The impact of the EU Emission Trading Scheme (EU ETS) on firms' performance and energy efficiency

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ABSTRACT

This paper aims to contribute to the literature by measuring the impact of the EU ETS on the performance of firms in a wide EU context during the three operational phases of the EU ETS. The interactions between improvements in energy efficiency and GHG emissions reductions achieved by the implementation of the EU ETS are analyzed aiming to provide recommendations about how the functioning of the EU ETS could be improved. To this end, many economic, financial and energy data are analyzed through the regression analysis.

The proposed methodology would be of major usefulness for monitoring, benchmarking and policy planning purposes. It could contribute into a better understanding of the EU ETS mechanism and its role on economic and environmental performance of firms.

1. INTRODUCTION

The European Union Emission Trading Scheme (EU ETS), launched in 2005, is regarded as the cornerstone of the EU climate policy. The EU ETS is by far the largest environmental market in the world, covering over 12,000 plants from CO2-emission intensive industrial sectors such as the electricity, combustion (>20 MW capacity), coke, iron, steel, cement, lime, glass, ceramics, brick, tile, refinery, paper and pulp industries. It is the flagship EU policy to mitigate greenhouse gas (GHG) emissions from the industries concerned and to reach the European Union Kyoto target. In particular, its official objective to 'promote greenhouse gas (GHG) reductions in a cost-effective and economically efficient manner' (European Commission, 2003).

The EU ETS relies on the principle of "cap-and-trade". Participants in the market are mandated to hold allowances corresponding to the amount of CO2 they release into the atmosphere. They can choose either to implement emission reduction measures or to buy European Union Allowances (EUAs) from other players that have it in excess. The EU ETS have - directly or indirectly – repercussions on the whole EU market. There has been considerable debate regarding EU ETS effects. This is mainly due to low quota prices and substantial allocation of free allowances to the industries that have changed significantly between the phases of the ETS. The financial crisis that hit in 2008 also affected the EU ETS as the European production and emissions changed dramatically. However, there is little literature assessing the emissions impacts of the EU ETS post-2008. This can be explained, among others, due to the lack of data available to assess the impacts, the complexity and on-going nature of the crisis, and the lag-time to release of sufficient levels of emission data.

The introduction of mandatory controls and a trading scheme covering approximately half of all carbon dioxide emissions across Europe has triggered a debate about the impact of emissions trading on the performance of firm and specifically their competitiveness and energy efficiency performance. In fact, a body of studies has been conducted on the carbon trading market, covering issues related to the operation of the EU ETS, the design of the allowance allocation scheme, and its effectiveness at the country or sectoral level.

This paper contributes to the ex-post research on the performance of the three phases of the EU ETS. The main question to be answered is whether performance of energy firms covered by EU ETS have improved because of the EU ETS and/or other external factors. This study aims to contribute to the literature by measuring the impact of the EU ETS on the firms' performance in a wide EU context since its launch. Specifically, the profitability of industrial firms under EU ETS is analyzed. Furthermore, the interactions between improvements in energy efficiency and GHG emissions reductions achieved by the implementation of the EU ETS are examined. Therefore, a number of macroeconomic and environmental data of a large sample of EU firms covered by the scheme are used.

The proposed methodology could be of major usefulness for monitoring, benchmarking and policy planning purposes. It can contribute into a better understanding of the EU ETS mechanism and its role on economic and environmental performance of firms.

The paper is organized in six sections. Section 2 provides a literature review whereas Section 3 presents the data used in the analysis. Sections 4 and 5 describe the methodology and the results, respectively. Finally, Section 6 discusses the main conclusions and some directions for future research.

2. LITERATURE REVIEW

The EU ETS is divided into four phases. The first phase was a three-year pilot period (2005-2007) of 'learning by doing' to prepare for phase two, when the EU ETS would need to function effectively to help ensure the EU and Member States met their Kyoto Protocol emission targets. During this period, almost all allowances were given to businesses free of charge. The second phase (2008-2012) coincided with commitment under Kyoto Protocol over the same period. During this period at least 90% of EUAs allocated for free. The third phase, which runs from 1 January 2013 to 31 December 2020, brings major changes including, harmonised allocation methodologies and additional greenhouse gases and emission sources. Auctioning, not free allocation, is now the default method for allocating allowances. The European Commission presented in July 2015 a legislative proposal to revise the EU emissions trading system for the period after 2020. This is the first step in delivering on the EU's target to reduce greenhouse gas emissions by at least 40% domestically by 2030 in line with the 2030 climate and energy policy framework and as part of its contribution to the new global climate deal. The forth trading period will run from 2021 to 2028 aiming at a reduction of emissions by 43% compared to 2005 from sectors covered by the ETS. To this end, the overall number of emission allowances will decline at an annual rate of 2.2% from 2021 onwards.

Since its initiation, debates have arisen on the impact of the EU ETS on the firms' performance. Some studies have found that the EU ETS plays a negative role on firms. Commins et al. (2011) found that the EU ETS has a significant negative effect on return-on-capital on a panel of 162.771 European firms between 1996 and 2007. They also found that the impacts on employment, total factor productivity, and investment are not statistically significant. Yu (2011) measured the effect of the EU ETS on profit margins of electricity and district heating firms in Sweden from 2005 to 2006 and concluded that the EU ETS has a significant negative impact in 2006.

Other researchers concluded that the ETS has had little effect on firms (Demailly and Quirion, 2008; Anger and Oberndorfer, 2008). For example, Oberndorfer et al. (2006) published a review of the literature on the effect of the EU ETS on competitiveness and employment in Europe and concluded that the effects are modest.

Abrell et al. (2011) found that there is no statistically significant effect of EU ETS on firm value added, profit margin or employment of 2000 European firms during 2005–2008. There is another view that the ETS has a positive effect on firms (Benz and Trück, 2006; Veith et al., 2009; Oberndorfer, 2009).

Anger and Oberndorfer (2008) assessed the impacts of EU ETS on firm performance and employment in Germany. They concluded that the EUAs do not play a significant role on revenues and employment of German firms under the EU ETS.

3. DATA AND VARIABLES

Our dataset consists of a panel of European firms under EU ETS. The firms are classified into eight main industrial sectors based on the two digit NACE Rev.2 code. The analysis covers the period 2006–2014. The selection of the examined sectors was based on the available data related to economic and environmental variables. Table 1 presents the examined sectors as well as the number of firms per sector. The sectors of manufacturing and electricity own the largest number of firms under the EU ETS, both representing 90% of the sample.

Table 1: The examined industrial sectors and the number of firms per sector.

Main sector	Number of firms
A - Agriculture, forestry and fishing	130
B - Mining and quarrying	483
C - Manufacturing	15395
D - Electricity, gas, steam and air conditioning supply	5291
E - Water supply; sewerage, waste management and remediation activities	340
F - Construction	306
G - Wholesale and retail trade; repair of motor vehicles and motorcycles	722
H - Transportation and storage	305

Firms are classified in 25 countries[1]. Table 2 presents the regional distribution of examined firms. Germany, Italy and Spain are the most represented countries accounting for about half of our sample.

Table 2: Regional distribution of firms.

Country	Country ISO Code	Number of firms per country	Country share in total firms (%)
Austria	AT	82	1.96%
Belgium	BE	169	4.04%
Bulgaria	BG	71	1.70%
Czech Republic	CZ	219	5.23%
Denmark	DK	4	0.10%
Finland	FI	115	2.75%
France	FR	280	6.69%
Germany	DE	595	14.22%
Greece	GR	10	0.24%
Hungary	HU	104	2.49%
Ireland	IE	8	0.19%
Italy	IT	654	15.63%
Latvia	LV	9	0.22%
Lithuania	LT	3	0.07%
Luxembourg	LU	8	0.19%
Netherlands	NL	17	0.41%
Norway	NO	25	0.60%
Poland	PL	208	4.97%
Portugal	PT	162	3.87%
Romania	RO	132	3.15%
Slovakia	SK	118	2.82%
Slovenia	SI	53	1.27%
Spain	ES	632	15.10%
Sweden	SE	171	4.09%
United Kingdom	GB	336	8.03%

The economic data is obtained from the ORBIS[2] whereas the environmental data comes from the European Union Transaction Log (EUTL)[3]. We match the emissions data

[1] Croatia and Cyprus are excluded due to small number of firms.
[2] ORBIS is a global database which has information on almost 60 million companies. It includes accounting and financial data on international companies.
[3] The European Union Transaction Log (EUTL) is a central transaction log, run by the European Commission, which checks and records all transactions taking place within the trading system. The EU ETS data viewer provides aggregated data by country, by main activity type and by year on the verified emissions,

obtained from the EUTL to firm level performance data from the ORBIS database. From the EUTL emission data, we extract information on free allocation of emissions allowances and verified emissions during the period 2006-2014 at the installation level. The availability of the data until 2014 is important since it allows us to include in our analysis the third phase of the EU ETS. Both sets of data were matched via the installation or aircraft operator ID of the firms in each country and we end up with a set of 4185 firms.

The allocation factor (AF), defined as the quotient of free allocation of emissions allocated to the verified emissions (Anger and Oberndorfer, 2008) is computed. An AF > 1 means that an installation has received allowances that exceed its emissions whereas an AF < 1 means that this installation should either buy additional emission allowances or abate some of its emissions to comply with EU ETS.

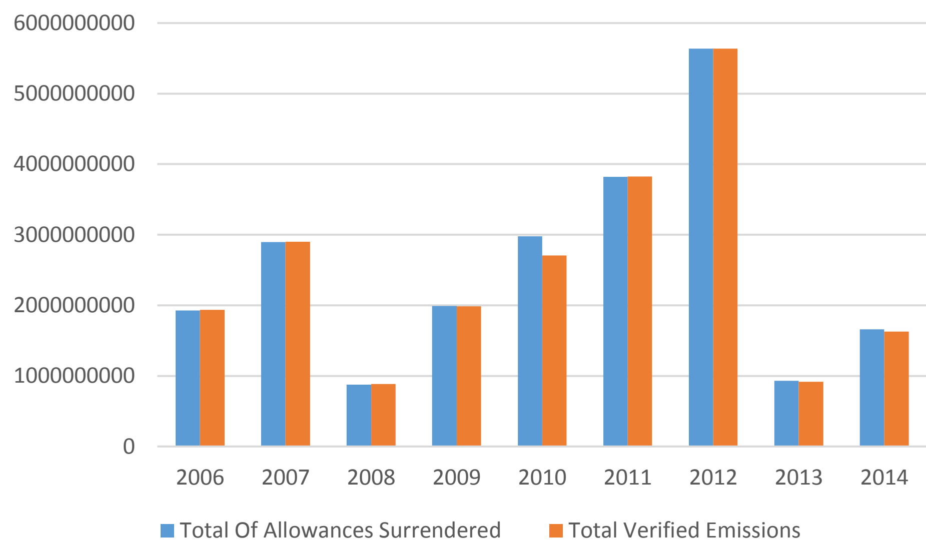
At the start of the second phase (2008) firms in 25 EU countries have received the allowances that exceed their emissions to the highest degree. On the contrary, firms presented the lowest amount of exceeded allowances to the verified emissions in 2012. Spain, Italy and Germany are the countries that presented the highest excess of allowances over emissions on average during the period under consideration (2006-2014). On the other hand, Denmark and Lithuania obtained the lowest amount of allowances relative to their emissions.

Figure 1 presents the total of the surrendered EU allowances and verified emissions of all firms per year. It is obvious that during the first phase of the EU ETS and particularly between 2006 and 2007 the amount of allowances surrendered and emissions increased by about 50%. However, at the start of the second phrase (2008) there was a sharp decline in the amount of both allowances and emissions. In particular, their number was reduced from 2007 to 2008 by about 70%. During the second phase the total allowances and emissions presented a continuous and sharp increase. In fact, at the end of the second phase (2012) the amount of allowances and emissions was about 500% higher than that at the start of the same phase (2008). On the contrary, their amount was significantly decreased at the start of the third period. A reduction by about 84% is observed in the total allowances and

allowances and surrendered units of the more than 12 000 stationary installations reporting under the EU emission trading system, as well as 1300 aircraft operators. The unit in which the information is downloaded from the EUTL is million tonnes of CO2 equivalent and million emission trading units (one unit being equivalent to one tonne of CO2).

emissions from 2012 to 2013. However, a sharp increase (about 77%) is presented in 2014 in the amount of allowances and emissions.

The highest amount of the allowances and emissions is presented at the end of the second phrase (in 2012). It is also obvious that the trends in total allowances and emissions are strongly positively correlated. The most significant difference in the number of allowances and emissions is shown in 2010. In particular, the total amount of allowances exceeded the verified emissions by 10%. As it is expected, the trends in allowances and emissions over the phases differ between sectors and countries.



Note: The unit of data in y-axis is million tonnes of CO_2 equivalent and million emission trading units (one unit being equivalent to one tonne of CO_2).

Figure 1: Total number of allowances and verified emissions per year.

Based on the literature, the economic variables used in the analysis include the current ratio (CR), the solvency ratio (SR), the EBIT divided by total assets (EBITTA), the logarithm of the total assets (SZ), the number of employees to total assets (NETTA) and the operating revenue to total assets (ORTTA). The environmental performance of the firms is examined using the allocation factor (AF) and the quotient of verified emissions to the sales (VETS). A detailed description as well as the source of these variables is given in Table 3.

Variable	Explanation	Database
CR	Current Assets / Current Liabilities	ORBIS
SR	(Shareholders Funds / Total Assets) * 100	ORBIS
EBITTA	Operating P/L[=EBIT]/Total assets	ORBIS
SZ	log (Total assets)	ORBIS
NETTA	Number of employees / Total assets	ORBIS
ORTTA	Operating revenue / Total assets	ORBIS
AF	Allowances allocated/Verified emissions	EUTL
VETS	Verified emissions / Sales	EUTL & ORBIS

Table 3: Description of variables used in analysis.

4. METHODOLOGY

Using panel data on the emissions and performance of more than 4185 European firms from 2006 to 2014, we run the regression analysis in STATA to analyze the effectiveness of the EU ETS. In particular, we aim at measuring the profitability of the firms under EU ETS and the impact of emissions data on it. Many economic and environmental variables, based on data availability and the existing literature, are used to this end (Table 3).

In the analysis, we considered four different settings for the variables used for the regression analysis, thus leading to four models (henceforth denoted as M1, M2, M3 and M4). Table 4 presents the variables used in the examined models. The variable EBITTA is the dependent variable whereas a combination of economic and environmental factors are the independent variables in the examined models (Table 4).

The first model (M1) uses only the economic variables that characterise the EU firms. In the other models, environmental variables are also added in the analysis. In particular, the M2 takes into account the allocation factor (AF) aiming at examining if the excess of allowances over the emissions, or the inverse, affects the firm’s profitability (EBITTA) or not. VETS is the environmental variable that is added in M3. The forth model (M4) includes all economic and environmental variables, thus providing more detailed insight into the impact of the environmental variables on firms’ profitability covered by EU ETS. Consequently, six, seven or eight variables are used by the models.

Table 4: The variables used in the four examined models (M1, M2, M3, M4).

	Variable	M1	M2	M3	M4
Economic Variables	CR	✓	✓	✓	✓
	SR	✓	✓	✓	✓
	EBITTA	✓	✓	✓	✓
	SZ	✓	✓	✓	✓
	NETTA	✓	✓	✓	✓
	ORTTA	✓	✓	✓	✓
Environmental Variables	AF		✓		✓
	VETS			✓	✓

The first model (M1) uses only economic variables (SR, SZ, CR, NETTA, ORTTA) to assess the relative importance of each variable in the firms' profitability. Thus, M1 is expressed by a function (Eq. 1) of EBITTA in year t and firm i.

$$EBITTA_{it} = a_0 + a_1 SR_{i,t-1} + a_2 SZ_{i,t-1} + a_3 CR_{i,t-1} + a_4 NETTA_{i,t-1} + a_5 ORTTA_{i,t-1} + C_i + S_i + \varepsilon_{it}$$

(Eq. 1)

where:

$EBITTA_{it}$ = profitability of firm i in year t

$SR_{i,t-1}$ = solvency ratio of firm i in year $t-1$

$SZ_{i,t-1}$ = size (logarithm of total assets) of firm i in year $t-1$

$CR_{i,t-1}$ = current ratio of firm i in year $t-1$

$NETTA_{i,t-1}$ = number of employees to total assets of firm i in year $t-1$

$ORTTA_{i,t-1}$ = operating revenue to total assets of firm i in year $t-1$

C_i = the id (code) of the country

S_i = the id (code) of the firm's main sector

ε_{it} = error term that has a distribution with mean zero and variance σ^2.

In the above model (M1), the environmental variables AF and VETS are added, leading to M2, M3 and M4. Specifically, M2 examines the effect of the allocation factor on the firm's profitability (Eq. 2):

$$EBITTA_{it} = a_0 + a_1 SR_{i,t-1} + a_2 SZ_{i,t-1} + a_3 CR_{i,t-1} + a_4 NETTA_{i,t-1} + a_5 ORTTA_{i,t-1} + a_6 AF_{i,t-1} + C_i + S_i + \varepsilon_{it}$$

(Eq. 2)

Where:

$AF_{i,t-1}$ = allocation factor of firm i in year $t-1$

M3 considers the variable VETS (Eq. 3) whereas M4 includes all economic and environmental variables providing more detailed insight into the impact of all examined variables on firm's profitability (Eq. 4).

$$EBITTA_{it} = a_0 + a_1 SR_{i,t-1} + a_2 SZ_{i,t-1} + a_3 CR_{i,t-1} + a_4 NETTA_{i,t-1} + a_5 ORTTA_{i,t-1} + a_6 VETS_{i,t-1} + C_i + S_i + \varepsilon_{it}$$

(Eq. 3)

Where:

$VETS_{i,t-1}$ = verified emission to sales of firm i in year $t-1$

$$EBITTA_{it} = a_0 + a_1 SR_{i,t-1} + a_2 SZ_{i,t-1} + a_3 CR_{i,t-1} + a_4 NETTA_{i,t-1} + a_5 ORTTA_{i,t-1} + a_6 AF_{i,t-1} + a_7 VETS_{i,t-1} + C_i + S_i + \varepsilon_{it}$$

(Eq. 4)

All models (M1, M2, M3, M4) use dummies for the main sectors and countries under consideration. The value of all independent variables used in models are one unit of time ago compared to the dependent variable.

5. RESULTS

Table 5 reports the descriptive statistics for EBITTA (dependent variable) and the number of economic and environmental characteristics (independent variables). It also depicts all the pairwise correlation coefficients between them.

Table 5: Descriptive statistics and Pearson correlation coefficients.

	Variable	Mean	St. dev.	1	2	3	4	5	6	7
1	**EBITTA**	0.043	0.107	1						
2	**SR**	41.301	25.510	0.209	1					
3	**SZ**	4.935	0.866	0.096	-0.105	1				
4	**CR**	1.830	1.744	0.065	0.436	-0.070	1			
5	**NETTA**	0.005	0.007	-0.078	0.035	-0.397	-0.018	1		
6	**ORTTA**	1.062	0.750	0.167	-0.143	-0.023	-0.098	0.203	1	
7	**AF**	0.797	0.926	-0.074	-0.024	-0.077	-0.003^{+}	0.034	-0.058	1
8	**VETS**	4.753	10.013	-0.072	0.078	-0.198	0.078	0.054	-0.189	-0.131

Note: All correlations are significant at the 1% level except $^{+}$ (p-value = 0.651).

From Table 5, it is obvious that there is no multicollinearity among variables. The dependent variable (EBITTA) is correlated positively with all economic variables, except NETTA. On the other hand, it is negatively correlated with the environmental variables (AF, VETS). Specifically, SR presents the highest correlation with EBITTA (r=0.209), followed by the variable of the ORTTA (r=0.167).

Table 6 presents the outcomes of the regression analysis for the four examined models. The data in columns (coefficients) shows the impact of each independent variable to the dependent variable (EBITTA) whereas the coefficient's sign shows whether this impact is positive or negative. The data into parentheses (p-value) determines the statistical significance of the coefficients at the 10% (* p < 0.1), 5% (** p < 0.05) and 1% (*** p < 0.01) level of significance.

SR, SZ, and ORTTA contribute positively to EBITTA through all examined models. Specifically, SR and ORTTA are statistically significant at the 1% level through all examined models. SZ is also significant at the same level (1%) under M1 but it becomes less statistically significant in M2, M3 and M4.

The remaining economic variables (CR and NETTA) have a negative impact on EBITTA. They are statistically significant at least at the 5% level in all models. In particular, the strong significance of NETTA is consistent in all models.

Regarding the environmental variables (AF, VETS), both have a negative contribution to the firm's profitability. Their effect is statistically significant at the 1% level in M2, M3 and M4.

It is also obvious that CR, NETTA, ORTTA, AF and VETS present a continuous strong significance (at 1% level) through all models. In M4, that examines the impact of all variables under consideration on EBITTA, all examined variables are statistically significant at least at the 10%. Thus, it is obvious that both economic and environmental variables have an impact on the profitability of firms.

Table 6: Outcomes of the regression analysis under the four examined models.

	(M1) EBITTA	(M2) EBITTA	(M3) EBITTA	(M4) EBITTA
SR	0.0003^{***}	0.0003^{***}	0.0003^{***}	0.0003^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
SZ	0.0051^{***}	0.0048^{**}	0.0041^{**}	0.0036^{*}
	(0.009)	(0.013)	(0.036)	(0.066)
CR	-0.0020^{***}	-0.0020^{**}	-0.0019^{**}	-0.0018^{**}
	(0.010)	(0.010)	(0.015)	(0.016)
NETTA	-1.177^{***}	-1.171^{***}	-1.176^{***}	-1.167^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
ORTTA	0.0247^{***}	0.0245^{***}	0.0236^{***}	0.0232^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
AF		-0.0023^{***}		-0.0032^{***}
		(0.010)		(0.001)
VETS			-0.0005^{***}	-0.0005^{***}
			(0.000)	(0.000)
_cons	0.0434^{*}	0.0460^{**}	0.0514^{**}	0.0561^{**}
	(0.060)	(0.047)	(0.027)	(0.017)
N	17,630	17,630	17,630	17,630
r2	0.0768	0.0778	0.0779	0.0793
Chi-squared	397.2	404.4	409.7	421.9

Note: p-values in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$). A positive coefficient corresponds to variables that contribute in increasing firm's financial performance.

6. CONCLUSIONS

This paper aims at evaluating the overall impact of the EU ETS on the performance of the energy intensive sectors of the 25 EU countries during 2006-2014. Specifically, it assesses the role that the EU ETS plays on firm's profitability during the first, second and third phase of EU ETS.

In our analysis, we analyzed the profitability of 4185 EU firms covered by the EU ETS. In this respect, a relevant question could be addressed: Which are the main drivers behind that? To give a clear reply and in a way that policymakers could be cautious in drawing conclusions for policy decisions, we performed the regression analysis using four settings of independent variables. By using regression analysis, we can control for economic and environmental variables and test how these can influence the firms' profitability. The EBITTA is defined as the dependent variable whereas seven explanatory variables related to economic and environmental data are used as independent variables to the examined models.

According to the regression analysis results, economic and environmental characteristics contribute to the profitability of firms under EU ETS. Specifically, it is mainly affected by the solvency ratio, employment, operating revenue to total assets as well as by the verified emissions to sales and the number of free allocation of emissions allocated to the verified emissions.

Understanding the determinants that have the highest explanatory power in firms' profitability is also essential for the development of the appropriate policy-making initiatives and actions. The results from this study could be helpful towards this direction. Not surprisingly, we found that the combination of economic and environmental variables is important in explaining the firm's profitability. This suggests that policymakers should take into account both types of variables when formulating measures for increasing the firms' profitability.

The information gained through this study sheds light on the effect of the EU ETS at firm level. Thus, it provides a better understanding of the role that EU ETS plays in firms' performance. However, there is a wide range of issues that could be explored in future research. Among others, these may involve the enrichment of the data set with firms that are not participating in EU ETS, the analysis on different groups (under- versus over-allocated firms), a more extensive time period (up-to-date data), and the examination of more economic and environmental characteristics that could explain the firm's profitability.

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