second commitment period of the Kyoto protocol that begun in 2013, included an amendment that included new commitments to the Annex I countries as well as a new

list of greenhouse gasses that the parties of the protocol have to report on. (UNFCCC 2022)

2.2 EU ETS directive

Plans for an EU-wide Emissions trading system were finalized with the 2003 EU ETS directive. According to the directive, no firms may undertake the emission producing activities specified by the directive, without a greenhouse gas emissions permit. (European Parliament, 2003)

2.3 European Union Emissions Trading System

The European Union Emissions Trading System, EU ETS, is a carbon market system that operates on a so-called cap-and-trade principle. The system is based on the existence of a cap, a total amount that is set for emissions within the system. Overtime, the EU reduces the cap to gradually reduce the overall amount of emissions. Each year, the installations under EU ETS must hand over an amount of emissions allowances that completely covers the amount of emissions that the installation has emitted. Should they fail to do so, large fines would be issued by the European Union. (European Commission, 2021a)

The cap, that is set for emissions, ensures that the emissions allowances have a price. Consequently, installations under the EU ETS can buy and sell emissions allowances with each other to account for their emissions. The allowances can also be saved for later use, if the installation doesn't need to use all of it's allowances a certain year. (European Commission, 2021a)

The EU ETS covers multiple different sectors and greenhouse gases. The gases covered are carbon dioxide, nitrous oxide and perfluorocarbons. The sectors covered by the EU ETS are multiple energy-intensive industry sectors as well as commercial aviation, heat production, energy production and production of aluminum. (European Commission, 2021a)

2.4 Phases of the EU ETS

Established in 2005, the EU ETS has had four phases so far. It was the first international emissions trading system in the world. The first phase was a so called pilot period that lasted for three years. In that period, most of the allowances were given to the businesses for free. In phase I, instead of having one EU wide cap on emissions, the caps on emissions were set on a national level. Accurate information about emissions was not available at the time, which led to the overestimation of the amount of allowances issued. This and the fact that the phase I allowances could not be used in phase II led to the price of allowances dropping to zero at the end of phase I in 2007. (European Commission, 2020)

Phase II started in 2008 and lasted until 2012. In phase II the cap on allowances was lowered and free allocation of allowances was reduced to approximately 90%. The system was still based on the national caps on emissions, however, installations under the EU ETS were also allowed to buy international allowances in phase II. Aviation was also added as a sector to the EU ETS in 2012, however flights from and to countries that are outside of the European Union were not included for the year 2012. These changes increased the price of carbon, however the 2008 financial crisis reduced emissions more than expected, leaving a surplus of allowances and in so doing, lowering the price of carbon. (European Commission, 2020)

In phase III the EU ETS went through a considerable reform. The nation-wide caps on emissions were replaced by one EU-wide cap. The method of free allocation was also changed to a system that allocated free allowances based on production performance. This method is called benchmarking. Previously the method of free allocation, grandfathering, allocated free allowances based on previous emissions. More greenhouse gasses were also included to the EU ETS. (European Commission, 2015)

The auction of millions of allowances was also postponed as a short-term means of reducing the surplus of allowances in circulation. The long-term solution to the problem of having too many allowances in circulation is the market stability reserve that was introduced in 2019. (European Commission, 2020)

The current phase, phase IV, started in 2021 and will conclude in 2030. The European Union has a goal to achieve carbon neutrality by the year 2050. To achieve this ambitious goal, the EU has to reduce its' greenhouse gas emissions by at least 55% by the end of 2030. This also means that the EU ETS has to reduce emissions by 43% from the level at which it was in 2005. (European Commission, 2021a)

Features	**Phase I**	**Phase II**	**Phase III**	**Phase IV**
Countries	Member states of the EU	Member states of the EU + Norway, Liechtenstein & Iceland	Member states of the EU + Norway, Liechtenstein, Iceland & Croatia	Member states of the EU + Norway, Liechtenstein, Iceland & Croatia
Sectors	Power stations & other combustion plants Oil refineries Coke ovens Iron and steel plants Cement clinker Glass Lime Bricks Ceramics Pulp Paper & board	Same as in phase I + Aviation from 2012	Same as in phase II + Nitrous oxide from acid production, perfluorocarbons from production of aluminum	Same as in Phase III
Gases	CO_2	CO_2, N_2O	CO_2,N_2O,PFC	CO_2,N_2O,PFC

Table 1. (European Commission, 2015, 2021a)

2.5 Relevant economic theories

Many economic theories are relevant to the EU ETS. One of them is the law of supply and demand. This theory, formally created in the 1700's by trailblazer economists such as Adam Smith and Alfred Marshall. The theory may have many fathers, still the contents remain the same: the price of a product or service is affected by its supply and demand. (Alfred Marshall, 1890)

This applies to the emission trading system, as the amount of allowances in circulation affects the price of carbon. This was seen in the first phase of the EU ETS, when the supply of allowances greatly exceeded the demand and the price of allowances dropped to 0. The companies weren't able to save the allowances for later use between phases I and II, which meant that there was almost no demand for allowances at the end of phase I. (European Commission, 2020)

After the start of phase II, the price of carbon recovered, however, the economic crisis of 2009 caused a sizeable decrease in emissions, creating a surplus of allowances, and thus lowering the price of carbon. This can be seen in figure 2, that illustrates the evolution of allowance prices (€) in the EU ETS from 2005 – 2022. (European Commission, 2020)

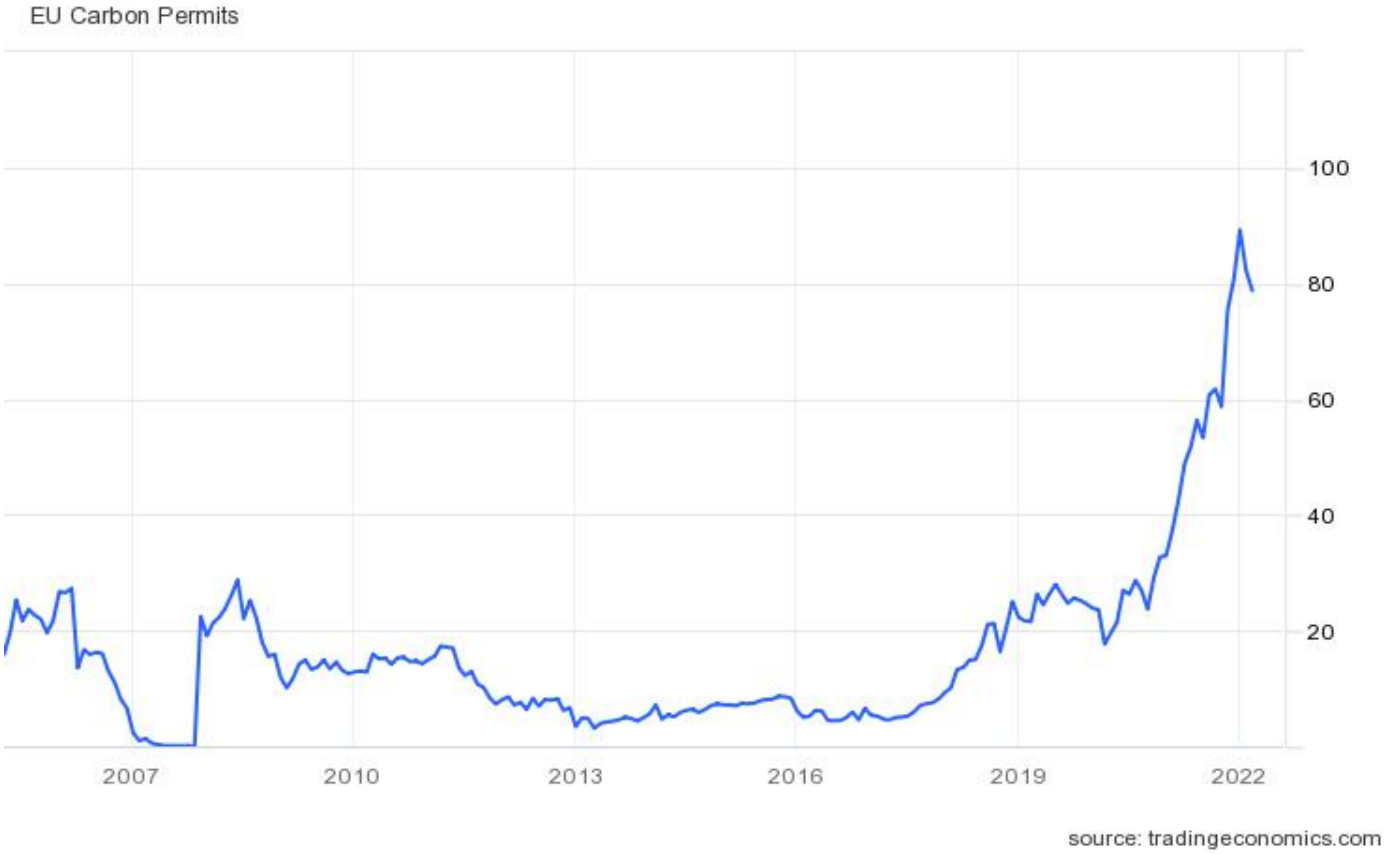

Figure 2. Price of EU carbon permits (€). (Trading Economics, 2022)

It is very important for the integrity of the EU ETS, that the price of carbon does not drop too low. This is why between 2014 and 2016, 900 million allowances were withheld from auctions in an action the European Union called “back-loading”. Later in 2019 the back-loaded allowances were put into the market stability reserve. The market stability reserve is a long-term solution that the European Union came up with to manage the rapid changes to the price of allowances. It is supposed to also help the EU ETS handle big shock that could happen in the market by adjusting the amount of allowances in circulation. (European Commission, 2021b)

The Coase theorem created by Ronald Coase in 1960, is a widely accepted theorem on which emissions trading is said to be based. According to the theorem, if trading of an externality, such as emissions for example, is possible, negotiation will lead to an efficient result regardless of the initial allocation of property (in this case allowances). The necessary conditions for the efficient result to happen, however, require very low transaction costs as well as clear definition of property ownership. (Coase, 1960)

2.6 Prior studies on the subject

Although the EU ETS along with its methods of free allocation is a very well researched topic, the relationship of free allocation and emissions has not yet been studied very extensively. For this reason, it is very important to study this subject further.

A 2012 paper by Stefan Pauer describes the new way of free allocation used in phase III, where free allocation is based on performance benchmarks, will preserve firms' competitiveness as well as reinforce the main idea of the EU ETS by upholding the price of allowances. He also underlines that the new way of distributing allowances for free will create incentives for firms to abate greenhouse gas emissions. (Pauer, 2012)

Frank Maarten Jan Venmans found in his 2016 study on Belgian ceramics, lime and cement manufacturers, that allocation of allowances below the levels of emissions, created an incentive for companies to invest in reducing their emissions. Hence, his findings are not in line with the Coase theorem, according to which the initial allocation of allowances does not affect greenhouse gas reduction motivations. (Venmans, 2016)

Beat Hintermann, however, found in his 2015 study on large energy producer firms, that the focus of firms is not on minimizing costs from emissions, but rather on maximizing profits. He also found evidence of purposeful price manipulation by firms via purchasing more allowances than necessary. His results also suggest that market power could possibly become a pertinent issue to the EU ETS. (Hintermann, 2015)

Corjan Brink, Herman R.J. Vollebergh and Edwin van der Werf evaluate different reform options for the EU ETS in their 2016 study. They found that by tightening the emissions cap and introducing a minimum price for carbon via carbon tax, would create incentive for low carbon technology investments as well as improving price certainty of carbon. (Brink et al. 2016)
Stefano Verde, Jordi Teixidó, Claudio Marcantonini and Xavier Labandeira found, in their study on the EU ETS free allocation rules, that free allocation is still necessary to

protect firms' competitiveness and consequently reducing the risk of relocation. They also underline, that free allocation can not be the only way to prevent firms from relocating in the future. (Verde et al, 2019)

Clara Ulmer determines in her 2022 paper, that free allocation has had no impact on the trends of exports and imports. She also found no significant link between trading behavior of firms and receiving free allocation. Had there been a link between the two, it would have raised concerns about firm relocation to areas with laxer legislation concerning emissions. (Ulmer, 2022)

3. Data and methods

The method of data analysis used in the empirical section of this bachelor's thesis is regression analysis. The program used for this analysis is Stata, a statistical software meant for analyzing quantitative data.

3.1 Data

The data used in this study is from the data.europa.eu database. The specific dataset used contains data from the European Union Transaction Log. The set contains emission and allowance data by country, year and industry from the start of the EU ETS in 2005, until 2021. For this study, only data from the years 2008 – 2020 will be used as it reflects the data from the second and third phase of the EU ETS.

To clean up the dataset, all information before the year 2008 and after the year 2020 was left out. In addition, all countries and sectors were added together to form one figure to represent verified emissions and free allocation amounts per year. The data already had values for "all stationary installations" that added together all sectors except aviation.

Aviation was added to the scope of the EU ETS in 2012, and it had to be added to the figures so that they accurately represent both verified emissions and freely allocated allowance amounts. After adding aviation to the values, 13 datapoints for verified emissions and 13 datapoints for freely allocated allowances were left, representing the 5 years of phase II and 8 years of phase III.

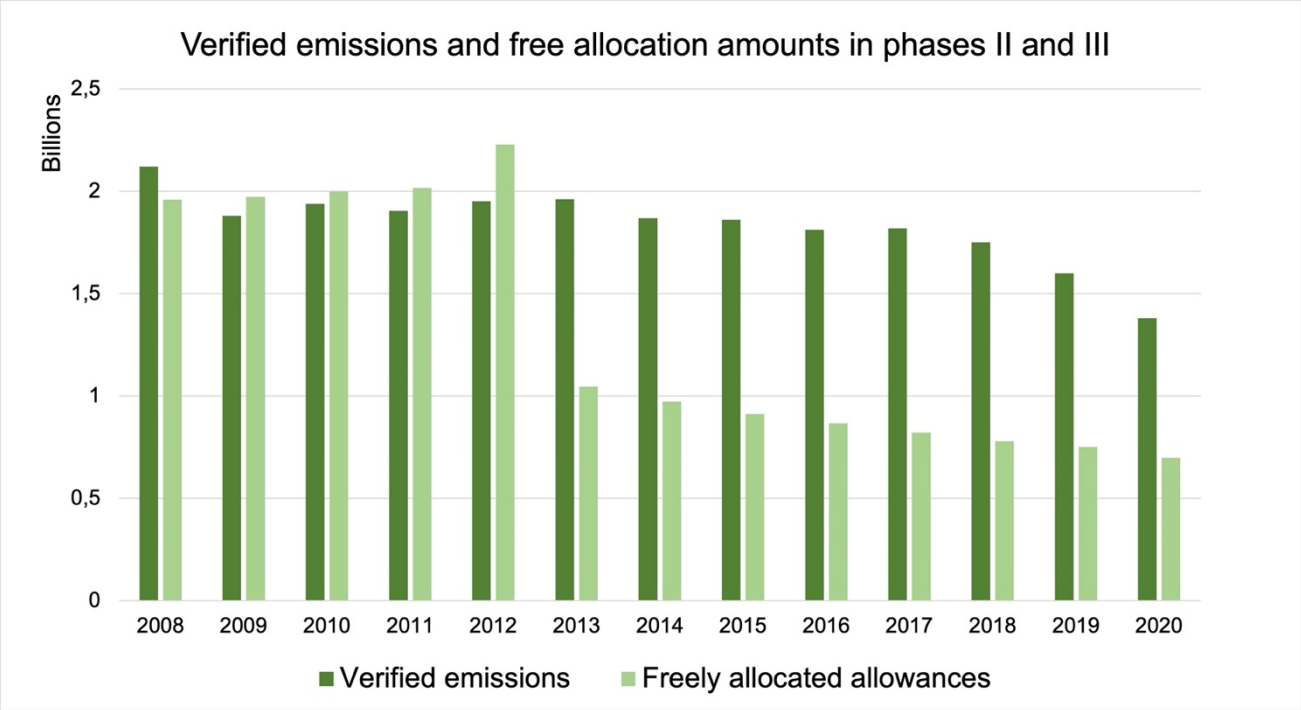

Figure 3. Verified emissions and free allocation amounts. (data from data.europa.eu database)

3.2 Regression analysis

Regression analysis is a statistical analysis tool that is used to study whether or not there is a relationship between two variables. For this thesis two regression analyses will be performed, one for phase II data and another for phase III data. This is done so that the results can be compared to each other. (Tietoarkisto, 2022)

Based on the data, the first hypothesis is that free allocation had no impact on emissions in the phase II of EU ETS. This is because the 2009 crisis created such large reductions in emissions that allocation of allowances exceeded emissions.

The second hypotheses is that in the phase III of the EU ETS, the free allocation had a reducing effect on emissions. This is based on both the data and prior literature on the subject, especially Venmans's study that found a connection between free allocation below emissions and investments to emission reductions. (Venmans, 2016)

4. Results

This section contains the results from the two regression analyses. The first regression analysis, that explored the data from phase II, will be presented and discussed first, then the second analysis, and lastly, the results of the analyses will be compared to each other.

The null hypothesis for the regression analyses is that there is no relationship between the two variables, amount of free allocation and amount of verified emissions. The statistical significance of the models will be assessed using the F test and the p-value it provides. The R-squared values will be used to evaluate how much of the variation in the dependent variable, verified emissions, can be explained by the independent variable, free allocation amount, as well as to compare the two models. All of this information was derived from the regression analysis done in Stata.

4.1 Phase II analysis

Results	Analysis 1 (Phase II)
F test	0.09
p-value for F test	0.7820
R^2	0.0296
Adjusted R^2	-0.2939
t	-0.30
p-value for t	0.782
Standard error	0.4856
Coefficient	-0.1469

Table 2.

The first analysis provided the results shown in Table 2. It can be interpreted from the p-value of the F test, that the model was not statistically significant. This means that the null hypothesis can not be rejected, signifying that free allocation amounts can not be used to explain the variation in emission amounts in phase II. The R squared of the model, 0.029, is also very small. Had the model been statistically significant, this would indicate that only less than three percent of the variation in the dependent variable, verified emissions, can be explained by the explanatory variable, amount of free allocation. Therefore the impact of free allocation amount on the amount of verified emissions would be very small even if the model was statistically significant.

These results are not surprising, when looking at the data from phase II shown in figure 4. There are several possible explanations as to why the results are as they present, and many factors could have had an effect on their outcome. One of the most likely influences is the fact that phase II was a very short period and thus provided only 5 datapoints for analysis. In addition, the unexpected changes in emission amounts and the lack of ways to allocate free allowances, resulted in a significant oversupply of allowances in phase II. The financial crisis in 2008 caused emissions reductions that were much larger than the European Union expected and the free allocation method

was not flexible enough to predict what the perfect free allocation amount was for each year.

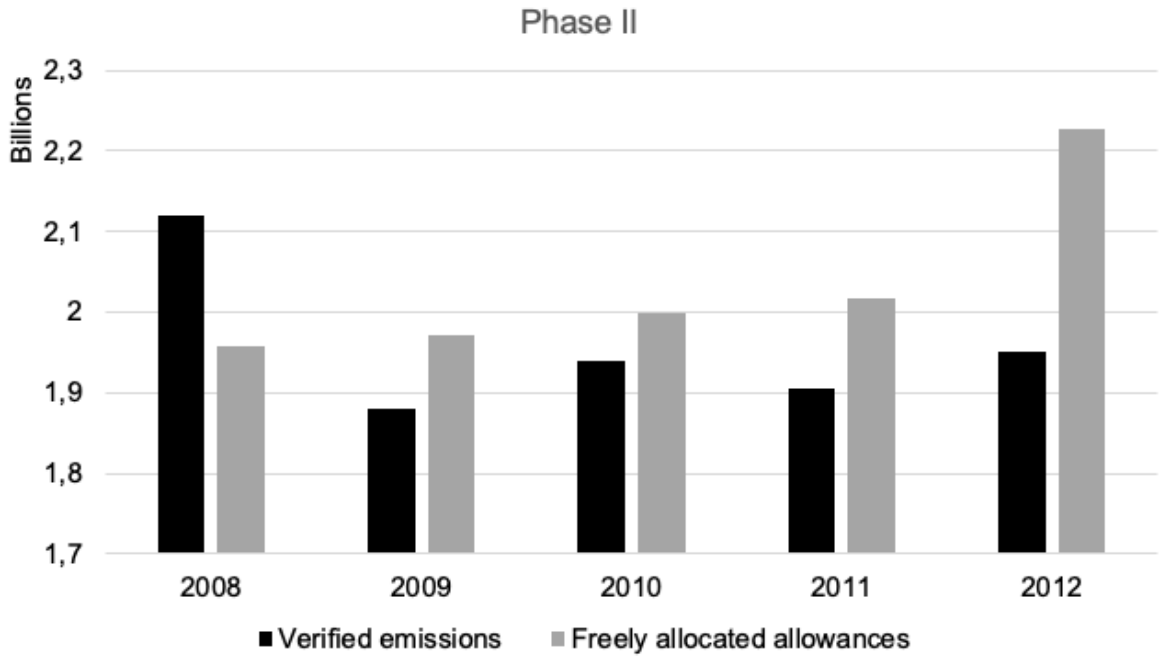

Figure 4.

The method of free allocation was grandfathering, which meant that all of the free allocation was done based on the historical emissions of the companies. The aviation sector was also added to the scope of the EU ETS in 2012, resulting in a large increase of free allocation in 2012. The data for emissions for the aviation sector was based on historical emissions from 2004 – 2006 and the allowance cap as well as the free allocation amount were based on this information. However, the flights to and from countries outside of the European Union were not included to the EU ETS in 2012 (European Commission, 2020). This meant that the free allocation amount for that year was much larger than the amount of verified emissions, as can be seen in figure 3 as well.

The EU ETS was also quite new at that point in time, having only operated for three years at the start of phase II in 2008. This meant that although there was data available from the first phase, the EU ETS was still trying to find the optimal way to operate and to allocate allowances to firms in a way that would create incentives for them to reduce emissions. (European Commission, 2015)

4.2 Phase III analysis

The second model, shown in table 3, gave very interesting results as well. According to the R squared value, approximately 76% of the variance in verified emissions can be predicted by the free allocation amount variable. The model was also statistically significant, with a p-value of 0.0044. This means that the null hypothesis, according to which there is no relationship between the variables, can be rejected.

Results	Analysis 2 (Phase III)
F test	19.68
p-value for F test	0.0044
R^2	0.7663
Adjusted R^2	0.7274
t	4.44
p-value for t	0.004
Standard error	0.3122
Coefficient	1.3848

Table 3.

These results are interesting because the coefficient has a positive value, 1.38, meaning that when free allocation increases by one unit, ceteris paribus, the verified emissions are expected to rise by 1.38 units. In other words, there is a positive relationship between free allocation amounts and verified emissions. Furthermore, because the model is linear, a decrease in free allocation amounts would also result in a decrease in verified emissions.

Though the results suggest that there is a relationship between free allocation amounts and verified emission amounts, evidently, the results do not demonstrate a causal relationship between the two variables. It is entirely possible that the reduction in verified emissions was caused by other factors than free allocation or that the reductions in the two things are caused by a third factor.

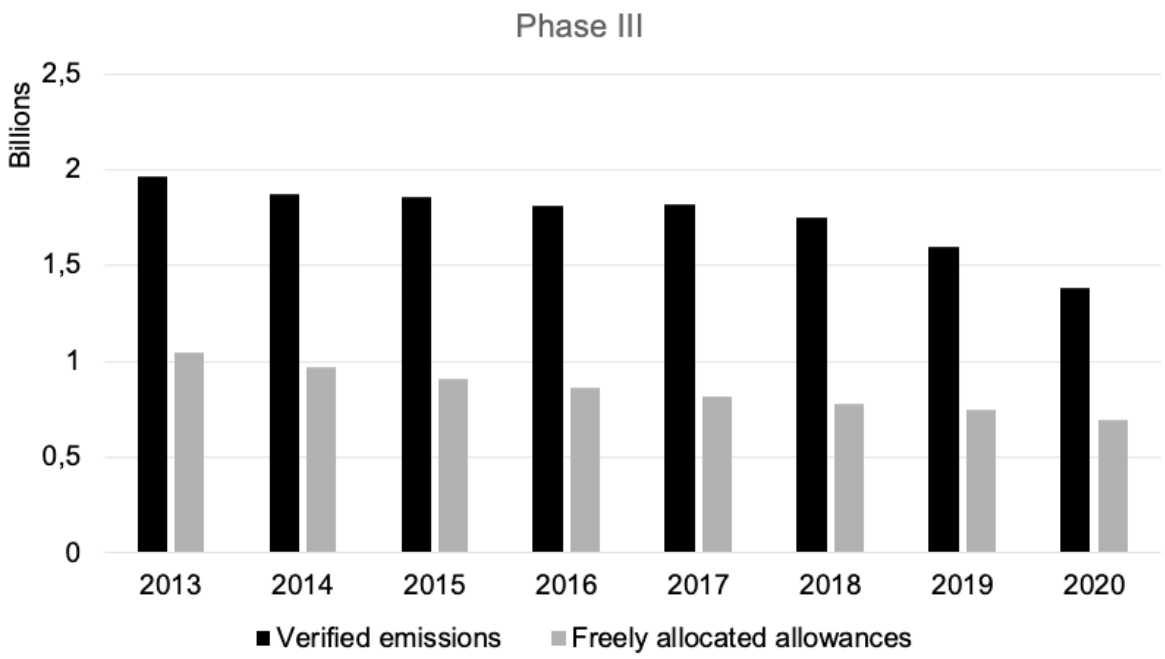

Figure 5.

As can be seen from the figure 5, the amount of free allocation is much smaller at the start of phase III than it was in the end of phase II. The free allocation amounts are decreasing each year and the emission amounts can also be seen declining during phase III. This is most likely due to the new policies and practices concerning free allocation of allowances that the European Union embraced in phase III. Free allocation was no longer the main way for firms to get allowances, in turn, auctioning allowances was made the default option in phase III (European commission, 2020).

4.3 Comparison of the two

When compared to each other, it is evident that the two regression analysis results are very different. The results of the first analysis suggest that in phase II the amount of free allocation did not affect the verified emission amounts. Conversely, the results of the second analysis suggest that there is a connection between free allocation amounts and the amount of verified emissions in phase III.

5. Conclusions

The goal of this thesis was to determine whether or not the free allocation has had an effect on emission amounts. The data used in this study was obtained from the European Union transaction log from the data.europa.eu website. The study was conducted in two parts. The first part was a regression analysis on the data points from phase II of the EU ETS and the second was a regression analysis on the phase III data. After conducting both analyses, the results were compared to each other.

The first analysis was not statistically significant and thus the null hypothesis, according to which there is no relationship between the variables, could not be rejected. The second analysis, however, yielded statistically significant result and the null hypothesis was rejected.

The research question for this thesis was: *"Has the reduction of free allocation had an effect on emissions?".* The results provided a multifaceted answer. Free allocation had no perceivable impact on verified emissions during phase II of the EU ETS. However, in phase III, the amount of free allocation and the amount of verified emissions had a positive relationship, meaning that they move in tandem on the regression line. Thus, when free allocation is decreased by one unit, verified emissions decrease by 1.38 units.

Because the exact topic of this thesis has not been studied yet, it was difficult to find relevant studies to compare the results to. However, the 2016 study that was mentioned before in section 2, by Frank Maarten Jan Venmans, found that allocating less allowances than companies need, creates incentives for said companies to invest in emissions reductions (Venmans, 2016). The findings of the second analysis in this thesis support Venmans findings, and also push it a bit further, suggesting that free allocation amounts and verified emissions have a positive relationship with each other.

6. Future research

Future research could include a more in depth analysis of the phases II and III, perhaps using firm level data. It would be very interesting to find out if the results of this study could be supported by a more profound investigation. It would also be interesting to study whether or not there is a causal relationship between free allocation reductions and verified emissions reductions. In addition, it would be fascinating to see what the impact of the Covid-19 pandemic was on installations under the EU ETS and their emissions. When phase IV finishes, it would also be good to study the differences between phase III and IV in a similar way to see whether or not the new free allocation rules had a profound effect on emissions.

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