REGULATION AS DETERMINANT OF EUA PRICES

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ABSTRACT

In this paper we analyse the impact of supply and demand factors on EUA Phase II future prices, with a particular emphasis on the European Commission announcements regarding the organisation of Phase II and Phase III of the European Union Emission Trading Scheme. Using two different methodologies we find strong significance of EC announcements in particular regarding the National Allocation Plans and the cap for Phase III. Our results are particularly relevant to the light of the decisions that the EC must take to achieve the 20-20-20 objectives.

KEYWORDS

CO2 Futures, EUAs, Phase II, Phase III, energy prices, EU ETS, Regulation

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1. INTRODUCTION

The European Union (EU) Emission Trading Scheme (ETS) is the most important carbon cap and trade system so far, not only in terms of sectors covered but also in terms of emission reductions. As in any cap and trade system, the supply of European Union Allowances (EUAs), each of which gives the right to emit a tonne of CO_2 equivalent in the EU, is determined by the reduction target which translates into the "cap" established by the European Commission (EC). Instead, demand of EUAs comes from very different sources. First, from almost 12.000 energy-intensive industrial installations that belong to the most CO_2 emission intensive sectors listed in Annex I of the Kyoto Protocol.[1] Second, from financial intermediaries, institutional actors and speculators who trade EUAs as financial assets.

The implementation of the EU ETS is organized in phases: Phase I, a trial period running from 2005 to 2007; Phase II, coinciding with the Kyoto Protocol period running from 2008 to 2012; and Phase III starting on January 2013 and lasting until December 2020. Note that banking was not allowed from Phase I to Phase II (i.e. it was forbidden to use Phase I allowances for compliance in Phase II), but it is allowed between Phase II and Phase III. Consequently, only Phase I and Phase II EUAs must be considered as two separate assets whereas Phase II and Phase III EUAs is a sole and single asset.

While during Phase I and Phase II the cap was proposed by Member States in the National Allocation Plans (NAPs) that were submitted to the EC for approval, for Phase III, the cap has been fixed by the EC for countries all together in the Climate and Energy Package. The later, approved in December 2008, establishes a reduction of 21% compared to 2005 in the supply of EUAs for Phase III. The previous cap must decrease every year by 1.74% compared to 2010 until 2020. Moreover, new sectors and gases are covered in Phase III which increases coverage of about 25% (Directive 2009/29/EC).

The European Commission is currently considering raising the 2020 pan-European reduction target to a 25% or 30% reduction as compared to 1990 emissions. To the light of future announcements regarding the reduction of the cap on emissions and in general the regulation of the market, studying the impact of those announcements on EUA prices is particularly relevant.

While many papers have studied the fundamentals behind the EUA's demand and consequently their price (see for example Mansanet-Bataller et al., 2007 and Hintermann, 2010 for Phase I, and Creti et al., 2012 for a comparison between Phase I and Phase II) few have studied the impact of the EC's announcements regarding (excess) supply and market regulation. Alberola et al. (2008) and Mansanet-Bataller and Pardo (2009) analyse the effects of NAPs announcements and verification of real emissions announcements on EUAs prices, but their study focused only on Phase I prices. More recently Conrad et al. (2012) study the impact of "surprising" EC decisions regarding Phase II NAPs on high frequency Phase II prices finding that NAP announcements are the most important drivers for EUA prices. The previous paper just considers Phase II NAP approvals whereas herein we consider a larger scope of announcements that we find statistically significant when analysing their effects related to the price formation mechanism of the EU ETS. In particular, besides NAP announcements, negotiations and emissions verification we find that announcements concerning the EU-wide Cap for Phase III, Phase III auction regulation and the inclusion of the aviation sector are explanatory variables for EUA price variations.

Herein we extend Creti et al. (2012) to consider the impact on EUA prices of the EC release of information concerning regulatory aspects of carbon markets such as notification and acceptance of

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[1] Covered by the 2003/87/EC Directive, amended by Directives 2004/101/EC and 2009/29/EC.

NAPs, auctions regulation and timing, decisions regarding the cap of Phase III, etc. This allows us to disentangle the importance of EUAs demand, supply and regulatory determinants, highlighting the importance of the two latter in particular. We use two different approaches. First, following Mansanet-Bataller and Pardo (2009) we estimate what they call the "truncated mean model", which measures the abnormal returns in each day an announcement is released using a benchmark period of 10 days prior to it. Second, we estimate the EUA abnormal returns as coefficients of different dummy variables that correspond to announcement dates in a regression using the Newey-West covariance matrix. Using the first method we find that many announcements have an impact on EUA prices and that sometimes the impact starts before the announcement itself, due to the filtration of information before the formal announcement. Using the second method we find that, besides the fundamentals regarding demand of energy (oil, natural gas) announcements regarding the supply by the EC and its relative scarcity are significant for explaining EUA variations. Using two alternative methods allow us to prove the robustness of our results, which underline the significance of EC announcements as key drivers of EUA price variations.

The paper is organized as follows. In Section 2 we describe the data. In Section 3.1 we describe the truncated mean model and its results. In Section 3.2 we describe our regression estimation and its results. In Section 4 we conclude.
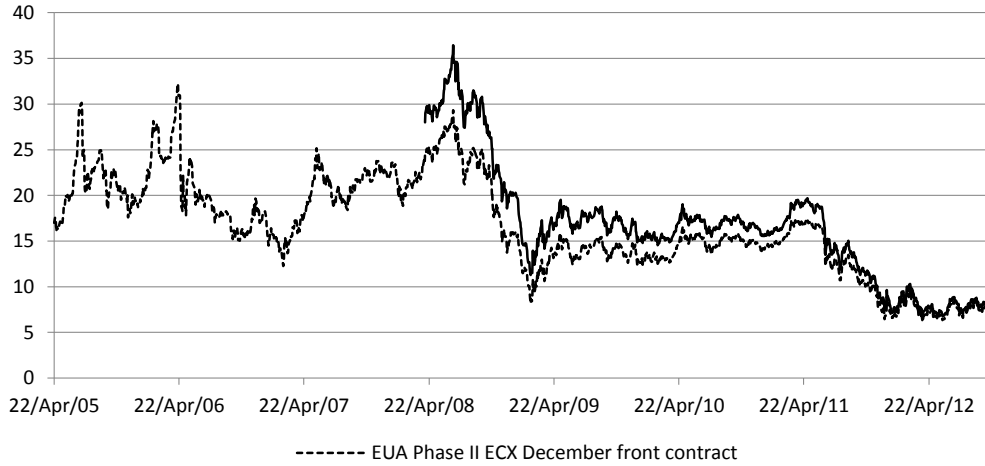
2. DATA DESCRIPTION

With the objective of analysing the determinants of current carbon prices in the EU ETS (including demand, supply and regulatory factors) we consider the most representative price series for carbon in Europe, the daily EUA prices traded at the most important futures market (the ICE/ECX). With this purpose, (i) we built up the Phase II front contract rolling over the nearest December futures contracts, in order to obtain the most liquid Phase II price series, and (ii) we consider the December 2013 future contracts as the representative EUA price for Phase III. Our sample period runs from the 22nd April 2005 to the 29th October 2012. As we may appreciate in Figure 1, these two series are highly correlated. Once converted in stationary series by taking the first logarithm returns, the correlation is equal to 0.98, and it is statistically significant at 1% level. This may be explained by the fact that Phase II allowances can be used for compliance in Phase III (banking). Then, the excess of Phase II allowances' supply can be carried on to Phase III, and consequently determinants of both prices must be the same.

Regarding the main determinants of the EUA demand, following the previous literature (see for example Alberola et al., 2008), we consider the most representative prices of oil, natural gas and coal in Europe. In all cases, we use the monthly front contract to better take into account the daily variations of carbon prices. Thus, our energy database consists of daily futures prices of Brent, Natural Gas, and Rotterdam Coal, all of them traded at the International Petroleum Exchange (IPE). The futures contract on Brent is quoted in US$ per barrel, the futures contract on Natural Gas is quoted in GBp per therm and the coal contract is quoted in US$ per tonne. To carry out the study, we convert them into Euros using the daily exchange rate data available from the European Central Bank.[2] In Figure 2 the evolution of these prices is presented.
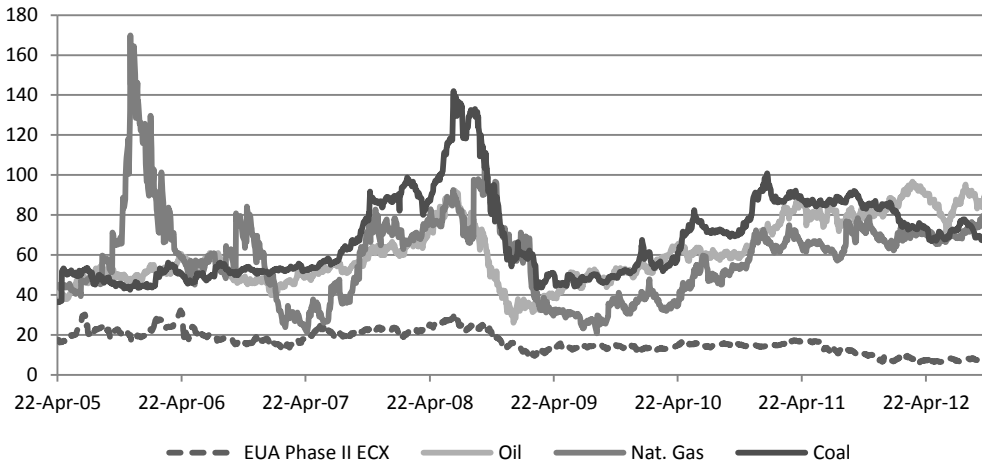
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[2] http://www.ecb.int/stats/exchange/eurofxref/html/index.en.html (last visited the 5/11/2012)

Figure 1: Evolution of Phase II and Phase III EUA prices

.... EUA Phase II ECX December front contract

Source: ECX

Figure 2: Evolution of the Energy prices

- - - EUA Phase II ECX   Oil   Nat. Gas   Coal

We have carried out our study using continuous compounded returns constructed as $r_t=ln(P_t/P_{t-1})$, where P_t is the price at time t.

To take into account the impact of climate variation on energy consumption and consequently on EUAs' prices, similarly to Alberola et al. (2008), we consider a temperature index, i.e. the European temperature index published by Metnext.[3] This temperature index is a population weighted index that accounts for the temperature of 18 countries and that is also weighted by the importance of

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[3] We would like to thank CDC Climat Recherche and Metnext to make those data available to us.

those countries in the EU ETS.[4] As underlined by Mansanet-Bataller et al. (2007), the temperatures have no impact on futures prices if they are considered in a linear way. Consequently we build up two variables that account for the extreme and persistent weather. The variable *temp*$_{min\text{-}pers}$ equals 1 if the temperature is on the first quintile for the 5 previous days and the specific day and consequently, accounts for the days of extremely cold and persistent weather. The variable *temp*$_{max\text{-}pers}$ equals 1 if the temperature is on the last quintile for the 5 previous days and the specific day and consequently, accounts for the days of extremely hot and persistent weather.

Additionally, following Creti et al. (2012) we include the Dow Jones Euro Stoxx 50, i.e. a European equity futures index, as a proxy of the financial and economic environment on a daily basis, considered in first log differences. As underlined by Creti et al. (2012) this is the leading stock index for futures in Europe and allows considering EUAs as a financial asset controlling for the recent financial crisis.

Finally, in order to take into account the EUAs' supply side, we construct a series of dummy variables that capture different types of announcements made public by the EC in their website.[5] First, we build a dummy variable called D_{NT} in order to account for all events regarding Phase II NAPs: D_{NT} is equal to 1 when an announcement regarding the Phase II cap takes place. However, these announcements may be classified in different dummies depending of which specific type of announcement is considered. D_{Not} is equal to 1 each time that a Phase II NAP is notified to the EC by a member country. D_{NAI} is equal to 1 each time that additional information regarding the previous NAPs is provided to the EC. Many times, after the first notification of a country's NAP, the EC asks for additional information, which may be more or less demanding. In many cases the country asks for amendments on their original NAP when providing this additional information, which explains the importance of the inclusion of this variable in our database. These amendments can be sometimes rejected by the EC, which results in additional exchanges of official letters until an agreement is achieved and consequently the NAP is approved.[6] When a NAP is approved our variable D_{NA} is equal to 1. Instead, when a rejection takes place our variable D_{NR} is equal to 1.

In order to take into account the verification of the real emissions of the installations under the EU ETS, the dummy D_{VT}, has been built and it is equal to 1 at each date in which the EC publishes real verified emissions. The importance of this type of announcements derives from the fact that those verified emissions let us know to which extent the cap on emissions is binding which has a direct impact on the price of carbon. This dummy variable that accounts for all the verifications of real emissions has also been split up in 4 dummies in order to take into account separately the verification of real emissions for each year. Thus, the variable D_{V2008}, takes the value 1 when referring to verifications of real emissions of the year 2008 for the first time, D_{V2009}, takes the value 1 when referring to verifications of real emissions of year 2009 for the first time, and the same applies for the dummies D_{V2010}, and D_{V2011}.

As we already mentioned, from the beginning of Phase III, countries will no longer determine EUA's supply. Instead, the EC will do it for all European countries. Additionally, an increasing part of the allowances will be auctioned (allowances for sectors that are not subject to international

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[4] Note that this index started to be published on September 2009. Thus, from the period 22/04/2005 to 31/08/2009 we used the equivalent index, published by Tendances Carbone, that accounted for the 4 biggest countries in the EU ETS (Germany, France, UK and Spain) that better represent the weather in Europe.

[5] See http://ec.europa.eu/clima/news/news_archives_en.htm for the details of the announcements analysed. (Last visited 09/12/2012).

[6] This is the case of Estonia and Poland who's NAPs have been rejected, in the former case several times.

competition like the power sector).[7] We construct four different dummies that capture the news related to the regulation of the EU ETS for Phase III. The first one, D_C is equal to 1 each time an announcement regarding the total cap for Phase III takes place, the dummy D_{AR} captures announcements regarding the amount of emissions to be auctioned and auction regulation in general as well as the set-asides. The previous news, in particular the set-aside, reflects to which extent the EUA cap for Phase III will be binding.

Finally, we take into account the emissions from airplane roots passing through Europe are included in the EU ETS as from 2012, even if at the moment of writing this paper some delays in this process are taking place. The allowances allocated to the aviation sector are only partially fungible with the other EUAs: airlines can buy EUAs from the EU ETS whereas EU ETS installations cannot use for compliance EUAs assigned to the aviation sector. Thus, we expect this scheme to affect the demand of EUAs but not the supply. All announcements regarding the organization of the aviation ETS are captured by the dummy $D_{Av.}$

All dummies considered in the study are listed in Table 1. The dates associated to the dummies previously mentioned and a summary of NAP announcements and dates by country are summarized in Appendix A (Table A.1 and A.2, respectively).

TABLE 1: LIST OF DUMMIES CONSIDERED IN THE STUDY

PANEL A: ANNOUNCEMENTS REGARDING THE NATIONAL ALLOCATION PLANS
- D_{Not}: NOTIFICATION OF PHASE II NAPS TO THE EC;
- D_{NAI}: NOTIFICATION OF ADDITIONAL INFORMATION REGARDING THE NAPS PROVIDED TO THE EC;
- D_{NA}: NAPS APPROVAL;
- D_{NR}: REJECTION OF NAPS;
- D_{NT}: ALL EVENTS REGARDING PHASE II NAPS.

PANEL B: ANNOUNCEMENTS REGARDING THE VERIFICATION OF REAL EMISSIONS
- D_{VT}: ALL EVENTS REGARDING THE VERIFICATION OF THE REAL EMISSIONS OF THE INSTALLATIONS UNDER THE EU ETS;
- D_{V2008}: VERIFICATION OF REAL EMISSIONS IN THE EU ETS FOR THE YEAR 2008;
- D_{V2009}: VERIFICATION OF REAL EMISSIONS IN THE EU ETS FOR THE YEAR 2009;
- D_{V2010}: VERIFICATION OF REAL EMISSIONS IN THE EU ETS FOR THE YEAR 2010;
- D_{V2011}: VERIFICATION OF REAL EMISSIONS IN THE EU ETS FOR THE YEAR 2011.

PANEL C: ANNOUNCEMENTS REGARDING THE DEVELOPMENT OF THE EU ETS IN PHASE III
- D_C: ANNOUNCEMENTS REGARDING THE TOTAL CAP FOR PHASE III;
- D_{AR}: ANNOUNCEMENTS REGARDING THE AUCTION REGULATION;
- D_{Av}: ANNOUNCEMENTS REGARDING THE ORGANIZATION OF THE AVIATION ETS SYSTEM.

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[7] In order to allow, as from 2012, the hedging of short positions on allowances in Phase III the EC has decided to auction 120 Mt of CO_2 already in 2012. Those 120 Mt correspond to 60Mt of the total allowances that would have been auctioned in 2013 and 60 Mt of those that would have been auctioned in 2014.

3. SUPPLY AND DEMAND DETERMINANTS OF CARBON PRICES

As mentioned in the introduction, to analyse the short term price behaviour for Phase II allowances and its determinants, we apply two different methodologies: the truncated mean model proposed by Mansanet-Bataller and Pardo (2009) and a regression using the Newey-West covariance matrix.

3.1 Truncated Mean Model

When studying regulatory announcements in the carbon market, the formal date of the announcement may not coincide with the date when the new information reaches the market. In some cases the information arrives to the market before the formal announcement is made, in some others the information takes some time to materialize in agent's market strategies. In these cases directly performing the estimation with a regression is misleading since the proper lag should be selected as well as the specific news that, due to their content, have an impact on EUAs prices. To account for these phenomena we perform an event study *à la* Mansanet-Bataller and Pardo (2009).[8] Following the previous paper, we have considered a prediction period of 7 days (including the announcement date) and an estimation period of 10 days. This choice allows us to consider a sufficient length in order to have a good benchmark and to predict the expected return for the announcement day and the three days surrounding it, before and after. Thus, the application of this method is as follows: for each day when an announcement takes place, the prediction period is defined as the announcement day and the six days surrounding it. On the other hand, as shown in Figure 3, the estimation period is the ten-day period starting 13 days before the announcement considered. For each day in the prediction period a standardized abnormal return is calculated as the difference of the return at time *t* minus a benchmark return (a truncated mean of the returns) from the estimation period, divided by its standard deviation.[9] Note that both, the benchmark return and thus its standard deviation are obtained excluding the 10% higher returns and the 10% lower returns in the estimation period.[10] Then, for each group of announcements, the portfolio standardized excess returns for each day in the prediction period is obtained. The portfolio of standardized excess returns is an equally weighted portfolio of the standardized excess returns of the same type of announcements. Finally, we test the null hypothesis that the portfolio of excess returns is equal to zero on the day of the announcement and six days surrounding it. If the portfolio of excess returns is negative and statistically significant we can say that in average this type of announcement provokes a decrease in EUA prices. We can conclude the opposite when the portfolio of excess returns is positive and statistically significant. Figure 3 depicts graphically the truncated mean model.

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[8] It is worth noting that the truncated mean model of Mansanet-Bataller and Pardo (2009) is a modification of the constant mean adjusted return model of Brown and Warner (1985).

[9] Note that using the standardized abnormal returns is consistent with the idea of considering that the market participants have a daily hedging strategy.

[10] The existence of an announcement in the estimation period is taken into account by calculating the truncated mean and the standard deviation as described above. Using this methodology we avoid the impact that the existence of an extreme return in the prediction period could have in determining the benchmark return we use to compare returns in the estimation period.

Figure 3: Graphical representation of the truncated mean model
Standardized excess returns
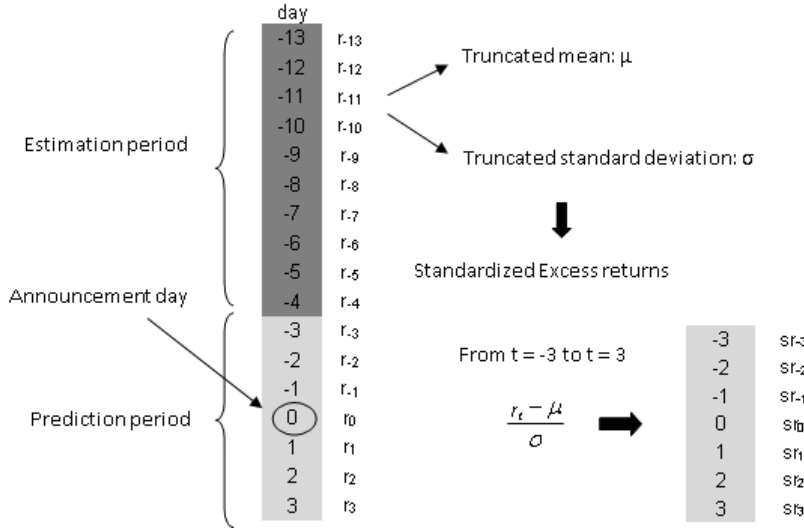
Figure 3: Graphical representation of the truncated mean model (continued)
Portfolio of standardized excess returns
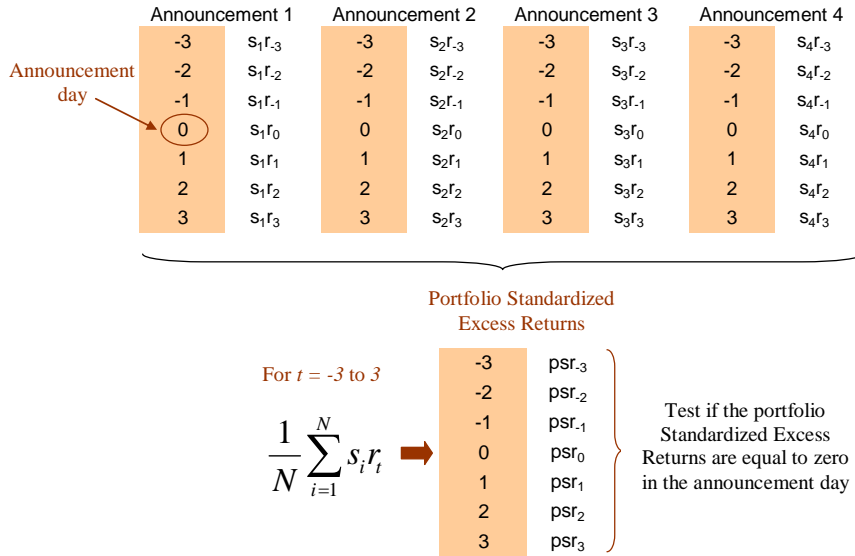
Results of the truncated mean model are summarized in Table 2[11]. As we can appreciate, for several of the news release considered, there are abnormal significant returns before the announcement date. This can be explained by the fact that some news leak to the market before the

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[11] This table, as well as Table 3 and 4, presents the results of the t-statistic test in which the null hypothesis is that the portfolio excess return equals zero.

formal announcement by the EC takes place. Additionally, most of the returns on announcement days present statistical significance. In this case the information has an effect on the price series when it is formally issued meaning either that there has been no information leakage before the formal announcement day or that information only becomes credible when the EC does the formal announcement. Only few of the announcements are significant after the formal release. Our results suggest that the EMH is in general verified in this market.

Table 2: Truncated mean model results

Panel A: Announcements considered grouped

	NATIONAL ALLOCATION PLANS			VERIFICATION OF REAL EMISSIONS	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0.1060	0.3093	-3	-1.7100	0.0006
-2	-0.1110	0.2870	-2	-0.4437	0.3749
-1	-0.1288	0.2168	-1	-0.7715	0.1228
0	-0.1092	0.2948	0	-0.3989	0.4250
1	-0.0281	0.7876	1	0.9119	0.0682
2	-0.2407	0.0210	2	-0.0822	0.8694
3	-0.0214	0.8373	3	0.1967	0.6940
NUMBER OF ANNOUNCEMENTS		92	NUMBER OF ANNOUNCEMENTS		4

Panel B: Disaggregated National Allocations Plans related announcements

	NOTIFICATION OF NAPs			NOTIFICATION OF ADDITIONAL INFORMATION	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0,6279	0,0026	-3	-0,1974	0,1628
-2	-0,3382	0,1048	-2	-0,1325	0,3490
-1	0,2099	0,3141	-1	-0,3311	0,0192
0	-0,0720	0,7300	0	-0,2643	0,0617
1	0,4775	0,0220	1	-0,0641	0,6503
2	0,0216	0,9176	2	-0,5574	0,0001
3	0,1497	0,4727	3	0,1289	0,3621
NUMBER OF ANNOUNCEMENTS		23	NUMBER OF ANNOUNCEMENTS		50

	NATIONAL ALLOCATION PLAN APPROVAL			NATIONAL ALLOCATION PLAN REJECTION	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	1,1301	0,0000	-3	-1,2845	0,0102
-2	0,3289	0,1883	-2	-0,4749	0,3422
-1	0,1906	0,4458	-1	-0,7240	0,1476
0	0,3174	0,2043	0	0,0656	0,8957
1	-0,5334	0,0329	1	-0,2663	0,5943
2	0,3185	0,2027	2	-0,0211	0,9663
3	-0,3674	0,1417	3	-1,4267	0,0043
NUMBER OF ANNOUNCEMENTS		16	NUMBER OF ANNOUNCEMENTS		4

Panel C: Disaggregated yearly real verification related announcements

VERIFICATION OF REAL EMISSIONS 2008				*VERIFICATION OF REAL EMISSIONS 2009*		
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE		DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-4.4597	0.0000		-3.0000	-1.2965	0.1948
-2	-2.9069	0.0037		-2.0000	0.6463	0.5181
-1	-2.5394	0.0111		-1.0000	-0.0614	0.9510
0	-2.8922	0.0038		0.0000	2.3004	0.0214
1	0.1558	0.8762		1.0000	3.0171	0.0026
2	-0.0973	0.9225		2.0000	0.7832	0.4335
3	1.3266	0.1846		3.0000	0.2778	0.7811
NUMBER OF ANNOUNCEMENTS		1		NUMBER OF ANNOUNCEMENTS		1

VERIFICATION OF REAL EMISSIONS 2010				*VERIFICATION OF REAL EMISSIONS 2011*		
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE		DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3.0000	-0.9818	0.3262		-3.0000	-0.1020	0.9188
-2.0000	-0.1431	0.8862		-2.0000	0.6288	0.5295
-1.0000	0.4850	0.6276		-1.0000	-0.9703	0.3319
0.0000	-0.3522	0.7247		0.0000	-0.6515	0.5148
1.0000	0.0346	0.9724		1.0000	0.4400	0.6599
2.0000	-0.7704	0.4411		2.0000	-0.2443	0.8070
3.0000	-0.0835	0.9335		3.0000	-0.7340	0.4629
NUMBER OF ANNOUNCEMENTS		1		NUMBER OF ANNOUNCEMENTS		1

Panel D: Other regulatory announcements

AUCTION REGULATION				*PHASE III CAP*		
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE		DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	0,6601	0,0222		-3	-2,4690	0,0005
-2	-0,4388	0,1285		-2	-1,6334	0,0209
-1	0,7390	0,0105		-1	-0,7225	0,3069
0	-0,5184	0,0725		0	1,1687	0,0984
1	0,6041	0,0364		1	1,1066	0,1176
2	-0,2560	0,3752		2	-0,0577	0,9349
3	0,3281	0,2557		3	1,4343	0,0425
NUMBER OF ANNOUNCEMENTS		12		NUMBER OF ANNOUNCEMENTS		2

AVIATION		
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0,2012	0,5047
-2	-0,9135	0,0024
-1	0,7347	0,0148
0	-1,0590	0,0004
1	0,1901	0,5284
2	0,4495	0,1360
3	1,2654	0,0000
NUMBER OF ANNOUNCEMENTS		11

When considering all 92 NAP related news (Panel A of Table 2) we find no significant reaction of the market the day of the announcement. This may be explained by the fact that this variable accounts for announcements of a very different nature (and therefore provoking reactions of opposite sign) that, mixed together, compensate each other. Instead, if we split the NAPs variable into the 4 dummies considered, that is, we separate the news concerning the notification of NAPs, those regarding the notification of additional information, the ones related to the approval of NAPs and the rejection of NAPs, we find that the variable capturing the notification of additional information (NAI) has a negative impact that is significant at 10% (Panel B of Table 2). NAI announcements include all back and forth correspondence between member states and the EC, in particular amendments to NAPs already notified. The negative sign of the influence of NAI announcements on EUA prices reflects the fact that the market considers that the EC is too generous with member states wishing to get a more flexible cap.

Regarding the delayed (or advanced) reaction of the market when considering all 92 NAP related news no significant effect on EUA prices is registered. Instead, in the case of NAI, the market seems to anticipate the previously described negative reaction and to continue the downward adjustment after the formal announcement is made at a 10% significance level.

Regarding verified emissions (Panel C of Table 2), we find a negative influence of the 2008 verified emissions and a positive influence of the 2009 verified emissions meaning that in 2008 the market perceives that the EU ETS is longer than expected and thus the prices adjust decreasing, whereas in 2009 agents seem to understand that even if the market is still long, it is less long than expected and thus, again, the prices adjust the day of the announcement. In the first year of Phase II the information that the countries had emitted fewer emissions than the distributed EUAs leaked well in advance as it usually happens at the beginning of a new Phase (Mansanet-Bataller and Pardo, 2009). This is what explains the negative signs during the three days before the formal announcement was made in this first year.

Besides the announcements regarding NAPs and emission's verifications, also considered in Mansanet-Bataller and Pardo (2009) and Conrad (2012), herein we study other type of announcements that may impact the way the EU ETS is organized. As we already said Phase II and Phase III allowances can be considered the same asset, so, since most EUAs during Phase III will be distributed through auctions, auctions regulation may have an impact on the EUAs front future contact considered. News regarding auction regulation includes the fact that 120 Mt of CO_2 of Phase III allowances will be already auctioned at the end of 2012. We also consider in this group of news, the announcements related to the fact that, in Phase III, the EC will use those auctions to retrieve EUAs from the market (what in technical terms is called back-loading when is temporal and set-aside when is permanent). The results show (Panel D of Table 2) that the market reacts to the anticipation of EUAs auctioning with a negative effect on EUA prices which can be explained by the relative abundance of EUAs in Phase II, that is, auctioning allowances from Phase III in Phase II increases the current supply of EUA and thus diminishes its price.

Regarding the announcements on Phase III global cap on emissions (Panel D of Table 2), the market seems to anticipate a non-binding cap before the formal announcement is made (significant negative impacts) and a slight upward adjustment the day of the announcement itself.

The 11 formal announcements regarding the inclusion of the aviation sector in the EU ETS have a negative and significant impact on EUA prices and seem to be anticipated by the market (Panel D of Table 2). As we already explained, the aviation sector will not be fully linked to the EU ETS: carriers may buy from the EU ETS but the installations under the EU ETS cannot use the allowances from the Aviation trading scheme for their compliance. Since the inclusion of the aviation sector does not increase EUAs supply but may increase demand one would expect a positive effect on EUA prices. Instead, our results show a negative significant effect, which means

that the market perception regarding that news is still that the market is long as compared to installation needs.

Table 3 Truncated mean model results, 1st refinement

Panel A: Announcements considered grouped

DAYS	NATIONAL ALLOCATION PLANS PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	VERIFICATION OF REAL EMISSIONS PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0,4131	0,0068	-3	-1,7100	0,0006
-2	-0,4111	0,0070	-2	-0,4437	0,3749
-1	-0,4232	0,0055	-1	-0,7715	0,1228
0	-0,3283	0,0313	0	-0,3989	0,4250
1	-0,6223	0,0000	1	0,9119	0,0682
2	-0,8080	0,0000	2	-0,0822	0,8694
3	-0,0697	0,6478	3	0,1967	0,6940
NUMBER OF ANNOUNCEMENTS		43	NUMBER OF ANNOUNCEMENTS		4

Panel B: Disaggregated National Allocations Plans related announcements

DAYS	NOTIFICATION OF NAPS PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	NOTIFICATION OF ADDITIONAL INFORMATION PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0,0471	0,8758	-3	-1,3717	0,0000
-2	-0,4744	0,1156	-2	-0,9893	0,0000
-1	0,0588	0,8453	-1	-0,7753	0,0010
0	-0,1747	0,5623	0	-0,5163	0,0285
1	-0,3893	0,1967	1	-0,7154	0,0024
2	-0,3119	0,3010	2	-1,9565	0,0000
3	0,0630	0,8346	3	0,2594	0,2710
NUMBER OF ANNOUNCEMENTS		11	NUMBER OF ANNOUNCEMENTS		18

DAYS	NATIONAL ALLOCATION PLAN APPROVAL PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	NATIONAL ALLOCATION PLAN REJECTION PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	1,2221	0,0001	-3	-1,9992	0,0005
-2	0,5117	0,0896	-2	-0,0930	0,8720
-1	-0,1725	0,5672	-1	-0,9968	0,0843
0	-0,2509	0,4054	0	-0,0475	0,9344
1	-0,6595	0,0287	1	-0,7827	0,1752
2	0,3512	0,2440	2	0,0134	0,9814
3	-0,3387	0,2613	3	-1,5442	0,0075
NUMBER OF ANNOUNCEMENTS		11	NUMBER OF ANNOUNCEMENTS		3

Panel C: Disaggregated yearly real verification related announcements

	VERIFICATION OF REAL EMISSIONS 2008			*VERIFICATION OF REAL EMISSIONS 2009*	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-4.4597	0.0000	-3	-1.2965	0.1948
-2	-2.9069	0.0037	-2	0.6463	0.5181
-1	-2.5394	0.0111	-1	-0.0614	0.9510
0	-2.8922	0.0038	0	2.3004	0.0214
1	0.1558	0.8762	1	3.0171	0.0026
2	-0.0973	0.9225	2	0.7832	0.4335
3	1.3266	0.1846	3	0.2778	0.7811
NUMBER OF ANNOUNCEMENTS		1	NUMBER OF ANNOUNCEMENTS		1

	VERIFICATION OF REAL EMISSIONS 2010			*VERIFICATION OF REAL EMISSIONS 2011*	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0.9818	0.3262	-3	-0.1020	0.9188
-2	-0.1431	0.8862	-2	0.6288	0.5295
-1	0.4850	0.6276	-1	-0.9703	0.3319
0	-0.3522	0.7247	0	-0.6515	0.5148
1	0.0346	0.9724	1	0.4400	0.6599
2	-0.7704	0.4411	2	-0.2443	0.8070
3	-0.0835	0.9335	3	-0.7340	0.4629
NUMBER OF ANNOUNCEMENTS		1	NUMBER OF ANNOUNCEMENTS		1

Panel D: Other regulatory announcements

	AUCTION REGULATION			*PHASE III CAP*	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	0,6601	0,0222	-3	-2,6657	0,0077
-2	-0,4388	0,1285	-2	1,0134	0,3109
-1	0,7390	0,0105	-1	-2,2271	0,0259
0	-0,5184	0,0725	0	1,7357	0,0826
1	0,6041	0,0364	1	0,7760	0,4377
2	-0,2560	0,3752	2	-1,1916	0,2334
3	0,3281	0,2557	3	0,8580	0,3909
NUMBER OF ANNOUNCEMENTS		12	NUMBER OF ANNOUNCEMENTS		1

	AVIATION	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0,3092	0,3536
-2	-1,2660	0,0001
-1	0,9938	0,0029
0	-1,3596	0,0000
1	0,1585	0,6344
2	0,3546	0,2874
3	1,4497	0,0000
NUMBER OF ANNOUNCEMENTS		9

We have verified the previous results by estimating a refinement of the previous model. First we have considered only announcements that are not preceded by other announcements by 3 days, what we call the 3-previous-day model presented in Table 3. The purpose is to see whether the previously described significant variables stay significant with this refinement. After eliminating the announcements that are preceded by other announcements during the previous 3 days the number of announcements in some of the variables is considerably reduced. Results are exactly the same as the ones described before with the exception of total NAPs that now become significant. This may be the case due to the elimination of NAPs that compensate each other due to corrections of the EC regarding previous announcements.

We have also performed a similar analysis considering only the announcements that do not have any other announcement in the 6 days surrounding it, what we call the "6-surrounding-days-model" presented in Table 4. Once again our results are verified both in terms of significance the same day of the announcement and in terms of information filtration before and after the formal announcement.

The fact that results presented in Table 3 and Table 4 are consistent with results in Table 2 proves the non-existence of contamination between the events considered.

Finally, it is worth noting that we have studied the potential influence of other variables that prove to be non-significant. This is the case of the announcements regarding:

which sectors will be under free allocations instead of auctioning during Phase III;

the management of the Registry for Phase III;

the improved methods of measurement and verification for Phase III;

the linking of the EU ETS with other national systems (i.e. Australian);

the improvements on market security after the fraud registered on the VAT and the stolen allowances from the registry of Poland; and

the cap for the next phase of the EU ETS (Phase IV, that will probably start on January 2021 and last until December 2028).

The non-significance of the previous variables is expected since none of them have an impact on supply of EUAs and news regarding Phase IV refer to a too far-away-period to affect Phase II front future contracts.

Table 4: Truncated mean model results, 2nd refinement

Panel A: Announcements considered grouped

	NATIONAL ALLOCATION PLANS			VERIFICATION OF REAL EMISSIONS	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0,2545	0,2125	-3	-2,2809	0,0013
-2	-0,2255	0,2693	-2	-1,1391	0,1072
-1	-0,0238	0,9074	-1	-1,7548	0,0131
0	-0,3027	0,1381	0	-1,7718	0,0122
1	-0,8051	0,0001	1	0,2979	0,6735
2	-1,1803	0,0000	2	-0,1708	0,8092
3	-0,5853	0,0041	3	0,2963	0,6752
NUMBER OF ANNOUNCEMENTS		24	NUMBER OF ANNOUNCEMENTS		2

Panel B: Disaggregated National Allocations Plans related announcements

	NOTIFICATION OF NAPs			*NOTIFICATION OF ADDITIONAL INFORMATION*	
DAYS	**PORTFOLIO STANDARIZED EXCES RETURNS**	**P-VALUE**	**DAYS**	**PORTFOLIO STANDARIZED EXCES RETURNS**	**P-VALUE**
-3	0,2733	0,5032	-3	-1,0669	0,0025
-2	-0,6316	0,1218	-2	-0,4981	0,1589
-1	0,5801	0,1553	-1	-1,0341	0,0034
0	-0,5405	0,1855	0	-0,0056	0,9874
1	-0,3595	0,3785	1	-1,9043	0,0000
2	-0,0409	0,9201	2	-2,9969	0,0000
3	0,0208	0,9594	3	-1,1465	0,0012
NUMBER OF ANNOUNCEMENTS		6	**NUMBER OF ANNOUNCEMENTS**		8

	NATIONAL ALLOCATION PLAN APPROVAL			*NATIONAL ALLOCATION PLAN REJECTION*	
DAYS	**PORTFOLIO STANDARIZED EXCES RETURNS**	**P-VALUE**	**DAYS**	**PORTFOLIO STANDARIZED EXCES RETURNS**	**P-VALUE**
-3	0,8207	0,0203	-3	-2,8889	0,0000
-2	0,2330	0,5098	-2	0,2495	0,7242
-1	0,6139	0,0825	-1	-0,3447	0,6259
0	-0,4330	0,2207	0	-0,2568	0,7164
1	-0,2947	0,4046	1	0,2134	0,7628
2	-0,3731	0,2912	2	-0,5609	0,4276
3	-0,1568	0,6574	3	-1,8727	0,0081
NUMBER OF ANNOUNCEMENTS		8	**NUMBER OF ANNOUNCEMENTS**		2

Panel C: Disaggregated yearly real verification related announcements

	VERIFICATION OF REAL EMISSIONS 2008			*VERIFICATION OF REAL EMISSIONS 2011*	
DAYS	**PORTFOLIO STANDARIZED EXCES RETURNS**	**P-VALUE**	**DAYS**	**PORTFOLIO STANDARIZED EXCES RETURNS**	**P-VALUE**
-3	-4.4597	0.0000	-3	-0.1020	0.9188
-2	-2.9069	0.0037	-2	0.6288	0.5295
-1	-2.5394	0.0111	-1	-0.9703	0.3319
0	-2.8922	0.0038	0	-0.6515	0.5148
1	0.1558	0.8762	1	0.4400	0.6599
2	-0.0973	0.9225	2	-0.2443	0.8070
3	1.3266	0.1846	3	-0.7340	0.4629
NUMBER OF ANNOUNCEMENTS		1	**NUMBER OF ANNOUNCEMENTS**		1

Panel D: Other regulatory announcements

	AUCTION REGULATION			PHASE III CAP	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE	DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	0,6601	0,0222	-3	-2,6657	0,0077
-2	-0,4388	0,1285	-2	1,0134	0,3109
-1	0,7390	0,0105	-1	-2,2271	0,0259
0	-0,5184	0,0725	0	1,7357	0,0826
1	0,6041	0,0364	1	0,7760	0,4377
2	-0,2560	0,3752	2	-1,1916	0,2334
3	0,3281	0,2557	3	0,8580	0,3909
NUMBER OF ANNOUNCEMENTS		12	NUMBER OF ANNOUNCEMENTS		1

	AVIATION	
DAYS	PORTFOLIO STANDARIZED EXCES RETURNS	P-VALUE
-3	-0,3092	0,3536
-2	-1,2660	0,0001
-1	0,9938	0,0029
0	-1,3596	0,0000
1	0,1585	0,6344
2	0,3546	0,2874
3	1,4497	0,0000
NUMBER OF ANNOUNCEMENTS		9

3.2 Regression Estimation

Aside from the previous method to detect the announcements that have an impact on EUA returns we perform an OLS estimation. Note that we use the Newey-West covariance matrix in order to take into account the existence of autocorrelation and heteroskedasticity. This method allows us to take into account both the impact of the variables considered in the literature as the main factors affecting carbon prices (energy variables, weather and economic activity) and the regulatory announcements that the previous method allowed us to select. Additionally, this methodology is simpler to implement than the truncated mean model previously applied since the benchmark parameters and the abnormal returns are estimated in one step (see Binder 1998) as the abnormal returns are measured through the regression coefficients of the dummy variables considered. The model that we estimate is the following:

$$R_{CO_2,T} = C + B_1 R_{OIL,T} + B_2 R_{NGAS,T} + B_3 R_{COAL,T} + B_4 R_{EUROSTOXX50,T} + B_5 D_{NT,T} + B_6 D_{VT,T} +$$

$$B_7 D_{C,T} + B_8 D_{AR,T} + B_9 D_{AV,T} + B_{10} TEMP + B_{11} TEMP_{MIN-PERS,T} + B_{12} TEMP_{MAX-PERS,T} + B_{13} D_{MIN,T} +$$

$$B_{14} D_{MAX,T} + E_T$$

Where r_{CO2} are the EUA returns, c is a constant, r_{oil} are the oil returns, r_{ngas} are the natural gas returns, r_{Coal} are the coal returns, $r_{Eurostoxx50}$ are the Dow Jones Euro Stoxx 50 futures index returns,

D_{NT} is the dummy accounting for all events regarding Phase II NAPs, D_{VT} is the dummy variable that takes into account all the verification of the real emissions of the installations under the EU ETS, D_C is the dummy variable that accounts for the announcements regarding the total cap for Phase III, D_{AR} is the dummy that captures the announcements regarding the auction regulation, D_{Av} is the dummy that captures all announcements regarding the organization of the aviation ETS, *temp* is the variable accounting for the European temperature index, $temp_{min-pers}$ is the dummy variable that accounts for the days of extremely cold and persistent weather, $temp_{max-pers}$ is the dummy variable that accounts for the days of extremely hot and persistent weather, e_t is the error term. Note that following the truncated mean model analysis, all variables are considered contemporaneous. Instead, as in Mansanet-Bataller et al. (2007), we have included two dummy variables, $D_{max,t}$ and $D_{min,t}$, that eliminate the effect of three positive and three negative extreme CO_2 price changes, respectively. That is, they have ones the three days with the highest (lowest) returns in CO_2 prices. The results of this model are presented in Table 5 (Model 1).

Table 5: Results of the regression estimation, Model 1and Model 2

	MODEL 1		MODEL 2	
	COEFFICIENT	STANDARD ERROR	COEFFICIENT	STANDARD ERROR
$R_{OIL,T}$	0.23701*	0.03265	0.23502*	0.03270
$R_{NGAS,T}$	0.08124*	0.01506	0.08062*	0.01488
$R_{COAL,T}$	0.00182	0.0285	0.00204	0.02864
$R_{EUROSTOXX50,T}$	0.00235	0.00300	0.00233	0.00301
$D_{NT,T}$	-0.0002	0.00188		
$D_{NOT,T}$			-0.00036	0.00351
$D_{NAI,T}$			-0.00169	0.00324
$D_{NA,T}$			0.00340	0.00675
$D_{NR,T-3}$			-0.01394*	0.00451
$D_{VT,T}$	-0.00699	0.00803		
$D_{V2008,T}$			-0.02353*	0.00090
$D_{V2009,T}$			0.01835*	0.00116
$D_{V2010,T}$			-0.00580*	0.00088
$D_{V2011,T}$			-0.01720*	0.00074
$D_{AR,T}$	-0.01949*	0.00942	-0.01952*	0.00944
$D_{C,T}$	0.01373*	0.00253	0.01367*	0.00250
$D_{AV,T}$	-0.01348**	0.00807	-0.01357**	0.00808
TEMP	0.00016	0.00012	0.00016	0.00012
$TEMP_{MIN-PERS,T}$	0.00323	0.00241	0.00014	0.00200
$TEMP_{MAX-PERS,T}$	0.00021	0.00200	0.00320	0.00243
$D_{MIN,T}$	-0.19463*	0.03974	-0.19470*	0.03981
$D_{MAX,T}$	0.18262*	0.02926	0.18257*	0.02932
C	-0.00268	0.00181	-0.00264	0.00181
R-SQUARED	0.20212		0.20341	
ADJUSTED R-SQUARED	0.19627		0.19503	
AKAIKE INFO CRITERION	-4.51960		-4.51575	
SCHWARZ CRITERION	-4.47624		-4.45496	
DURBIN-WATSON	1.86342		1.86527	

Notes:
r_{CO2} accounts for the EUA returns, α is a constant, r_{oil} are the oil returns, r_{ngas} are the natural gas returns, r_{Coal} are the coal returns, $r_{Eurostoxx50}$ are the Dow Jones Euro Stoxx 50 futures index returns, D_{NT} is the dummy accounting for all events regarding Phase II NAPs, D_{VT} is the dummy variable that takes into account all the verification of the real emissions of the installations under the EU ETS, D_C is the dummy variable that accounts for the announcements regarding the total cap for Phase III, D_{AR} is the dummy that captures the announcements regarding the auction regulation, D_{Av} is the dummy that

captures all announcements regarding the organization of the aviation ETS, temp is the dummy variable related to the temperature european index, $temp_{min-pers}$ is the dummy variable that accounts for the days of extremely cold and persistent weather, $temp_{max-pers}$ is the dummy variable that accounts for the days of extremely hot and persistent weather, ε_t is the error term. Note that following the truncated mean model analysis, all variables are considered contemporaneous with the exception of the dummy related to the NAPs rejection that is considered lagged 3 periods. $D_{max,t}$ and $D_{min,t}$, are the dummy variables that eliminate the effect of three positive and three negative extreme CO_2 price changes, respectively. * and ** denote statistically significance at 5% and 10% respectively.

As we can appreciate in Table 5, we find that Coal prices have no significant impact on the Phase II EUA prices whereas Oil and Natural Gas prices are significant fundamentals. This is in line with the findings of Mansanet-Bataller et al. (2007) and Alberola et al. (2008) regarding the determinants of Phase I prices. Aside from the previous, Creti et al. (2012) find Granger causality between CO_2 and the Dow Jones Eurostoxx 50. Instead, in our regression estimation we find this variable is non-significant in any of the specifications tested. This discrepancy may be due to the fact that Creti et al. (2012) states a long run relationship (cointegration method) between this variable that is used as a proxy of macroeconomic activity and the EUA prices. Instead, we analyze the explanatory power that daily variations on different variables have on daily EUA returns. The non-significance of stock returns may be then explained by the fact that, the short-run impact that macroeconomic activity has on EUA returns is already captured in the variation of the other price determinants included in our estimation.

Related to the impact of temperature in Phase II EUA returns, our model indicates that they are not statistically significant. In order to consider temperature variables that are the most likely to be significant (due to their impact on electricity demand), we include two variables that capture high and low extreme and persisting (for more than 5 days) temperatures. The non-significance result may be explained by the fact that fluctuations in electricity demand that impact EUA prices are already captured by the other fundamentals included in the analysis.

Regarding the variables that take into account the organisation of the EU ETS in Phases II and III, we must disentangle different results. First, the variables capturing the impact of auction regulation and the inclusion of the aviation sector in the EU ETS have a negative and significant influence, as obtained in the truncated mean model. Second, also in accordance with the truncated mean model, the variable capturing the impact on EUA prices of the Global Cap for Phase III has a positive and significant influence.

Third, the variable capturing all announcements related to NAPs as well as the variable capturing all emissions verifications are non-significant. This result is in line with our findings in the previous section. Again, considering all together all NAPs announcements implies taking into account announcements of very different nature and therefore the effects on Phase II EUA returns could compensate each other making the coefficient non-statistically significant. Similarly, when the verified emissions for all years are considered as a single variable a negative impact of verification of emissions on EUA prices could compensate a positive one giving a non-significant aggregate impact, translated in the absence of abnormal returns. In fact, this result is similar to what Mansanet-Bataller and Pardo (2009) had found for Phase I prices.

To solve this issue we have estimated the Model 2, which results are also presented in Table 5. In this model we disaggregate the NAP related news by type and the verified emissions by years. The model is specified as follows:

$$r_{CO_2,t} = c + \beta_1 r_{oil,t} + \beta_2 r_{ngas,t} + \beta_3 r_{coal,t} + \beta_4 r_{Eurostoxx50,t} + \beta_5 D_{Not,t} + \beta_6 D_{NAI,t} +$$
$$\beta_7 D_{NA,t} + \beta_8 D_{NR,t-3} + \beta_9 D_{V2008,t} + \beta_{10} D_{V2009,t} + \beta_{11} D_{V2010,t} + \beta_{12} D_{V2011,t} + \beta_{13} D_{C,t} +$$
$$\beta_{14} D_{AR,t} + \beta_{15} D_{Av,t} + \beta_{16} temp + \beta_{17} temp_{min-pers,t} + \beta_{18}\, temp_{max-pers,t} +$$
$$\beta_{19} D_{min,t} + \beta_{20} D_{max,t} + e_t$$

Where r_{CO2}, c, r_{oil}, r_{ngas}, r_{Coal}, $r_{Eurostoxx50}$, D_{AR}, D_C, D_{Av}, $temp$, $temp_{min-pers}$, $temp_{max-pers}$, $D_{max,t}$ and $D_{min,t}$, are kept from the previous model but instead of considering all NAP announcements and verification announcements together we disaggregate them. Consequently, we now include D_{Not} that is the dummy related to the notification of Phase II NAPs to the EC, D_{NAI} that is the dummy that takes into account the notification of additional information provided to the EC, D_{NA} that is a dummy variable that accounts for the announcements of NAPs Approval, D_{NR} that is the dummy that takes into account the rejection of NAPs, D_{V2008}, that is the dummy that considers the verification of real emissions in the EU ETS for the year 2008, D_{V2009} that considers the verification of real emissions for the year 2009, D_{V2010} for the year 2010 and D_{V2011} for the year 2011. Based on the AIC criterion, in this version of the model the dummy related to the rejection of NAPs is considered lagged 3 periods. This is in fact in line with the result of the truncated mean model.

The results for this model (Table 5) indicate that the variables regarding the notification of NAPs, additional information and acceptance of NAPs are non-significant in accordance with our analysis in the truncated mean model. Instead the variable regarding the rejection of amendments by the EC is significant and negative three days prior to the date of the formal rejection. This is in accordance to our truncated mean model results and underlines the fact that the information arrives to the market prior to the formal announcement, provoking an immediate reaction. We have also disaggregated the announcements regarding the verification of emissions and the results are in perfect accordance with our results in the truncated mean model both in terms of sign and significance, that is the announcements of real emissions for the year 2008 are statistically significant and negative, while the announcement of real emissions for the year 2009 are statistically significant and positive. Additionally, this model indicates that the announcement of verification of real emissions of the year 2010 and 2011 is negative and statistically significant indicating that the real emissions have been lower than expected and thus the prices adjust to this new information. Finally, a statistically significant and negative impact of announcements regarding the auctions regulation and the introduction of the aviation sector is also in line with the results obtained by the truncated mean model.

4. CONCLUSIONS

In this paper we have studied the fundamentals for Phase II EUA prices considering both demand and supply factors, with a particular emphasis on the EC announcements regarding the organisation of both Phase II and Phase III of the EU ETS. Our results are especially relevant as we are considering the particularities of this market in which, differently from most asset markets, the market regulator decides the market supply. Consequently, they are interesting not only for academics but also for market participants and especially for the regulator (the EC).

Using two different methodologies (a truncated mean model first proposed by Mansanet-Bataller and Pardo, 2009 and a regression approach) we find strong significance of EC announcements, in particular regarding the Phase II NAPs announcements and the global cap for Phase III. These results are in line with the specificities of this market and its regulation. Since the EC decided to

allow banking between Phase II and Phase III of the EU ETS, both allowances depend on the same fundamentals and thus, announcements regarding Phase III of the EU ETS affect Phase II prices.

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APPENDIX A

Table A.1: Announcements dates and dummies classification

Date	Description	D_{NOT}	D_{NAI}	D_{NA}	D_{NR}	D_{NT}	D_{V2008}	D_{V2009}	D_{V2010}	D_{V2011}	D_{VT}	D_{AR}	D_C	Dav
30-Jun-06	German Phase II NAP Notified	1				1								
07-Jul-06	Lithuania Phase II NAP Notified	1				1								
12-Jul-06	Ireland Phase II NAP Notified & Estonia Phase II NAP Notified	1				1								
18-Jul-06	Luxembourg Phase II NAP Notified	1				1								
16-Aug-06	Latvia Phase II NAP Notified	1				1								
18-Aug-06	Slovakia Phase II NAP Notified	1				1								
28-Aug-06	UK Phase II NAP Notified	1				1								
01-Sep-06	Sweden and Greece Phase II NAP Notified	1				1								
12-Sep-06	Aditional Information Lithuania		1			1								
18-Sep-06	Aditional Information Ireland		1			1								
22-Sep-06	Aditional Information Germany		1			1								
26-Sep-06	France Phase II NAP Notified	1				1								
27-Sep-06	Malta Phase II NAP Notified	1				1								
28-Sep-06	The Netherlands Phase II NAP Notified	1				1								
29-Sep-06	Belgium Phase II NAP Notified	1				1								
03-Oct-06	Aditional Information UK		1			1								
11-Oct-06	Cyprus Phase II NAP Notified	1				1								
13-Oct-06	Aditional Information The Netherlands		1			1								
19-Oct-06	Aditional Information Slovakia and The Netherlands		1			1								
20-Oct-06	Aditional Information Luxembourg		1			1								
26-Oct-06	Finland Phase II NAP Notified	1				1								
27-Oct-06	Aditional Information France		1			1								
30-Oct-06	Portugal Phase II NAP Notified	1				1								
02-Nov-06	Slovenia Phase II NAP Notified	1				1								
06-Nov-06	Aditional Information UK and Luxembourg		1			1								
07-Nov-06	Estonia Notification II Aditional Information		1			1								
08-Nov-06	Aditional Information Latvia		1			1								
10-Nov-06	Aditional Information Sweden		1			1								
14-Nov-06	Aditional Information Greece		1			1								
16-Nov-06	Aditional Information Latvia		1			1								
22-Nov-06	Aditional Information Lithuania		1			1								
23-Nov-06	Aditional Information Malta		1			1								
29-Nov-06	Germany, Greece, Ireland, Latvia, Lithuania, Luxembourg, Malta, Slovak Republic, Sweden, UK Approval (w/ required changes) NAPs II				1	1								
30-Nov-06	Spanish Phase II NAP Notified	1				1								
08-Dec-06	Czech Republic Phase II NAP Notified	1				1								
12-Dec-06	Aditional Information Cyprus		1			1								
13-Dec-06	Aditional Information Belgium		1			1								
15-Dec-06	Aditional Information The Netherlands and Notification Italy	1	1			1								
18-Dec-06	Aditional Information Cyprus AI		1			1								
20-Dec-06	Proposition aviation EU ETS													1
21-Dec-06	Sweden Amendment Propossal Phase II and Romania Notification		1			1								
22-Dec-06	Aditional Information Belgium		1			1								
29-Dec-06	Lithuania, Slovakia Amendment Propossal, France AI		1			1								
08-Jan-07	Aditional Information Slovenian		1			1								
10-Jan-07	Global CAP												1	
12-Jan-07	Aditional Information Cyprus		1			1								
15-Jan-07	Austria Phase II NAP Notification	1				1								
16-Jan-07	Belgium and the Netherlands Approval NAPs II				1	1								
17-Jan-07	Aditional Information France		1			1								
23-Jan-07	Hungary Phase II NAP Notification	1				1								
29-Jan-07	Aditional Information Finland and Slovenia		1			1								

Date	Description	D_NOT	D_NAI	D_NA	D_NR	D_NT	D_V2008	D_V2009	D_V2010	D_V2011	D_VT	D_AR	D_C	Dav
01-Feb-07	Aditional Information Spain		1			1								
05-Feb-07	Slovenia Phase II NAP Approval			1		1								
16-Feb-07	Aditional Information Czech Republic		1			1								
22-Feb-07	Aditional Information Spain		1			1								
26-Feb-07	Spain Phase II NAP Approval			1		1								
27-Feb-07	Aditional Information Cyprus		1			1								
01-Mar-07	Aditional Information Italy		1			1								
05-Mar-07	Aditional Information Austria		1			1								
07-Mar-07	Denmark Phase II NAP Notification	1				1								
13-Mar-07	Aditional Information France		1			1								
15-Mar-07	Aditional Information France		1			1								
21-Mar-07	Aditional Information Austria		1			1								
22-Mar-07	Aditional Information Cyprus		1			1								
23-Mar-07	Aditional Information Italy		1			1								
26-Mar-07	Poland, France and Czech Republic Phase II NAP Approval (w/ changes required)			1		1								
02-Apr-07	Austria Phase II NAP Approval and Aditional Information Hungary			1		1								
04-Apr-07	Aditional Information Poland		1			1								
16-Apr-07	Hungaria Phase II NAP Approval			1		1								
18-Apr-07	Lithuania Additional information amendment		1			1								
02-May-07	Aditional Information Denmark		1			1								
04-May-07	Estonia NAP II Rejected (allowances allocated individually for installation)				1	1								
08-May-07	Aditional Information Denmark		1			1								
15-May-07	Italian Phase II NAP Approval			1		1								
04-Jun-07	Finland NAP II Approval (w/ changes required)			1		1								
13-Jul-07	Lithuania NAP II Ammendements Rejection & Sweden NAP II Rejection Amendments				1	1								
18-Jul-07	Cyprus NAP II Aproval			1		1								
02-Aug-07	Aditional Information Portugal		1			1								
06-Aug-07	Aditional Information Bulgaria, Portugal and Romania		1			1								
17-Aug-07	Aditional Information Bulgaria		1			1								
31-Aug-07	Denmark NAP II Aproval			1		1								
07-Sep-07	Aditional Information Portugal		1			1								
19-Sep-07	Aditional Information Slovakia		1			1								
18-Oct-07	Portugal Phase II NAP Aproval			1		1								
22-Oct-07	Portugal Phase II NAP Notified													
26-Oct-07	Bulgaria and Romania Aproval			1		1								
07-Dec-07	Slovakia NAP II Amendment Approval			1		1								
08-Jul-08	Vote EU parlement on aviation ETS													1
10-Oct-08	Directive of the council Inclusion of aviation													1
24-Oct-08	Inclusion of aviation in the EU ETS													1
05-Mar-09	Poland Phase II NAP Notified	1				1								
15-May-09	Verified Emissions						1				1			
04-Jun-09	Public consultation auctioning launched											1		
11-Dec-09	Estonia and Poland NAP II rejected				1	1								
01-Apr-10	80% Verified emissions 2009							1			1			
08-Apr-10	Aditional Information Poland		1			1								
19-Apr-10	Poland NAP II Aproval			1		1								
14-Jul-10	Member States back Commission proposed rules for auctioning of allowances											1		
21-Sep-10	Debate on aviation activities in the EU ETS													1
22-Oct-10	Cap Phase III adopted by the commission												1	
12-Nov-10	Auctioning Regulation Phase III											1		

Date	Description	D_{NOT}	D_{NAI}	D_{NA}	D_{NR}	D_{NT}	D_{V2008}	D_{V2009}	D_{V2010}	D_{V2011}	D_{VT}	D_{AR}	D_C	Dav
08-Feb-11	Estonia revised NAP Phase II Notified	1				1								
21-Feb-11	Common platform for auctioning carbon allowances in the third phase of the EU Emissions Trading System											1		
07-Mar-11	Inclusion of aviation in the EU ETS: Commission publishes historical emissions data on which allocations will be based													1
01-Apr-11	Release of verified data and compliance data on emissions from EU ETS installations for the year 2010								1		1			
06-Apr-11	Implementation aviation emission legislation by Member States. EC urges MS													1
20-Apr-11	Inclusion into the EEA agreement of the EU ETS on aviation: Commission publishes an EEA-wide list of operators													1
29-Apr-11	Estonia's revised NAP II rejected				1	1								
30-May-11	Carbon emissions "at their highest ever levels in history", according to estimates from the International Energy Agency													
13-Jul-11	Member States agree to auction 120 million phase 3 allowances in 2012											1		
05-Sep-11	Estonia NAP II Notified last version	1				1								
26-Sep-11	European Commission sets the rules for allocation of free emissions allowances to airlines													1
06-Oct-11	Aviation into the EU ETS: Connie Hedegaard "glad to see that the EU Directive is fully compatible with international law"													1
05-Dec-11	Estonia NAP II aproval			1		1								
30-Jan-12	Single EU Registry activated for aircraft operators													1
22-Mar-12	Germany notifies opt-out auction platform											1		
25-Apr-12	Member States approve listing of Germany's first phase 3 auction platform											1		
15-May-12	Verified Emissions (decline in 2011)									1	1			
11-Jul-12	Member States approve listing of the UK's phase 3 auction platform											1		
25-Jul-12	Commission prepares for change of the timing for auctions of emission allowances & Announcement of retirement of permits to auction from 2013-2020 & Change of Schedulle Auctions Phase III											1		
10-Sep-12	Commission appoints European Energy Exchange AG (EEX) as first common auction platform											1		
28-Sep-12	Preliminary auction calendars for 2012 determined											1		
30-Oct-12	2012 auction calendars fixed for the transitional common auction platform											1		

Note that DNot is the dummy related to the notification of Phase II NAPs to the EC, DNAI is the dummy that takes into account the notification of additional information provided to the EC, DNA is a dummy variable that accounts for the announcements of NAPs Approval, DNR is the dummy that takes into account the rejection of NAPs, DNT is the dummy accounting for all events regarding Phase II NAPs, DVT is the dummy variable that takes into account all the verification of the real emissions of the installations under the EU ETS, DV2008, is the dummy that considers the verification of real emissions in the EU ETS for the year 2008, DV2009 the verification of real emissions for the year 2009, DV2010 for the year 2010 and DV2011 for the year 2011, DC is the dummy variable that accounts for the announcements regarding the total cap for Phase III, DAR is the dummy that captures the announcements regarding the auction regulation, DAv is the dummy that captures all announcements regarding the organization of the aviation ETS system.

Table A.2: NAP announcements by country

Country	Notification	Aditional Information	Aproval	Rejection
Austria	15-01-07	05-03-07 21-03-07	02-04-07	
Belgium	29-09-06	13-12-06 22-12-06	16-01-07	
Bulgaria	21-12-06	05-08-07 17-08-07	26-10-07	
Cyprus	11-10-06	12-12-06 18-12-06 01-12-07 27-02-07 22-05-07	18-07-07	
Czech Republic	08-12-06	16-02-07	26-03-07	
Denmark	07-03-07	02-05-07 08-05-07	31-08-07	
Estonia	12-07-06	07-11-06 08-02-11 05-09-11	05-12-11	04-05-07 11-12-09 29-04-11
Finland	26-10-06	29-01-07	04-06-07	
France	28-09-06	27-10-06 29-12-06 17-01-07 13-05-07 15-05-07	26-03-07	
Germany	30-06-06	22-09-06	29-11-06	
Greece	01-09-06	14-11-06	29-11-06	
Hungary	23-01-07	02-04-07	16-04-07	
Ireland	12-07-06	18-09-06	29-11-06	
Italy	15-12-06	01-03-07 23-03-07	15-05-07	
Latvia	16-08-06	08-11-06 16-11-06	29-11-06	
Lithuania	07-07-06	12-09-06 22-11-06 29-12-06 18-04-07	29-11-06	13-07-07
Luxembourg	18-07-06	20-10-06 06-11-06	29-11-06	
Malta	27-09-06	23-11-06	29-11-06	
Netherlands	28-09-06	13-10-06 19-10-06 15-12-06	16-01-07	
Poland	05-03-09	08-04-10	26-03-07 19-04-10	11-12-09
Portugal	30-10-06	04-04-07 08-02-07 04-05-07 01-08-07 06-08-07 07-09-07	18-10-07	
Romania	21-12-06	08-05-07 06-08-07	26-10-07	
Slovakia	18-08-06	19-10-06 29-12-06 19-09-07	29-11-06 07-12-07	
Slovenia	02-11-06	08-01-07	05-02-07	
Spain	30-11-06	22-02-07 10-11-06	26-02-07	
Sweden	01-09-06	21-12-06	29-11-06	13-07-07
United Kindom	28-08-06	03-10-06 06-11-06	29-11-06	