INVESTIGATING THE IMPACT OF EU ETS ALLOWANCES ON THE CAPITAL MARKET – THE CASE OF GERMAN COMPANIES

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ABSTRACT
To achieve the international targets for limiting carbon emissions the Emissions Trading System of the European Union (EU ETS) was implemented. Considering the crucial role of this system in the process of decarbonization of the economy, it is essential to investigate whether and to what extent there is an impact on the capital market. To investigate this, the dataset of 38 German companies from 2013 until 2020 is used. The data set consists of paid allowances, free allowances, stock prices, return on assets (ROA) ratio, and dividend payouts. The study uses three econometric methods for panels including the pooled ordinary least squares, the fixed effects model, and the random effects model. In addition, the F-test and Hausman tests are used, to determine which method is more appropriate. The results show that the ordinary least square (OLS) model and fixed effect model are most suitable for the stock price estimation and confirm the negative impact of free allowances on stock prices. A random effect is considered for the ROA and dividend estimation, confirming the negative impact of free allowances on the ROA ratio and the positive on the dividend distributions.

Keywords: *EU ETS, Stock price, Dividends, Return on assets, Allowances.*

JEL classification: *G11, G15.*

1. INTRODUCTION

Due to the increased awareness of the possible consequences of climate change, international communities and organizations proposed setting international targets to limit the global average temperature. Accordingly, with the adoption of the Paris Agreement in 2025, a target of below 2°C, or around 1.5°C, above pre-industrial levels were accepted. This agreement assumes that the signatory countries must take certain actions to limit the total emissions in the air in order to achieve these targets. Although ambitions to tackle climate change have increased, some reports (see the Intergovernmental Panel on Climate Change (IPCC) Summary for Policymakers, 2018) suggest that the temperature may exceed 1.5°C until 2040, even for the very low greenhouse gas emissions scenario. This implies that in the next period, the activities of policymakers will increase and cause significant changes in economic processes.

As carbon dioxide emissions (CO_2) are considered the main driver of climate change (see Ritchie and Roser, 2020), countries started introducing measures and mechanisms to reduce them. Accordingly, in 2005, the European Commission (EC) implemented the "European Union Emissions Trading System" (EU ETS). The system is considered the first successfully implemented “cap and trade” scheme covering around 40 percent of all EU emissions. Since its implementation in 2005, the system has gone through four phases of development. Currently, it operates in all EU country members including Iceland, Liechtenstein, and Norway. The functioning of the system is very simple. Companies covered by the system are granted free allowances or buy allowances through auctions. Unlike the allowances that are available through auction, certain sectors that have a higher risk of carbon leakage or moving the production outside the union are granted free allowances. These are sectors related to industrial production and heating because they have the highest risk of carbon leakage in other countries with more flexible legislation. In case companies need more allowances, they go to the market and buy allowances from those companies that have more than needed. Theoretically, this means that the companies that buy allowances are still carbon-intensive and have not reduced their emissions, unlike those companies that sell allowances and have managed to reduce their emissions. Buying and selling allowances on a net basis in the economy should not make a difference in terms of the number of emissions, as excess emissions are netted by the number of reduced emissions by different companies.

Since actions need to be scaled up to mitigate climate change, the cap is expected to be gradually adjusted downward. The reduction of emissions implies changing the work operations and processes, which will consequently have an impact on the results and performance of the companies. It is also expected that the capital market will redirect funds to finance economic entities with a sustainable business perspective and environmentally responsible behaviour.

Taking into account the relevance and importance of the topic, it is crucial to investigate the impact of EU ETS on the financial markets. Many studies have explored this topic primarily focusing on the impact on the stock prices. This paper makes a valuable contribution by selecting key financial indicators to examine the potential relationship between the two markets. It also uses data from the third phase, when the transition from grandfathering to auctions occurred (European Commission, 2021), a period when the relationship between the two markets would be most pronounced. Confirming that there is a significant impact from EU ETS on the capital market, would indicate that the capital market makes a distinction between companies that successfully reduce emissions and companies that fail to reduce or even increase the carbon intensity. This would further mean that the capital market can be used as a successful tool to decarbonize the economy.

To achieve the research objective, this paper uses data from (1) the EU ETS system, i.e. data on free and paid allowances, and (2) data from the capital market including data on average share prices weighted by volume, dividends paid to shareholders about the total amount of net income and return on assets (ROA). The data refer to German companies, since the German economy is the largest carbon emitter in Europe (Eurostat, 2023). The econometric techniques to investigate the possible relationships between the selected variables consist of pooled ordinary least squares, the fixed effects model, and the random effects model.

2. LITERATURE REVIEW

2.1. Development of the EU ETS

EU ETS went through four phases of development (European Commission, 2021). The first phase, from 2005 until 2007, was more of an experimental period in which the market was being set up. This phase covered emissions from selected industries including the energy-intensive and production industries. Countries were supposed to prepare a plan and determine the quantity of allowances that they would allocate on the market. Due to the determination of allowances on a national basis which were also granted for free, there were more allowances

than emissions on the market. The price of the allowances was very volatile and not market-created, while the limits set by the countries were considered as unambitious.
Even though the second phase (2008-2012) was supposed to significantly adjust the allowances downward (around 6.5 percent lower than the 2005 level) and to set more ambitious limits, the number of allowances once again exceeded the emissions which pushed the price down. The European Commission introduced the Market Stability Reserve (MRS) to absorb the surplus of allowances and to straighten the price signal (Nissen *et al*., 2022).
In the third phase (2013-2020) the cap was once again significantly reduced to at least 20 percent below the 1990 levels or 21 percent below the 2005 levels, while the allowances were reduced by a linear factor of 1.74 percent. To straighten the price signal and to enable the functioning of the market, the default method of free allocation of allowances was replaced with the auctioning method. With some sectors being riskier than others in terms of carbon leakage, free allocation was still allowed to prevent shifting production outside the EU where the legislation is more flexible. This method is planned to be completely excluded from the system until 2027.
In the current, fourth phase (2021-2030), the EC scaled up its climate ambitions and committed to new targets of reaching climate neutrality by 2050. The emissions are supposed to be reduced by 55 percent until 2030 compared with the 1990 levels, or 61 percent compared with 2005 levels. Accordingly, the EC proposed an annual reduction of 4.2 percent and a one-off reduction of 117 million allowances from the system (European Commission, 2021).
From 2005 to 2021, the EU ETS showed satisfactory results in reducing the verified emissions mostly due to the decarbonization trend, reduced use of non-renewable resources, or increased use of renewable sources (see Nissen *et al*., 2022). This shows that the system is an important instrument in decarbonization and since the targets gradually increase, many changes are expected in the corporate sector. Apart from the impact on reducing emissions, the question arises whether the data so far indicate an influence of the EU ETS on the capital market.

2.2. The impact of EU ETS on the capital market

Since the EU Emissions Trading System (EU ETS) is considered a crucial mechanism to reduce carbon emissions and is expected to drive many changes in investors' decisions, a substantial number of studies focus on examining the possible impact it may have on the capital market. The relevant literature provides important empirical evidence regarding the impact of the EU ETS system on the capital market and corporate performance, which can be presented in three categories.
First, the authors present results that EU ETS can negatively impact the capital market. Millischer *et al*., (2022) analysed over 300 European companies in the period from 2013 to 2021 and found a significant negative statistical relationship between the carbon price and stock returns, meaning that higher cost of paid allowances is associated with weaker shares during periods of rising carbon prices. Bushnell *et al.* (2013) analysed 552 stocks from the EUROSTOXX index and contributed to the literature with empirical evidence that in the case of carbon or energy-intensive industries, decreasing the price of allowances has a negative impact on the stock returns.
Some authors found the positive impact of European Carbon Allowance (EUA) on stock prices and companies' performance. Oestreich and Tsiakas (2012) analysed the effect of the European Union Emissions Trading Scheme on German stock returns. The results suggest that companies that were granted free allowances in the first years of the scheme's implementation had significantly better performance compared with companies that did not receive free allowances, which can be explained by the higher cash flows due to the free allocation of carbon emission allowances, and due to the exposure to the higher carbon risk thus higher returns. Da Silva *et*

al. (2015) analyse the impact of the European Union Emission Trading System (EU ETS) on firms' stock market returns of Spanish industries and confirm the presence of a positive impact on electricity, cement, and oil sectors, and a negative impact on the iron sectors and steel. Smale *et al*., (2006) investigated the impact of CO_2 emissions on corporate profits and market prices of a few energy-intensive sectors and found that most of them would be expected to profit. García *et al*. (2020) used data from six European Union members including Austria, France, Germany, Italy, Netherlands, and Spain, and found statistically significant and positive long-run effects from EU allowance prices on the European power sector stock market in the third Phase. Chan *et al*. (2013), Veith *et al*. (2009), and Mo *et al*. (2012) also present empirical evidence for the existence of positive relationships between price changes in the EU system and stock returns of the European power sector.

The third category provides a non-existent or very small impact on the companies' performance. The results of Qiu *et al*., (2023), show that the long-term connection between the carbon market and the stock market and between the carbon market and renewable energy is almost zero or non-existent, while in the short term, a positive connection is found, which is believed to be further enhanced by the Covid-19 crisis. Demailly and Quirion (2008) analysed the impact of EU ETS on production and profitability and found that the losses in competitiveness are small for the iron and steel industry. Anger and Oberndorfer, (2008) investigated the role of the EU ETS in corporate revenues and employment in Germany and found that it did not have a significant impact on corporate performance and employment.

This paper investigates the impact of EU ETS allowances on the capital market in the case of German companies, since Germany accounts for one-quarter of the EU's total CO_2 emissions from fossil fuel combustion for energy use (Eurostat, 2023). The contribution of this paper is that it examines the impact of the EUA on the capital market through the stock prices, dividends disbursements, and ROA ratio.

3. DATABASE AND METHODOLOGY

To examine the relationships between the variables, this paper uses annual data for 38 German-listed companies. The data are for the period from 2013 to 2020, that is, for the third phase of the EU ETS development. Data on allowances are taken from the database used in the paper Millischer *et al.* (2022). The database used in this paper includes time series for average share prices weighted by volume, the dividend payout ratio (DPR), and the ROA ratio per company, all provided by Thomson Reuters. Table 1 provides general information about the variables.

Table 1: Descriptive statistics

Indicators	Stock Price	ROA	Divididends	Free Allowances	Paid Allowances
Mean	2.32	0.51	170.02	2,118,320.26	508,502.07
Median	1.92	0.26	-	187,833.50	46,129.00
Maximum	30.21	6.19	6,125.00	42,591,924.00	13,658,327.00
Minimum	-	(10.65)	-	(3,370,651.00)	(11,756,372.00)
Observations	304	304	304	304	304

(Source: Authors' calculation)

We used panel data analysis, fixed effect model, and random effect model. In addition to these models, we implemented the F-test and Hausman test to determine which model is more appropriate (see Baltagi, 2008 and Hsiao, 2003).

From the research questions, the following hypotheses were formulated:

H1: Free allowances have a negative impact on stock prices, while a positive impact on return on assets and dividend disbursement in the case of the selected German companies.

H2: Paid allowances have a negative impact on stock prices, return on assets, and dividend disbursements in the case of the selected German companies.

If the estimations suggest (1) that there is a positive impact of free allowances on stock price, return on assets, and dividends, it would mean that due to the free distribution of allowances, companies do not face additional costs, and are not incentivized to lower the carbon emission, leading to better cash flow results; (2) if there is a negative impact, it would mean that the increase in free allowances causes a lower market value of the companies, meaning that the capital market recognize the importance of decarbonization, a is penalizing the companies that do not have a green perspective; this would additionally mean that the EU ETS is an important tool for decarbonization, that may further speed up the process to meet international targets; (3) if there is an absence of a relationship between the variables, it would mean that the EU ETS system has no impact on the capital market.

In the case of paid allowances if there is (1) a positive impact on the selected variables that would suggest that the number of paid allowances does not have a negative impact on profit, stock price, and dividends and, thus are not very important to the company's financial results, meaning that EU ETS is still not effective in terms of enhancing decarbonization; (2) negative relationship would suggest that as paid allowances (or in other words, the carbon intensiveness) increase, the companies face more costs and are being "punished" by the capital market by lowering their market value; (3) if there is an absence of a relationship between the variables, it would again mean that EU ETS has no impact on the capital market.

Pooled OLS is employed since it assumes that there is no significant company nor significant temporal effect, i.e. all intercepts and coefficients are assumed to be the same. Since the panel data set has more companies than years, we include dummy variables for each time period to absorb the time effect. The F-test is used to determine if the pooled ordinary least squares is the best estimation model for this database. The null hypothesis of the test assumes that all coefficients are equal to zero, so if accepted, it will confirm that the OLS model is the best choice of econometric model to test the hypothesis.

Fixed or random models are used when observing the same sample of the companies and the Hausman test is used to decide which model is more suitable. The random effects model is a better choice under the null hypothesis, while the alternative hypothesis assumes that the fixed effects model is preferred. If the p-value is significant, a fixed effects model should be used.

Table 2: Cross-sectional dependence test results

Cross-sectional dependence test for panel data

Null hypothesis: Cross-sectional independence

Pearson CD Normal	Statistic	Prob.	Cross-dependence
Stock price estimation	3.81909	0.000	There is cross-dependence
ROA estimation	1.359771	0.174	No cross-dependence
Dividend estimation	0.506684	0.6124	No cross-dependence

(Source: Authors' calculation)

As a first step, we employ a cross-sectional dependence test. It will determine if the residuals from the cross-sectional units are correlated. Since the N dimension is larger than the T dimension, Pesaran CD test was conducted. The test results show significant cross-sectional dependence in the first estimation. The existence of cross-section dependency among the units in the first estimation suggests that the investors may be taking into account the effect of the other companies' stock prices in the country when making decisions. This dependence is in line with economic logic, so it might suggest that the model is effectively reflecting certain

fundamental economic relationships. In the case of ROA and dividends, there is no cross-sectional dependence.
In addition, Breusch-Pagan test for heteroskedasticity is employed. The p-values for the three estimations are higher than 0.05, indicating that we fail to reject the null hypothesis. This suggests that there is no significant evidence of heteroskedasticity in the model.

4. RESULTS AND ANALYSIS

Table 3 shows the results of the pooled OLS models. According to the results, the number of paid allowances is not significant and positively related to the stock prices. This relation is not according to expectations and suggests that if the number of paid allowances increases, the stock price is expected to also increase. This suggests that an increase in the paid allowances or the carbon intensiveness of the companies is not being “punished” by the capital market through lower market value. Positive relationships between these two markets can also be found in Da Silva *et al.* (2015), Veith *et al*. (2009), Mo *et al*. (2012). On the other hand, the first estimation also indicates that free allowances are statistically significant and inversely correlated with stock prices. This means that as the number of free allowances increases, stock prices tend to decrease. This relationship might be influenced by market expectations of future costs, since the EU reduces the number of free allowances, companies will need to purchase the allowances, which could increase operational expenses. Moreover, this suggests that the capital market is becoming an important tool for decarbonization.

Table 3. Results from the pooled OLS model

Variable	Expected sign	Coefficient	Std. Error	Prob.
Stock price				
ROA		0.421	0.092	0.000
DIVIDEND		0.352	0.078	0.000
FREE	-	(0.148)	0.052	0.005
PAID	-	0.059	0.043	0.176
C		0.061	0.463	0.896
R-squared		27%		
F-statistic		8.754		
Prob(F-statistic)		0.000		
ROA				
STOCK		0.426	0.093	0.000
DIVIDEND		(0.643)	0.056	0.000
FREE	+	0.102	0.053	0.059
PAID	-	(0.091)	0.043	0.036
C		2.689	0.376	0.000
R-squared		64%		
F-statistic		43.260		
Prob(F-statistic)		0.000		
Dividend				
ROA		(0.897)	0.078	0.000
STOCK		0.497	0.110	0.000
PAID	-	(0.161)	0.049	0.001
FREE	+	0.262	0.058	0.000
C		3.343	0.431	0.000
R-squared		67%		
F-statistic		48.732		

(Source: Authors' calculation)

The results of the second equation show that the free allowances are positively, but statistically insignificant, related to the return on assets (ROA). This is in line with our expectations since the free allocation of allowances is expected to be associated with better performance due to higher cash flows and exposure to the higher carbon risk and higher returns, as found in Oestreich and Tsiakas (2012). Paid allowances are inversely related to the ROA ratio, aligning with our expectations. These findings indicate that an increase in paid allowances can lead to

a decrease in the ROA ratio. This may be due to market preferences for products and services from companies that demonstrate corporate environmental responsibility, as well as the higher costs of purchasing these allowances.
The last equation shows that the results are in line with our expectations since there is negative impact of paid allowances and positive of free allowances on the dividend distribution.
The results from the F-test statistics show that the model as a whole is significant because the F statistics is greater than the critical value.
Table 4 shows the results from the fixed, random models and the Hausman test for stock price equations. The fixed model shows an R-squared of 69 percent, which is satisfactorily high. The results show statistically significant negative impact of free allowances on the stock price. The random model shows a value of the R-squared of only 3% and insignificant relations between the variables. The results of the Hausman tests show that the null hypothesis is rejected and fixed effects should be used. Accepting the fixed effects as a more appropriate model suggests that there are factors that can affect stock prices but do not necessarily vary over time for the companies, so the effects of those factors are contained, and the model focuses only on the influence of the allowances.

Table 4: Results from the fixed and random effect models and the Hausman test for stock prices

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Stock (Fixed)				
PAID_ALLOWANCES	-0.051	0.052	-0.983	0.327
FREE_ALLOWANCES	-0.36	0.116	-3.108	0.002
C	5.567	1.661	3.352	0.001
R-squared	**69%**			
Stock (Random)				
PAID_ALLOWANCES	-0.02	0.034	-0.575	0.566
FREE_ALLOWANCES	-0.081	0.043	-1.867	0.063
C	1.843	0.433	4.262	0
R-squared	**3%**			
Correlated Random Effects - Hausman Test				
Cross-section random		7.7	2	0.021

(Source: Authors' calculation)

Table 5 shows the results from the fixed, random models and the Hausman test for the ROA equations. The fixed model shows R-squared of 56 percent, which is satisfactory high, however there is no significant relationship between the variables. The random model shows a value of the R-squared of only 8% and significant negative relationship between the free allowances and return on assets. The Hausman test, show that we cannot reject the null hypothesis since the p-value is greater than the significance level, so we should use the random effects model. In this case, the model assumes that the unobserved company characteristics are random, so it analyzes how both within-company changes and between-company differences in allowances influence the ROA ratio.

Table 5: Results from the fixed and random effect models and the Hausman test for ROA ratio

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA (Fixed)				
PAID_ALLOWANCES	0.071	0.141	0.509	0.612
FREE_ALLOWANCES	0.328	0.323	1.016	0.312
C	-4.855	4.504	-1.078	0.283
R-squared	**56%**			
ROA (Random)				
PAID_ALLOWANCES	0.024	0.067	0.359	0.72
FREE_ALLOWANCES	-0.175	0.074	-2.371	0.019
C	1.665	0.555	2.998	0.003
R-squared	**8%**			
Correlated Random Effects - Hausman Test				
Cross-section random		2.612	2	0.271

(Source: Authors' calculation)

Table 6 shows the results from the fixed, random models and the Hausman test for the Dividend distributions. The fixed model shows an R-squared of 68 percent, which is satisfactory high, however there is no significant relationship between the variables. The random model shows a value of the R-squared of only 4% and a significant positive relationship between the free allowances and dividends. The Hausman test shows that the p-value is greater than 0.05, thus we should use the random effect model. This model assumes the same as for the ROA random effects equation, that is the model considers both the variation within each company over time and the variation between different companies.

The overall results suggest free allowances have a negative and significant impact on the stock prices. This is confirmed by both the pooled OLS model and the fixed effect. The pooled OLS model for ROA and dividends do not account for the unobserved heterogeneity, hence the random effects model is considered more appropriate. In this case, free allowances have negative impact on the ROA ratio, but positive on the dividends.

Table 6: Results from the fixed and random effect models and the Hausman test for dividends

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dividends (Fixed)				
PAID_ALLOWANCES	-0.137	0.167	-0.818	0.415
FREE_ALLOWANCES	-0.416	0.5	-0.833	0.407
C	11.774	6.332	1.859	0.066
R-squared	**68%**			
Dividends (Random)				
PAID_ALLOWANCES	-0.178	0.098	-1.818	0.072
FREE_ALLOWANCES	0.256	0.116	2.216	0.029
C	4.221	0.869	4.858	0
R-squared	**4%**			
Correlated Random Effects - Hausman Test				
Cross-section random		2.136	2	0.344

(Source: Authors' calculation)

This paper has certain limitations, which are mostly due to the sample, i.e., not all companies in Germany that participate in carbon emissions are covered. Also, the sample is limited only to the third phase of development of the EU ETS system. Regarding future related research, it is suggested to expand the sample to other countries, primarily Italy, Poland, and France as these countries have the highest share of total carbon emissions in Europe. The analysis can benefit from including other variables or analysing the impact on selected variables per industry too.

5. CONCLUSION

Climate change is a major global challenge. As policymakers are becoming more aware of the consequences that can arise from climate change, they put it in the spotlight when creating policies and systemic solutions for sustainable growth and development. The international ambitions for preventing climate change resulted in a successful implementation of the EU ETS scheme which aims to directly limit carbon emissions.

Since CO_2 emissions are the main driver of pollution, and Germany is the main emitter of the EU's total CO_2 emissions from fossil fuel combustion for energy use, this research paper selected 38 German companies to investigate the possible impact EU ETS may have on the capital market. To test the proposed hypotheses, three methods are implemented, including the pooled ordinary least square model, and fixed and random effects models. The F-test is used to select between OLS model and the fixed effect model, while the Hausman specification is used to make a selection among fixed or random effect model.

The results from the OLS model and fixed effects are aligned and suitable for the stock price estimation and the negative statistically significant coefficient for the free allowances is in line with our expectations. The model suggests that free allowances have a negative impact on stock prices. This may be linked to future costs associated with purchasing allowances rather than receiving them for free, as well as potential costs due to regulatory changes. On the other hand, the results for the ROA and dividends estimations suggest that the OLS model does not account for heterogeneity, hence the random effects are more suitable. They suggest that free allowances hurt ROA and a positive on dividends.

This paper has certain limitations and proposes that future analysis should extend the sample to other countries, primarily to Italy, Poland, and France (as these countries have the highest share of total carbon emissions in Europe), to add additional variables, and to make an analysis per industry.

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