The EU ETS and Firm Profits: An Ex-post Analysis in the Swedish Context

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Abstract

In January 2005, the EU launched their new emissions trading scheme (EU ETS), which aims at reducing carbon emissions in a cost-effective way. In this paper, we make use of the treatment/control, before/after design of the natural experiment approach to investigate the treatment effect of the EU ETS on the profitability of the regulated Swedish firms in 2005 and 2006. The treatment group is also divided into two sub-samples according to the relative allocation of allowances. This is done to study whether the under-cap firms and over-cap firms have different profitability related to the policy intervention. The results do not show any statistically significant impact of the EU ETS on firm profits in Sweden.

Key words: EU ETS, Difference-in-differences, Fixed effect

1. Introduction

In January 2005, the European Union launched the first continental wide trading scheme called EU ETS for short, which acts as the driving force to promote business interest in reducing CO_2 emissions. It is seen as an important tool for the EU to fulfill its commitment of greenhouse gas reduction in the Kyoto Protocol. With respect to the design of the scheme, the firms that own the regulated installations (hereinafter referred as regulated firms) may suffer net positive or negative consequences to the EU ETS. On one hand, the EU ETS creates benefits to firms in the sense that firms are given a quantity of free allowances, at least in the first period, which can be treated as an asset. On the other hand, the EU ETS creates costs because firms are charged for each relevant emission, which results in their input costs rising, and they have administration costs as well. The balance between these benefits and costs determine whether firms gain or lose from the EU ETS (Frontier Economics, 2006). In this paper, we take the policy intervention as a natural experiment and empirically assess whether the EU ETS has the treatment effect on the profitability of a sample of regulated Swedish firms in 2005 and 2006, the first two years after the intervention.

Previous quantitative studies of firm behavior under the EU ETS are mostly ex-ante analysis at national- or industry-level through simulation methods. Oberndorfer et al. (2006) summarize various simulation models applied to the EU ETS to date focusing on the competitiveness and employment. They sum up with modest impact of the EU ETS. In a related study, Brännlund and Lundgren(2007) use Swedish firm-level data on outputs and inputs between 1991 and 2001 to estimate a factor demand model, and simulate different policy scenarios using the results from the estimations. Their simulation results indicate that the effects of the EU ETS on Swedish base industry depend on the status of the current carbon tax, the price of the permits and the future price of electricity. Still, their analysis of the effects of the EU ETS is at the industry level and performed ex-ante. Comparatively, ex-post studies of the EU ETS using econometric models are rather scant due to a lack of data. One exception is Anger and Oberndorfer (2008), who do an econometric analysis to study the impact of the relative allocation of the EU emissions allowances on competitiveness and employment in a sample of German firms. Their results provide the evidence that the allowances allocation within the EU ETS framework did not have a significant impact on revenues and employment of regulated German firms. In our paper, we supplement the econometric studies of the EU ETS by using a different model from Anger and Oberndorfer (2008).

We adopt an unobserved fixed effect two-period panel data model and make use of the treatment/control, before/after structure of a natural experiment. By means of differencing the estimation can be implemented quite easily in a standard OLS framework, which leads to the so-called difference-in-differences. The purpose of the analysis is to econometrically test whether the EU ETS has impact on the profitability of a sample of Swedish regulated firms. The regulated firms are also divided into two groups according to an allocation factor which is calculated by dividing the allocated allowances by verified emissions. The idea is that firms with an allocation factor above one (that receives more allowances than verified emissions) should have a positive impact on profitability of the EU ETS since they can sell the additional allowances. The opposite should be true for firms with an allocation factor below one, since they are forced to either buy additional allowances or pay the punishment. The results in this study do not show any statistically significant impact of the EU ETS on the profitability of regulated firms in Sweden.

The rest of the paper is organized as follows. Section 2 introduces a general institutional background of both the EU ETS and Swedish climate policy. Section 3 presents the theoretical impact, the econometric model, the data and the estimation results. A concluding summary is given in Section 4.

2. Institutional Background

2.1 The general background of the EU ETS

During the past two decades, climate change has emerged as one of the most urgent environmental issues. In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted as the basis for a global response to the climate change[1]. In 1997, the UNFCCC was complemented by the Kyoto Protocol, in which the EU as a whole agreed to reduce the greenhouse gas (GHG) emissions by 8 percent based on the level in 1990 in the period from 2008 to 2012. In 1998, the EU reached the so-called EU Burden-Sharing Agreement to differentiate this target between member states. In order to promote this burden-sharing agreement, the EU launched their emissions trading scheme in 2005 based on the Directive 2003/87/EC. The Directive stipulates three phases in the EU ETS: (i) Phase 1: 2005-2007, Learning by Doing period; (ii) Phase 2: 2008-2012, Kyoto Protocol Period; and (iii) Phase 3: Post 2012 period. The regulated units are defined to be installations[2]. In the first Phase,

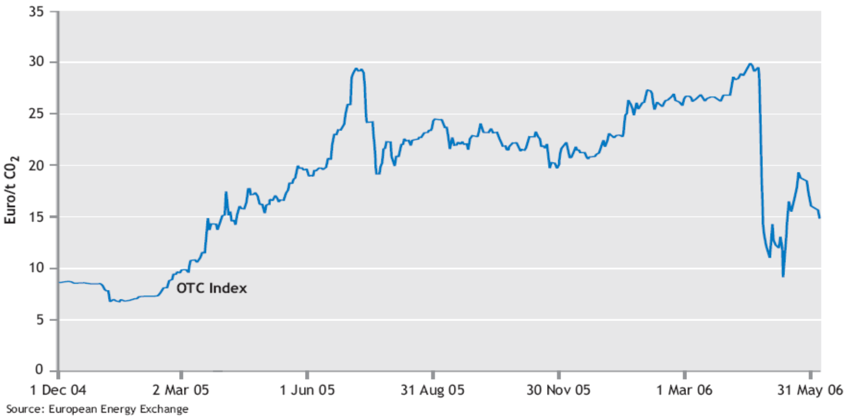
[1] See: http://unfccc.int/files/press/backgrounders/application/pdf/unfccc_and_kyoto_protocol.pdf

[2] ‘Installation’ means a stationary technical unit where one or more activities listed in Annex I are carried out and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have

there were around 11,500 installations from carbon-intensive sectors regulated and about 46 percent of European CO_2 emissions were covered by the EU ETS.

The EU ETS was built on a basic idea that sets the initial emissions caps and issues some allowances and allows them to be traded freely in the EU or even worldwide. Consequently, a market is created to enable the firms to find the lowest cost of abatement. Ideally this market will develop a price that theoretically equals the average marginal cost of abatement. In the months after the EU ETS was launched in 2005, the price of allowances rose from € 10/tCO_2 to a peak price of almost € 30/tCO_2 in the middle of 2005. And then, when the verified emissions data were released in the spring of 2006, the price fell sharply due to the revealed over allocation.

Figure 1. EUA price data (Carbon Trust, 2006)



2.2 The EU ETS in Sweden

Sweden has developed a relatively strict climate policy system which contains both national instruments and instruments common to the whole of the EU[3]. The EU ETS is such an EU wide economic instrument that mainly concerns the energy supply sector and some other energy-intensive sectors in Sweden. Before the introduction of the EU ETS, the economic policy instruments in the energy sector such as energy and carbon taxes and electricity certificates have been of great significance in Sweden. Energy taxes were introduced in the 1950s and have been an important source of public revenue (Johansson, 2006). From 1991, the energy tax has been supplemented by a carbon tax which is relatively high compared to other countries and has been increased several times. In order to support the expansion of electricity production and effectively control emissions, an electricity certificate system (ECS) was

an effect on emissions and pollution. (Directive 2003/87/EC, Article 3)

[3] For an overview on the Swedish climate policy, see the Swedish Energy Agency and Swedish Environmental Protection Agency (2007) and Ministry of Sustainable Development Sweden (2005).

introduced in 2003 and this system is planed to be in effect until 2030. During the four years after implementation, around 400 new installations have been built with expected production of renewable electricity of around 2.1 TWh per year. Although the ECS does not cover as many sectors and countries as the EU ETS does, it is still a contributing instrument for the control of CO_2 emissions from the electricity sector in Sweden[4]. Compared to the carbon taxes and the ECS, the EU ETS is a recently introduced instrument which plays a less important role. Table 1 shows the different policy instruments used in Sweden to control of CO_2 emissions.

Table 1. Policy instruments for Swedish climate strategy with quantified effects (Ministry of Sustainable Development Sweden, 2005)

Instrument/Sector	Main greenhouse gas concerned	Calculated effect in million tonnes CO_2 per year(2010)	Status
Cross-sectional instruments			
The Local Investment Programme, LIP	All	Up to 1.5 Mtonnes	Under completion
The Climate Investment Programme, KlimP	All	Up to 0.5 Mtonnes	Ongoing (2003-)
Energy excluding transport			
Energy tax	CO_2	10	Ongoing (1957-)
Carbon dioxide tax			Ongoing (1991-)
European Union Emission Trading Scheme (EU ETS)			Ongoing (2005-)
The electricity certificate system			Ongoing (2003-)
Industrial processes incl. emissions of F-gases			
Application of the environmental code	PFC	0.2	Ongoing (1999-)
Future F-gas ordinance and directive on mobile AC systems	Mainly HFC	0.15	Under planning
Transport sector			
Energy and Carbon dioxide taxes	CO_2	1.6-3.4	Ongoing
Change in taxation of company cars	CO_2	0.2	Ongoing (1997-)
Tax reduction for transport biofuels	CO_2	0.4	Ongoing (2004-)
Instruments for introduction of green cars	CO_2	0.2	Ongoing
Waste Sector			
Regulations on municipal planning, producers responsibility, landfill tax, ban on depositing unsorted combustible and organic waste	Methane	1.4	Ongoing

[4] For an overview of the electricity certificate system, see Swedish Energy Agency (2007)

3. Empirical Analysis

3.1 Theoretical impact

The appeal of the EU ETS is mainly that it creates certainty regarding the environmental outcome (cap), and that it will minimize overall compliance cost (cost-effectiveness) through trade. High marginal abatement cost firms buy permits from low marginal abatement cost firms in the permits market until the market clears and the demand for permits equals the fixed supply (Tietenberg, 2008). The trade of allowances provides firms with mechanism to search for the most cost-effective way of reducing emissions, and as long as marginal abatement costs differ, incentives for trade exist. As such, it is natural to consider the different treatment effect on over-cap firms and under-cap firms. More specifically, the regulated firms with more emissions than allowances must buy allowances to fulfill their obligations leading to reductions of profits, cet par. Conversely, regulated firms with excess allowances can increase the profit by selling the surplus of allowances. With the stipulation of the EU ETS, the regulated firms need to monitor and report the emissions from each installation and the authority should release the relevant data. After that we can easily see which regulated firms have over-cap emissions and which are under the cap. In the empirical part of this paper, we consider that the impact of the EU ETS should differ between those two different types of firms by dividing the data into two sub-samples. We follow Anger and Oberndorfer (2008) to develop an allocation factor which is calculated as the quotient of allocated allowances divided by the verified emissions. Afterwards we divide the regulated firms into two groups based on the allocation factor. It follows that the regulated firms with an allocation factor less than one are firms with over-cap emissions.

Moreover, the impact of the EU ETS on firm profits goes beyond the perception from pure trade. By means of trading, CO_2 emissions become a factor of production that has to be paid, in the same way as labor or raw materials (Smale et al, 2006). In combination with the potential abatement investment undertaken to reduce exposure to the cost of CO_2 emissions, the introduction of the EU ETS affect both fixed costs and variable costs of firms, and the following profits. Oberndorfer and Rennings (2007) elaborate the short-tem background of EU ETS impacts on competitiveness at the industry level by focusing on three factors, i.e. energy intensity, opportunity to abate carbon emissions, and ability to pass on cost of CO_2 emissions. Some companies and industry associations have criticized an anticipated loss of competitiveness due to the EU ETS, whereas in the academic literature there is consensus that most sectors have the theoretical potential to make short term profits from the existing structure of the EU ETS (Jean-Charles et al., 2007). The different viewpoint makes it interesting to study the profitability of regulated firms.

In our study, two metrics are chosen as measurements of profitability, one is the return on capital and the other one is the return on owner's equity. It should be mentioned that the equity used here is the owner's equity plus 72% of untaxed reserves. The reason to use the relative indices for profitability is that the regulated firms are quite big compare to other firms in Sweden. The relative indicator can partly relieve the unbalanced problem in comparison.

4.2 Econometric model

From this stand point that available data to us are in a longitudinal format, we adopt difference-in-differences estimation on an unobserved fixed effect two-period panel data model, since diff-in-diffs can provide a more robust estimate of the impact of the treatment (Blundell and Costa-Dias, 2000). We consider the implementation of the EU ETS as a natural experiment. With the research design, there are two groups of observations, one is the control group (comparison group), which is not directly affected by the policy change, and the other one is the treatment group, which is under the influence of the new policy.

Focusing on the impact of the EU ETS on the profitability of firms, the following equation is considered,

$$Y_{it} = \alpha + \delta_0 d_{2t} + \beta_1 ETS_{it} + a_i + u_{it}\ , t = 1, 2 \qquad (1)$$

where $t = 1$ represents the year before launching the EU ETS and $t = 2$ is the year when the EU ETS was in effect; the variable Y_{it} is the outcome variable of interest (i.e. our two different measures of profits); d_{2t} is a time dummy which is equal to 1 for $t = 2$ and 0 for $t = 1$; ETS_{it} is an indicator which is equal to 1 if the firm i in period t is regulated by the policy; a_i is the unobserved time invariant factors that affect Y_{it}; and u_{it} is the error term representing the time variant unobserved factors. We can simplify the estimation procedure by taking the difference of all variables in (1) with respect to the two time periods and obtain the following equation,

$$\Delta Y_i = \delta_0 + \beta_1 \Delta ETS_i + \Delta u_i \qquad (2)$$

The parameter δ_0 summarizes the way that firms are influenced by time. The most interesting parameter here is β_1 , which captures the casual effect of the treatment on the outcome for the treatment group. When the strict exogeneity assumption $E(u_{it}|ETS_{it}) = 0$ holds in equation (1), we can reproduce unbiased estimate of β_1 by applying the OLS approach to the equation (2), which leads to difference-in-differences as

$$\hat{\beta}_1 = \Delta\bar{Y}_{treat} - \Delta\bar{Y}_{control}$$

where the "treat" and "control" represent the treatment group and control group respectively, "Δ" refers to the time differencing. Next, in order to improve the efficiency of the estimation and reduce possible sample selection bias we add firm turnover and firm profit in 2003 into equation (2) to control for firm size and the initial level of firm profits. The equation to estimate is then

$$\Delta Y_i = \delta_0 + \beta_1 \Delta ETS_i + \beta_2 \Delta TO_i + \beta_3 Y_{t=0} + \beta_4 TO_{t=0} + \Delta u_i \qquad (3)$$

and β_1 now captures the causal effect of the introduction of the EU ETS on firm profits holding firm size and initial profit levels constant.

The difference-in-differences design is plausible to reveal the treatment effect, but important concern on inference may remain. Meyer (1994) stated clearly in his seminal paper of natural experiment that one of the main threat to the validity of inference from the diff-in-diffs design is the possibility of an interaction (besides the treatment) between the treatment group and the time period after the treatment happens. To put it differently, changes besides the treatment are not likely to always influence all groups in the same way. For instance, the fuel prices would affect the energy intensive sectors to great extent and our treatment group happens to belong to energy intensive sectors. By this token, the research design of the diff-in-diffs is most plausible when the control group is very similar to the treatment group so that the interactions are less likely. As such, we choose two kinds of control groups based on different considerations to exploit the non-experiment data. The first control group (Control Group I) uses all firms other than the regulated firms in the data set. It keeps most information but sacrifices the comparability. In order to improve the comparability, the second control group (Control Group II) is chosen by trying to match the sector distribution between the treatment group and the control group to further reduce the risk of sample selection bias. More specifically, we first count the number of firms of the treatment group in each sector, and then randomly choose the exact number of firms from all the other firms in the same sector to construct Control Group II.

As stated above, we consider that the effect on firm profits of the introduction of the system might be different depending on the relative allocation of the allowances; the treatment group is thus divided into two sub-samples based on the allocation factor. The analysis is then performed separately for the two sub-samples.

4.3 Data

In this study, we rely both on the emissions data of allocated allowances and verified emissions and on the firm level economic data. The data manipulation mainly follows Anger and Oberndorfer (2008).

The emissions data used in the study is an installation level data set published by the Swedish Energy Agency, which contains the data of allocated allowances and verified emissions at the installation level for the past years of the EU ETS. To be consistent with available economic data, we extract the installation level emissions data for 2005 and 2006 and aggregated to firm level. We then obtain a treatment group that has 216 firms[5]. These firms are also divided into two sub-samples according to the allocation factor which is the ratio of allocated allowances divided by verified emissions. The group with allocation factor larger than one in 2005, i.e. the under-cap firms, consists of 149 firms, and the other group consists of 67 firms[6]. In order to choose Control Group II in accordance with the sector distribution of the treatment group, we classify the regulated firms into six sectors based on the two digit SNI code and the consideration of the number of firms in each category. Table 2 shows the sector distribution in the treatment group. It can be seen that the electricity, gas and hot water supply sector covers more than half of the total amount in our sample.

Table 2. Sector Distribution of treatment group

Sector		Frequency	Percent
SEC1	Manufacture of pulp, paper and paper product	38	17.59
SEC2	Manufacture of chemicals and chemical products	10	4.63
SEC3	Manufacture of other non-metallic products	13	6.02
SEC4	Manufacture of basic metals	11	5.09
SEC5	Electricity, gas and hot water supply	111	51.39
SEC6	Others	33	15.28
Total		216	100

The economic data used in the study is supplied by Statistics Sweden. It is a panel data set for all Swedish firms with more than 50 employees from the year 2003 to 2006 providing basic accounting variables. Descriptive statistics for the main variables in the study are presented in table 3 for both the treatment and control groups. It should be noted that the firms affected by the EU ETS are generally quite large compared to other firms in Sweden. With respect to the available data, the pre-EU ETS year is chosen to be year 2004 in this study. The data in 2003 is included to control for the initial level of the dependent variable and the other covariate. The year 2005 and 2006 are the EU ETS years to be studied.

[5] 11 firms were excluded from the analysis due to missing economic data.
[6] There is no firm that has allocated allowances equal to the verified emissions.

Table 3. Summary (Unit: thousand SEK)

		Treatment group as a whole			Control group I			Control group II		
Variables	Year	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std.
Net Profit (Before	2003	216	218 574	1 200 739	276 117	691	54 116	191	48 854	536 881
	2004	215	325 275	1 581 068	297 429	1 196	59 749	200	50 283	549 878
	2005	216	412 679	2 620 257	324 797	1 462	74 214	216	77 141	739 333
	2006	216	407 885	2 172 956	325 582	1 849	92 395	216	45 655	460 818
Turnover	2003	216	2 202 517	6 676 289	276 117	14 158	263 948	191	149 594	857 793
	2004	215	2 396 231	7 028 095	297 429	14 227	273 772	200	134 433	760 801
	2005	216	2 546 853	7 383 327	324 797	14 238	279 348	216	132 606	762 387
	2006	216	2 736 413	8 142 495	325 582	15 531	310 462	216	138 125	763 885
Roe (no unit)	2003	216	0.42	2.52	273 427	0.18	196.01	191	-0.02	1.59
	2004	215	-0.49	7.42	294 121	0.35	191.51	199	-16.20	226.11
	2005	216	0.09	1.83	319 892	0.50	142.37	216	0.06	4.72
	2006	215	0.02	3.70	321 390	0.40	137.94	216	-4.67	71.26
Roc	2003	211	1.31	17.01	237 351	3.72	250.90	159	3.52	17.65
	2004	211	1.49	18.06	251 904	4.78	190.17	165	5.05	25.20
	2005	212	0.48	3.68	268 906	6.43	519.59	181	5.04	32.42

4.4 The empirical results

The estimation results focusing on the estimates of the coefficient of policy indicator are presented in Tables 4 and 5 below.

Table 4. Profitability for treatment group as a whole

	Control group	Return on equity			Return on capital		
		β_1(diff-in-diffs)	Obs.	R-adj.	β_1(diff-in-diffs)	Obs.	R-adj.
2005	I	0.1747 (1.0116)	269 919	0.2851	-5.4187 (4.3912)	218 778	0.6750
	II	-16.4080 (16.7187)	405	-0.0073	-2.6278 (2.1217)	361	0.1487
2006	I	0.3175 (0.8768)	270 424	0.3657			
	II	-11.3185 (17.6520)	404	-0.0088			

Note: The legends of stars are: * 0.1, **0.05, ***0.01. The following tables are with the same notes.

Table 5. Profitability for the separated treatment groups

	Control group	sub groups of treat. group	Return on equity			Return on capital		
			β_1(diff-in-diffs)	Obs.	R-adj.	β_1(diff-in-diffs)	Obs.	R-adj.
2005	I	Under-cap	-0.3641 (1.0634)	269 844	0.2851	-8.1149 (6.0537)	218 705	0.6750
		Over-cap	1.1037 (1.5791)	269 779	0.2851	-1.9833 (3.3767)	218 641	0.6750
	II	Under-cap	0.2030 (0.3633)	261	0.0069	-2.8150** (1.1038)	230	0.7701
		Over-cap	1.3818 (1.2922)	137	0.0801	-1.0922* (0.5606)	127	0.8905
2006	I	Under-cap	-0.2883 (0.9471)	270 349	0.3657			
		Over-cap	1.2974 (1.6079)	270 285	0.3657			
	II	Under-cap	0.1825 (0.4711)	261	0.1763			
		Over-cap	3.6194 (2.8265)	137	-0.0158			

The main insight of the results is that we do not find statistical significance of the treatment effect. From theoretical point of view it is conceivable of either positive impact or negative impact of the EU ETS on firm profits. However, our apparently inconsistent estimation results are reasonable in accordance with the actual situations. The first phase (2005-2007) of the EU ETS was designed as learning by doing period. Stern (2007) highlighted several important issues and mentioned that the EU ETS is still in infancy. For instance, the long-term confidence in the future of the scheme could affect seriously the investment decision of firms. A survey conducted before the implementation of the EU ETS put the need for certainty on future design issues in the scheme as a top priority (McKinsey et al., 2005). The survey also pointed out an agreement among survey participants that the first implementation of the EU ETS took place under considerable time pressure. Even though the situation got improved when entering the second period and designing the third period, the uncertainty and time pressure in the first period made firms take the wait and see strategy. It consequently weakened the treatment effect of the EU ETS in the period under study.

In the first period, the price of allowances was an important issue as well. At the start of trading in January 2005, traders had limited information on supply and demand for emission allowances because the NAPs did not contain clear data on the assumptions lying behind the projections of emissions used as the basis for allocation (Stern, 2007). As shown before, the price of allowances rose from € 10/tCO_2 to a peak price of almost € 30/tCO_2 in the middle of 2005. But, when the first data on verified emissions were released in the spring of 2006, as the data showed that most of the countries exhibited "long" position, the price fell sharply. Swedish actual emissions data at national level also showed over allocation, the surplus in 2005 was 3 million tons of CO_2 emissions and 2.5 million tons in 2006. As such, it was difficult to ensure the scarcity of the market.

In Sweden, the respective feature of environmental regulations also to some extent explains the insignificant treatment effect of the EU ETS. Before the introduction of the EU ETS, the economic instruments in the energy sector such as energy and carbon taxes and electricity certificates system have been of great significance in Sweden. Some of the energy intensive companies have set voluntary targets to reduce emissions. Comparatively, the EU ETS is new and unrestrictive. In addition, some authors bring forward that the introduction of the EU ETS will increase the electricity prices significantly and then the profitability, for example, ILEX Energy Consulting (2004), Carbon Trust (2004) and Sijm (2004). However, looking at the electricity price in Sweden in the years which our model relies on, we see that the price were relatively steady. As a consensus, there are many factors affecting the electricity price such as weather and temperature conditions, competition. The Swedish electricity price market is both national wide and Nordic wide. As part of the Nordic Power Market (NordPool), Sweden is one of the pioneers in liberalized electricity sectors and generally employs a very light-handed approach to regulating energy companies. The high competition in the electricity market helps Sweden relieve the impact of the EU ETS on the electricity price. Moreover, there is high proportion of clean energy sources in the power generation in Sweden. In 2005, 92.09 percent of the total electricity production was generated from clean energy in Sweden.

4. Conclusion

In this paper, we use a sample of Swedish firms to do an ex-post analysis of the impact of the EU ETS on firm profits. The purpose is to shed light on the treatment effect of the EU ETS at firm-level. We apply the difference-in-differences estimation on an unobserved fixed effect two-period panel data model with respect to the measurements of profitability. To our knowledge, this is the first of its kind concerning the EU ETS in the Swedish context.

The estimation results in the study do not uncover the significant impact of the EU ETS on firm profits. In the separate analysis for the different types of regulated firms according to the relative allocation, the estimation results do not uncover the significant impact either. Our results thus suggest that the treatment effect of the EU ETS within its first two years were not pronounced. The reasonable explanations are the relatively restrictive regulations in Sweden before the EU ETS, and the generous allocation of the allowances in the first period. Some implications regarding the policy can be made from our results. No significant impacts of the EU ETS on profits supports the more restrictive regulations related to the EU ETS in the following period in Sweden.

Analogue to Anger and Oberndorfer (2008), a point related to the methodology need to be emphasized here. It is certainly very early to conduct an ex-post analysis for the EU ETS. To date, the firm-level economic data available to us is only up to 2006. For a long-term policy, the ex-post analysis of the early years can bring forward intriguing insights, but the robustness is to be doubted. In this aspect, it is possible that the impact of the EU ETS on firm profits could occur in subsequent phases. Furthermore, the analysis can be applied to other measurements of interest as well. The reason for choosing profitability is that profits responses quickly to the reform. Some other measurements as investment may response with a time lag after the introduction of the policy, but are worth for studying. Therefore, the supplementation and improvement of analysis are supposed to be conducted in future. In addition, we try the strategy to pick up the control group in accordance with the sector distribution of the treatment group for the sake to make the comparison more concrete. It does not work very well with respect to the robustness of the estimation results. It is possible and necessary for the further study on the matching strategy to find a good “twins” for the treatment group.

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