Information Assimilation in the EU Emissions Trading Scheme: A Microstructure Study

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Questions

- Do order imbalance and returns respond to announcements in a way that correctly reflects the news component?
- Is there an increase in information asymmetry subsequent to announcements?
- Is there information leakage evident in the EUA market?
- What is the speed of adjustment?

Future symbol	CFI2Z9	CFI2Z0	CFI2Z1
Start date	2009-Jan-02	2010-Jan-04	2011-Jan-04
End date	2009-Dec-14	2010-Dec-20	2009-Dec-19
No. of trading days	243	247	246
Open Price	15.90	12.71	14.84
High Price	25.50	16.73	18.18
Low Price	8.05	12.25	6.30
Close Price	14.61	13.93	7.00
No. of Ticks	281605	261048	304862
Mean No. of Ticks per Day	1159	1057	1239
Mean Duration per Tick	64	34	31
Volume	1398540	2022053	2510464
Mean Volumne per Tick	4.9663	7.7459	8.2348
Volatility	1.6376	1.0177	2.8986
Average Bid-Ask Spread	0.0334	0.0204	0.0223

Table 1.1 Summary statistics for EUA futures

Source: European Climate Exchange.

Figure 1.1 Equidistant 1-minute prices of EUA futures



Figure 1.2 Equidistant 1-minute returns of EUA futures



Equidistant 1–Minute Return

Figure 1.3 Equidistant 1-minute volume of EUA futures



Figure 1.4 Equidistant 1-minute bid-ask spread of EUA futures



Figure 1.5 Equidistant 1-minute no. of ticks of EUA futures



Table 2.1 Brief description of macroeconomic announcements

Release Time Frequency Source Future Economic Outlook DE Ifo index CESinfo Monthly 10:00 AM DE ZEW index ZEW Monthly 11:00 AM EU consumer confidence index DG ECFIN Monthly 4:00 PM Reuters/U. of Michigan US U. Michigan index adv. Monthly 2:55 PM Monthly EU new orders Eurostat 11:00 AM CES 2:30 PM US nonfarm payrolls Monthly Current Economic Activity DE industrial production Eurostat Monthly 12:00 PM EU industrial production Eurostat Monthly 11:00 AM FR industrial production Eurostat Monthly 8:45 AM National Statistics GB industrial production Monthly 10:30 AM US ISM manufacturing PMI ISM Monthly 4:00 PM **GB** Manufacture **PMI** Markit Monthly 10:30 AM

Macroeconomic News Announcements

- Methodology:
- Following Balduzzi (2001), we [1] regress the changes of trade variables on the the announcements for different time relative to the release of the news, and [2] calculate the ratio of trade variables on announcement days to non-announcement days. Our trade variables include: prices, volumes, bid-ask spreads, and no. of ticks. [3] We also intuitively illustrate the market's responsiveness to announcements.
- Our news is defined as the standardised surprise of macroeconomic announcements:

$$S_{it} = (news_{it} - forecast_{it}) / \sigma_i$$

Price Change: $(P_t^{\tau} - P_t^{-5}) / P_t^{-5} = \beta_{0,i}^{\tau} + \beta_{1,i}^{\tau} S_{it} + e_{it}$

Table 2.2 Price change to macroeconomic news

	Minutes from Announcements												
	-2	-1	0	1	2	3	4	5	10	15	20	25	30
DE Ifo	-3.78	5.98	-2.19	3.42	6.68	1.82	4.05	0.38	1.69	-7.74	-4.05	-11.59	-10.71
	0.5315	0.6628	0.9028	0.8124	0.5600	0.8805	0.7405	0.9794	0.9232	0.5287	0.7340	0.3075	0.4540
DE ZEW	2.87	1.55	2.96	9.09	0.67	-0.45	0.08	0.10	16.38	7.79	1.77	18.21	5.95
	0.6970	0.8691	0.7169	0.4130	0.9384	0.9566	0.9922	0.9909	0.2314	0.4509	0.8713	0.3569	0.6324
EU CCI	-1.92	-12.66	-8.92	-6.91**	-8.61**	-20.71*	-9.50**	-8.15	-12.24	-12.44	-9.93	-5.60	-29.29***
	0.3547	0.1620	0.3247	0.0446	0.034	0.0601	0.0206	0.5294	0.1484	0.0206	0.1629	0.6603	0.0098
US UMI	7.96	13.10	9.26	10.54	18.66**	5.74	11.56	10.80	14.11	8.30	10.38	-1.18	9.45
	0.1954	0.1010	0.2827	0.2229	0.0405	0.6162	0.2626	0.2998	0.2269	0.5774	0.4892	0.9342	0.4918
EU NO	3.45	4.26	4.86	3.63	3.63	4.90	5.29	4.35	-1.31	3.49	-0.37	-0.31	-0.85
	0.6908	0.5864	0.5517	0.6638	0.6762	0.5695	0.6605	0.7203	0.8931	0.7863	0.9777	0.983	0.9499
US NFP	1.59	7.09	1.15	-0.30	3.16	-0.14	-2.49	-0.11	4.37	-2.12	-4.12	16.39	-3.88
	0.5169	0.4051	0.7808	0.9410	0.6208	0.9762	0.5825	0.9753	0.3017	0.6770	0.6712	0.0695	0.6873
EU IP	4.11^{*}	4.04	3.80	5.07*	6.49	22.41^{**}	26.72^{**}	30.85^{**}	24.26*	22.27*	19.18^{*}	21.92^*	18.15
	0.0651	0.1290	0.1389	0.0984	0.3642	0.0307	0.0131	0.0195	0.0504	0.0670	0.0866	0.0662	0.1447
DE IP	-17.08*	-16.46*	-17.32*	-19.67**	-19.60**	-22.14^{**}	-18.25*	-21.50**	-21.66^{**}	-10.87	-18.90*	-7.51	-9.11
	0.0810	0.0942	0.0732	0.0478	0.0488	0.0214	0.0503	0.0277	0.0314	0.3346	0.0563	0.3662	0.3035
FR IP	-0.57	-4.47	-4.05	-7.07	-9.32	-9.26*	-11.35*	-10.64*	-12.44^{**}	-14.04^{**}	-7.71	-11.07	-14.5
	0.8719	0.2524	0.2856	0.2642	0.1039	0.0947	0.0505	0.0625	0.0345	0.0485	0.2646	0.2763	0.1706
GB IP	-3.99	-4.75	1.91	-2.87	-5.34*	1.59	-3.38	-3.66	-3.02	0.74	0.17	1.00	0.97
	0.2133	0.1299	0.7341	0.6448	0.0864	0.7973	0.3527	0.2220	0.5502	0.9128	0.9826	0.8885	0.8864
US PMI	5.53	8.28	6.90	6.76	7.09	3.34	4.23	4.60	16.34	2.39	16.38	5.09	9.73
	0.3900	0.3524	0.3390	0.3261	0.4432	0.7783	0.5774	0.6323	0.2989	0.7926	0.2001	0.6496	0.5592
GB PMI	5.45	-1.03	-1.20	-2.67	-2.94	4.03	4.35	4.35	-2.92	7.64	11.27	2.03	-0.85
	0.2474	0.5397	0.5081	0.3013	0.1873	0.5838	0.4497	0.3269	0.7528	0.2206	0.2113	0.8244	0.9151

Notes. With regard to each macroeconomic announcement, the first line reports the coefficients for corresponding τ , and the second line reports the P-values.

*, **, *** represent statistical significance that the coefficient is significantly different from zero at 90%, 95% and 99% confidence level respectively.

• Price Change:

$$sqret_{i}^{\tau} = \left(\frac{1}{T_{a}}\sum_{t_{a}=1}^{T_{a}} sqret_{it_{a}}^{\tau}\right) / \left(\frac{1}{T_{na}}\sum_{t_{na}=1}^{T_{na}} sqret_{it_{na}}^{\tau}\right)$$

Table 2.3 Ratio of mean square returns of announcement to non-announcement days

	Minutes from Announcements (τ)							
			114105 110		meenionio	(1)		
	-30 to -5	-5 to 0	0	0 to 5	5 to 15	15 to 30	30 to 60	
DE Ifo	0.8974	0.5786	3.0192	1.7119	0.7123	0.7284	1.2247	
DE ZEW	1.1731	0.6795	0.4155	0.3755	0.7061	1.0750	1.2895	
EU CCI	1.7021	2.9924	2.1883	1.8192	1.5980	1.8898	1.1340	
US UMI	1.0023	0.3774	0.5851	0.6279	0.6380	0.5448	0.8990	
EU NO	0.7025	1.2540	0.3104	0.3101	1.1594	2.7046	0.7967	
US NFP	1.6825	0.5543	1.8462	0.7436	0.7704	0.9287	0.7964	
EU IP	1.8193	1.1758	0.0420	0.9095	0.8523	1.4166	0.6722	
DE IP	0.9170	2.5319	0.0055	0.0878	1.0227	0.6425	0.6675	
FR IP	0.2526	0.0740	0.1271	0.2220	0.3975	0.5945	1.4258	
GB IP	1.0366	0.9414	0.0188	2.0521	1.2407	1.0843	1.4406	
US PMI	1.3831	0.5646	0.4716	0.7896	1.8317	1.3098	1.7833	
GB PMI	0.5583	0.4239	1.0927	0.4299	0.4794	0.5998	0.6533	

• Volume:

$$volume_{i}^{\tau} = \left(\frac{1}{T_{a}}\sum_{t_{a}=1}^{T_{a}} volume_{it_{a}}^{\tau}\right) / \left(\frac{1}{T_{na}}\sum_{t_{na}=1}^{T_{na}} volume_{it_{na}}^{\tau}\right)$$

Table 2.4 Ratio of mean volume of announcement to non-announcement days

	Minutes from Announcements (τ)							
	-30 to -5	-5 to 0	0	0 to 5	5 to 15	15 to 30	30 to 60	
DE Ifo	0.9052	1.5339	1.4499	1.0649	0.9710	1.0313	1.3791	
DE ZEW	1.1680	1.4441	2.2153	0.7944	1.8075	1.4893	1.3684	
EU CCI	0.9452	0.9574	1.6609	1.2668	1.0818	1.0828	1.0893	
US UMI	0.8470	0.4722	2.7527	0.7654	0.6537	0.7257	0.8075	
EU NO	1.0107	1.3341	1.5998	1.5912	0.8633	1.2787	0.8441	
US NFP	1.0630	1.0918	1.0085	0.3066	0.6970	0.8639	0.9584	
EU IP	1.3520	1.3413	1.3640	1.1843	1.9330	1.0748	1.1614	
DE IP	1.1902	1.0909	0.0000	0.4844	1.4981	1.1091	1.0255	
FR IP	0.7644	0.7550	1.1885	0.7958	0.5827	0.7502	1.0325	
GB IP	1.1464	1.2589	0.0000	1.0371	0.9127	0.7034	1.1505	
US PMI	0.7042	1.5804	0.8427	1.0433	0.7438	0.5763	0.9084	
GB PMI	0.5462	0.3468	0.0000	0.8909	0.4172	0.5880	1.0695	

• Bid-ask spread:

$$BAspread_{i}^{\tau} = \left(\frac{1}{T_{a}}\sum_{t_{a}=1}^{T_{a}}BAspread_{it_{a}}^{\tau}\right) / \left(\frac{1}{T_{na}}\sum_{t_{na}=1}^{T_{na}}BAspread_{it_{na}}^{\tau}\right)$$

Table 2.5 Ratio of mean bid-ask spread of announcement to non-announcement days

	Minutes from Announcements (τ)								
	-30 to -5	-5 to 0	0	0 to 5	5 to 15	15 to 30	30 to 60		
DE Ifo	1.0411	0.9814	1.0346	1.0955	1.1212	1.0954	1.1280		
DE ZEW	0.9489	0.9498	1.0569	0.9771	1.0049	0.9600	0.9669		
EU CCI	1.0430	1.0164	0.9510	1.0284	0.9692	1.0599	0.9555		
US UMI	0.9989	0.9833	0.9625	0.9558	0.9543	0.9903	0.9527		
EU NO	1.0433	0.9526	1.0192	0.9525	0.9537	1.0420	1.0614		
US NFP	1.0764	1.2033	1.0425	1.0918	1.1134	1.1412	1.0784		
EU IP	1.0175	1.0031	1.1698	1.1213	1.0863	1.0323	0.9428		
DE IP	1.1297	1.1341	1.1597	1.0214	0.9927	0.9023	1.0839		
FR IP	1.0181	0.9697	0.9025	0.9203	0.9465	1.0169	0.9870		
GB IP	1.0131	1.0549	1.1466	1.0412	0.9625	1.0157	1.1015		
US PMI	0.9473	0.9120	0.8848	0.9839	1.0305	1.1060	1.0353		
GB PMI	1.0598	1.1609	1.1899	1.0434	1.0764	1.0051	0.9746		

• No. of ticks:

$$nTicks_{i}^{\tau} = \left(\frac{1}{T_{a}}\sum_{t_{a}=1}^{T_{a}} nTicks_{it_{a}}^{\tau}\right) / \left(\frac{1}{T_{na}}\sum_{t_{na}=1}^{T_{na}} nTicks_{it_{na}}^{\tau}\right)$$

Table 2.6 Ratio of mean bid-ask spread of announcement to non-announcement days

	Minutes from Announcements (τ)								
	-30 to -5	-5 to 0	0	0 to 5	5 to 15	15 to 30	30 to 60		
DE Ifo	0.9501	1.0970	1.0232	1.0099	1.0318	0.9506	1.1276		
DE ZEW	1.1944	1.2734	1.5869	0.9471	1.3658	1.1863	1.1378		
EU CCI	1.0217	1.0427	1.8803	1.3200	0.9631	0.9810	1.0287		
US UMI	0.9573	0.8608	1.9009	1.1859	0.7765	0.8195	0.8683		
EU NO	0.9403	1.1115	2.0492	1.2062	0.9041	1.1248	0.8712		
US NFP	1.0645	0.8412	0.9841	0.5492	0.8222	0.9330	0.8012		
EU IP	1.1099	0.92733	1.138	1.3937	1.1292	0.9635	1.1091		
DE IP	0.9795	1.2136	0.4128	0.8686	1.1044	0.8843	0.9947		
FR IP	0.9175	0.8048	1.0296	0.8481	0.6959	0.8167	0.9960		
GB IP	1.1127	1.1232	1.2163	1.1763	1.2313	0.8246	0.9927		
US PMI	0.8506	1.1948	0.8518	0.9878	0.9588	0.9021	0.9683		
GB PMI	0.7330	0.5833	1.3310	0.9288	0.5459	0.6711	0.9664		

• We follow Schmidt and Werner (2011) and examine the EUA futures movements in respond to verified emission announcements.

Table 2.7 Brief description of verified emission announcements

Verified Emission Announcements

	Year	Date	Time
Announcement Type			
access to installation-level 2010 verified emissions	2011	4/1/11	12:00:00
access to installation-level 2009 verified emissions	2010	4/1/10	12:00:00
access to installation-level 2008 verified emissions	2009	4/1/09	12:00:00

Notes. Among others, installation-level verified emissions are the first being publicly accessed, based on which data on the sector and national level can be calculated. Therefore we focus on this type of announcements.

Figure 2.1 Volatility responsiveness to verified emission announcements



Figure 2.2 Volume responsiveness to verified emission announcements



Figure 2.3 Bid-ask spread responsiveness to verified emission announcements



Figure 2.4 No. of ticks responsiveness to verified emission announcements



• Similarly to previous findings, we also find intraday seasonality evident in the EUA futures market.

Figure 3.1 Intraday seasonality of one-minute absolute return



Figure 3.2 Intraday seasonality of one-minute volume



Figure 3.3 Intraday seasonality of one-minute bid-ask spread



Figure 3.4 Intraday seasonality of one-minute no. of ticks



• To adjust for intraday seasonality, we employ the deterministic function of the time of the day suggested by Tsay (2005).

$$x_{i} = \frac{z_{i}}{f(t_{i})}$$

$$O(t_{i}) = \begin{cases} t_{i} - 34200 \\ 0 \\ 0 \end{cases}$$

$$C(t_{i}) = \begin{cases} 57600 - t_{i} \\ 0 \\ 0 \end{cases}$$

$$O(t_{i}) = O(t_{i}) / 10000$$

$$C(t_{i}) = C(t_{i}) / 10000$$

$$\ln(z_i) = \beta_0 + \beta_1 o(t_i) + \beta_2 c(t_i) + e_i$$
$$\hat{e}_i = \ln(z_i) - \hat{\beta}_0 - \hat{\beta}_1 o(t_i) - \hat{\beta}_2 c(t_i)$$
$$\hat{x}_i = e^{\hat{e}_i}$$



Figure 3.5 Intraday seasonality of volume & filtered volume

• However, Tsay's method is not applicable to filter the number of ticks, and it is less desirable to absolute returns and bid-ask spread. We follow Martens et al. (2002):

$$x_{t,k} = \frac{Z_{t,k}}{f_k}$$

• Using filtered trading variables, we get the similar results.

Conclusion

• We found that:

- information asymmetry increases in response to announcements;
- there is evidence of information leakages in the EUA futures market;
- the speed of adjustment to new information varies in terms of the type of information, but generally does not exceed the 90 minutes window around release;
- trading variables respond to some announcements in the opposite direction as we expect;
- Our findings are compared to those of Balduzzi et al. (2001) and of Conrad et al. (2012). We found similar patterns in EU ETS market to well-established markets studied by Balduzzi et al. (2001), however, less significantly and consistently. We came up with different conclusions from Conrad et al. (2012) in that adjustment directions might not be all consistent, as well as evidence of information leakage in EU ETS market.

Thank you.