

LIQUIDITY AND PRICE DISCOVERY IN THE EUROPEAN CO₂ FUTURES MARKET: AN INTRADAY ANALYSIS

Eva Benz
Jördis Hengelbrock

Bonn Graduate School of Economics

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Background

Since January 2005: European Union Greenhouse Gas Emission Trading Scheme (EU-ETS)

- ▶ Market based cap-and-trade system to achieve goals specified by Kyoto Protocol in cost-effective way
- ▶ Trading on firm level as specified by National Allocation Plans
- ▶ End of pilot phase (2005-2007)
- ▶ Beginning of first commitment period CP I (2008-2012)
- ▶ Summit in Bali: Prolongation until 2020

Background

Market

- ▶ Asset: European Union Allowances (EUAs), delivering right to emit one tonne of CO₂ equivalent GHG
- ▶ Trading: Bilateral, OTC, electronic limit order exchanges
- ▶ Market participants: obliged industries, brokers and banks
- ▶ Instruments: Spot contracts and derivatives

Related Literature

- ▶ Analyses of spot market: MANSANET-BATALLER ET AL. (2007), SEIFERT ET AL. (2008), BENZ & TRÜCK (2008)
- ▶ Price discovery on spot and futures markets: UHRIG-HOMBURG AND WAGNER (2007), DASKALAKIS ET AL. (2008), MILUNOVICH & JOYEUX (2007)

So far, there is no analysis ...

- ... using high frequency data
- ... comparing different trading platforms
- ... covering the whole pilot phase

Outline

Introduction

Institutional Background and Descriptive Statistics

Spread Analysis

Price Discovery

Conclusions

Institutional Background - Exchanges

- ▶ Five trading exchanges (**ECX**, **Nord Pool**, Powernext, EEX, EXAA)
- ▶ Annual trading volume (with OTC)

Year	Spot [Mio t CO ₂]	Futures [Mio t CO ₂]
2005	10.25	110.82
2006	49.53	508.29
2007	60.26	1 062.42

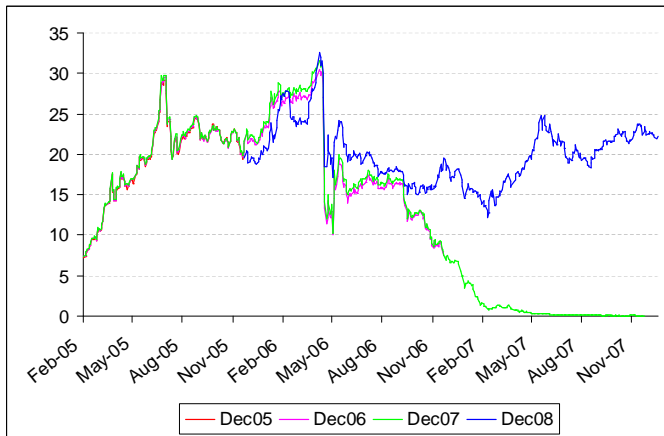
⇒ Analysis of futures market more relevant

Year	ECX		Nord Pool	
	Mio t CO ₂	Mio Euro	Mio t CO ₂	Mio Euro
2005	32.17	729	9.72	205
2006	150.04	2,834	11.55	209
2007	338.82	5,802	21.73	390

Institutional Background - Contracts

- ▶ Monthly, quarterly and annual standardized futures/forward contracts
- ▶ One contract (lot) corresponds to 1,000 EUAs (right to emit 1,000 tonnes of CO₂ equivalent)
- ▶ Minimum tick size EUR 0.01 per tonne of CO₂ equivalent
- ▶ Physical settlement, pilot phase certificates may only be used in pilot phase
- ▶ Anonymous open limit order book, continuous trading, existence of market makers

Market Development - Futures Prices in Pilot Phase



Spread Analysis

Bid-Ask Spread

- ▶ Spread = $p_t^{ask} - p_t^{bid}$
- ▶ Paid by liquidity demanders to liquidity providers
- ▶ Emergence of bid-ask spread due to ...
 - ... order processing costs
 - ... inventory costs
 - ... asymmetric information costs
- ▶ Problem: No quote data available

Trade Indicator Model

- ▶ Solution: Use trade indicator model that estimates traded spreads making use of trade initiation variable
- ▶ Apply model of MADHAVAN ET AL. (1997)
- ▶ Model of short-run price dynamics that decomposes spread into asymmetric information and transitory component
- ▶ Value and price processes adjusted for (non)-information costs borne by liquidity providers

Trade Indicator Model - Estimation

- ▶ Estimation equation:

$$p_t - p_{t-1} = (\phi + \theta)x_t - (\phi + \rho\theta)x_{t-1} + u_t, \quad (1)$$

where $u_t = \epsilon_t + \xi_t - \xi_{t-1}$

ϕ = Transitory spread component

θ = Asymmetric information component

- ▶ Estimate equation (1) by GMM
- ▶ Use definition of autocorrelation $\rho = E[x_t x_{t-1}] / E[x_t^2]$ to exactly identify $\hat{\phi}$ and $\hat{\theta}$
- ▶ Exclude overnight returns
- ▶ Use common trading periods for comparisons

Spread Analysis - GMM Estimation Results

By calender quarters

Contract	Period	ECX		Nord Pool	
		$\hat{s}/2$	in %	$\hat{s}/2$	in %
Dec 05	Q2 2005	0.061	0.31	0.059	0.31
	Q3	0.077	0.34	0.093	0.40
	Q4	0.036	0.16	0.066	0.29
Dec 06	Q1 2006	0.045	0.17	0.081	0.30
	Q2	0.080	0.50	0.125	0.79
	Q3	0.036	0.22	0.059	0.36
	Q4	0.030	0.32	0.052	0.42
Dec 08	Q1 2007	0.040	0.27	0.078	0.51
	Q2	0.032	0.15	0.070	0.31
	Q3	0.022	0.11	0.061	0.30
	Q4	0.021	0.09	0.032	0.14

Results

- ▶ Contracts: spreads \downarrow i.e. liquidity \uparrow
- ▶ Exchanges: spreads(NP) $>$ spreads(ECX)
- ▶ High spreads in times of high volatility

Price Discovery (PD)

- ▶ Process of impounding new information into prices
- ▶ Methodology: VECM, building on cointegration relationship

$$\Delta p_t^{ECX} = \alpha^{ECX} + \sum_{\tau=1}^k \beta_{\tau}^{ECX} \Delta p_{t-\tau}^{ECX} + \sum_{\tau=1}^k \gamma_{\tau}^{ECX} \Delta p_{t-\tau}^{NP} + \delta^{ECX} (p_{t-1}^{ECX} - p_{t-1}^{NP}) + \epsilon_t^{ECX}$$

$$\Delta p_t^{NP} = \alpha^{NP} + \sum_{\tau=1}^k \beta_{\tau}^{NP} \Delta p_{t-\tau}^{NP} + \sum_{\tau=1}^k \gamma_{\tau}^{NP} \Delta p_{t-\tau}^{ECX} + \delta^{NP} (p_{t-1}^{ECX} - p_{t-1}^{NP}) + \epsilon_t^{NP}$$

- ▶ Assessment of price leadership using common factor weights (SCHWARZ AND SZAKMARY (1994)) and information shares (HASBROUCK (1995))

Price Discovery - Data Set

Data Preparation

- ▶ Different official trading phases and times: Common trading periods for all contracts
- ▶ Different expiration days of same contract: Price discounting
- ▶ Different trading frequencies: Synchronization of the two series
→ Matching favoring Nord Pool
- ▶ Test preconditions for VECM

Price Discovery - Estimation Results

By calender quarters

Contract		EC		CFW		Volume	
		δ^{ECX}	δ^{NP}	ECX	Nord Pool	ECX	Nord Pool
Dec05	Q2 2005	*	*	0.513	0.487	79.8	34.5
	Q3		***	0.611	0.389	171.7	42.4
	Q4	**		0.133	0.867	136.3	25.8
Dec06	Q1 2006			0.565	0.435	415.2	26.2
	Q2		***	0.785	0.215	517.2	68.3
	Q3		***	0.794	0.206	248.3	41.3
	Q4		*	0.688	0.312	313.0	34.0
Dec08	Q1 2007			0.367	0.633	675.2	38.1
	Q2		***	0.920	0.080	966.7	78.5
	Q3		***	0.929	0.071	1296.7	71.3
	Q4	*	***	0.683	0.317	1087.4	98.1

Price Discovery - Results

Results

- ▶ For Dec05 and Dec06 contracts, both markets contribute to PD; ECX is clear price leader for Dec07 and Dec08 contracts
- ▶ Quarterly results: Seasonal variation in contribution to PD

Summing Up

- ▶ Marked increase in liquidity on both exchanges, smaller transaction costs on ECX
 - ▶ Relatively high asymmetric information costs; decline during the trading day, increase in times of high volatility
 - ▶ PD is observable in the EUA futures market
 - ▶ Stronger PD on ECX (but some NP influence)
- ⇒ New carbon trader should choose ECX!
- ⇒ Nord Pool should become more active!
- ⇒ Regarding trading criteria, market seems to operate efficiently!

Continued competition in 2008/2009

- ▶ ECX launched CER futures trading in March 2008 followed by other new products and facilities
- ▶ Both exchanges introduced new market makers in 2008
- ▶ Trading hours on Nord Pool extended in November 2008
- ▶ NASDAQ OMX acquired Nord Pool Intl. AS in October 2008
- ▶ In 2008, trading volumes increased by about 30% on Nord Pool as opposed to 130% on ECX
- ▶ 6 month annual fee relief period for new members on NASDAQ OMX Commodities/Nord Pool ASA from April 2009
- ▶ ...

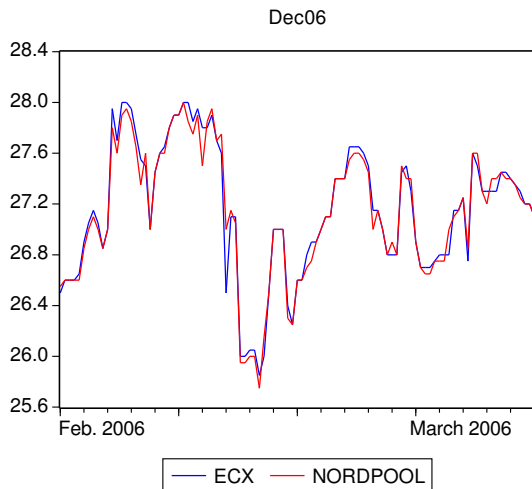
Thanks for your attention!

Price Discovery - Common Factor Weights

Common Factor Weights

Contract	EC		CFW	
	δ^{ECX}	δ^{NP}	ECX	Nord Pool
Dec05	**	**	0.593	0.407
Dec06	*	**	0.811	0.189
Dec07		**	0.830	0.170
Dec08		**	0.847	0.153

Price Discovery - Cointegration for Dec06 Contract



Price Discovery: VECM Estimation for Dec06

	ECX	Nord Pool
EC	-0.1247* (-1.68)	0.5360*** (7.20)
Δp_{t-1}^{ECX}	0.1283* (1.71)	-0.0620 (-0.82)
Δp_{t-2}^{ECX}	-0.0382 (-0.54)	-0.2215*** (-3.09)
Δp_{t-3}^{ECX}	0.0910 (1.38)	-0.1168* (-1.75)
Δp_{t-1}^{NP}	-0.0435 (-0.60)	0.1598** (2.20)
Δp_{t-2}^{NP}	-0.0175 (-0.26)	0.2568*** (3.76)
Δp_{t-3}^{NP}	-0.0668 (-1.07)	0.1933*** (3.07)
R^2	0.085	0.167
Lags included	8	8