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Trading patterns in the European carbon market: The role of trading intensity and OTC transactions

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ABSTRACT

This paper examines the effect of trading intensity and OTC transactions on expected market conditions in the early development period of the European Carbon futures market. Past duration and trading intensity are used as information related order flow variables in modelling time between transactions in two new specifications of Autocorrelation Conditional Duration (ACD) models. This allows for specific investigation of non-linear asymmetric effects on expected duration and the impact of OTC transactions. Evidence is presented of two main types of trading episodes of increased and decreased trading intensity. Both have a significant impact on price volatility, which increases further if an OTC transaction intrudes. OTC transactions also play a dual role. They slow down trading activity in the short term (over the next five transactions) but increase it substantially in the long term (over ten transactions). Both the liquidity and information price impact components increase following an OTC trade, but the information impact is greater. Price volatility calms down faster than liquidity effects following an OTC trade, and this is more pronounced in ECX and in Phase II. The combined evidence points towards increased market depth, efficiency and maturity of the trading environment.

1. Introduction

This paper investigates market depth, trading activity, liquidity, price volatility and the role of OTC transactions in the early development period of the European carbon market. Three enhanced auto-correlated duration (ACD) specifications are formulated to describe possible distinct effects of liquidity on trading dynamics of the two largest trading platforms of Carbon allowances, namely the European Climate Exchange (ECX) and Nord Pool (NP). Two of these specifications are formulated to identify high and low states, or regimes, of duration (time between trades) and of trading intensity (duration-weighted volume), and the third incorporates distinct characteristics of OTC trades. The emphases is on identifying types of liquidity trading episodes and on investigating their duration, volume, intensity, and price impact and volatility characteristics. Studying the anatomy of these episodes would allow for assessment of the markets' ability at absorbing duration and intensity shocks. Further, tracing the development of episode characteristics and the markets' ability at absorbing liquidity shocks would allow for the detection of possible differences in development and efficiency between the two main trading platforms, ECX and NP, and across their two first phases (Phase I: 2005–2007 and Phase II: 2008–2013). This would highlight the nature of the relationship between variations in liquidity and price volatility and the role of the distinct characteristics of OTC trades in trading activity in the carbon market. Specific to the latter is the question of whether high intensity and OTC trades have a distinct effect on trading activity and an impact on price volatility, which would have implications on their role in the resolution of uncertainty and pricing efficiency.

In December 1997 the vast majority of industrialised and EU countries has ratified a treaty known as "The Kyoto Protocol" aiming at the reduction of their green-house related emissions. The protocol establishes "flexibility mechanisms" for diminishing costs and achieving emission targets.[1] The European Union Emissions

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[1] For relative growth in the mechanisms see, for example, Carbon Report (2009), at www.pointcarbon.com. The three mechanisms are the Joint Implementation mechanism (JI) (under art.6), the Clean Development mechanism (CDM) (under art.12) and the Emissions Trading Scheme (ETS) (under art.17). Phase I (2005–2007) is the pilot period, Phase II (2008–2012) is the commitment period and Phase III (2013–2020) is the post commitment period for re-evaluation and further adjustments. Further information is found in Mansanet-Bataller and Pardo (2008) and IETA annual reports (2009).

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Trading Scheme (EU ETS), which is the mechanism that has been set up to achieve these objectives in Europe, has gradually gained complexity and has become the largest emissions trading scheme worldwide.[2] This futures market of emission allowances has some unique features. First, it is a truly 'cap and trade' system, where overall allowances are capped in line with emission abatement targets and applies to specific industrial sectors. The overall quantity, and consequently prices and trading activity, are, therefore, politically influenced. Second, the market is less liquid than other financial markets and prices are highly influenced by economic outlook. Third, standardised contracts are traded simultaneously in mainly two non-synchronous but overlapping markets. Finally, a non-unique feature is that both markets permit entry and registry of over-the-counter positions.[3] These features affect pricing and liquidity in various ways, of which those related to the last three features in particular are investigated in this paper.

Several studies have been conducted on the carbon market. Kruger, Oates, and Pizer (2007) and Chevallier (2009), amongst others, provide a general description of the trading mechanisms and several stylised facts. Christiansen, Arvanitakis, Tangen, and Hasselknippe (2005) and Mansanet-Bataller, Pardo, and Valor (2007), amongst others, examine price dynamics, and report strong links with the prices of related commodities. Uhrig-Homburg and Wagner (2006) and Daskalakis, Psychoyios, and Markellos (2009), amongst others, analyse political influence on market efficiency. A growing strand of literature focuses on market microstructure issues such as the intraday price formation (Benz & Hengelbrock, 2008) and intraday price leadership between alternative compliance units (Mansanet-Bataller, 2010). Some liquidity issues have also been investigated. Mizrach and Otsubo (2011), for example, report increasing liquidity with increasing price impact; Ibikunle, Gregoriou, and Pandit (2011) contends that this is not necessarily due to increased volume, and Bredin, Hyde, and Muckley (2011) suggest that it might be related to information dissemination between OTC and screen trades. In particular, although Benz and Hengelbrock (2008) and Bredin et al. (2011) take into account event time (*i.e.*, irregularly spaced events over time) duration is not yet fully investigated in EU ETS using ACD models.[4] Kalaitzoglou and Ibrahim (2012) is the exception. They model duration using a three-regime smooth transition ACD model with the main aim of identifying different groups of traders through variations in non-price related order flow variables. This paper also models event time through a combination of regime-switching and non-regime switching ACD models, but focuses instead on the identification of liquidity episodes and the investigation of their impact on prices and price volatility within different regimes of trading intensity. Further, the speed by which the markets absorb duration and intensity shocks varies across markets and phases especially when OTC trades intrude. A comparison across markets and phases of the liquidity and price characteristics of trading episodes, therefore, reveals distinct features of market development and carries implications on pricing efficiency. In addition, proper modelling of time between trades considers the informational content of transaction time and this has a variety of implications that are relevant to market and regulatory authorities, not least of which are suggestions for enhancing monitoring systems and improving market and price efficiency.[5] Better understanding of liquidity and pricing dynamics would also enhance inventory management and order submission strategies by traders and investors as a consequence of better informed management of execution, liquidity and adverse selection risks.

The remainder of this paper is organised as follows. Section 2 presents the methodology; Section 3 presents the data and a preliminary analysis; Section 4 presents a discussion of the implications of the estimation results and analyses of liquidity episodes; and Section 5 concludes.

2. Methodology

Engle and Russell (1998) propose ACD models for high frequency irregularly spaced data. They model the inter-trade interval, duration x_i, as a dependent point process, where the conditional mean, $E(x_i|x_{i-1}, \ldots, x_1)$, varies over time as a function of past durations. The ACD is formulated as:

$$x_i = \psi_i \varepsilon_i \tag{1}$$

$$\psi_i = \psi(x_{i-1}, \ldots, x_1; \varphi_1) \tag{2}$$

$$\varepsilon_i \sim i.i.d. \text{ with density } f(\varepsilon_i; \varphi_2) \tag{3}$$

where, x_i is duration, ψ_i is expected duration, ε_i is standardised duration and φ_1 and φ_2 are vectors of parameters. The general model allows for various specifications of the conditional mean, as a function of past durations. Engle and Russell use a linear ARMA(1,1) specification. The model also allows for various density functions for ε_1 (with positive support).[6] In this study, two non-linear specifications of the mean, and the exponential (E), Weibull (W) and generalised-gamma (G) distributions are used for the standardised duration.[7] The two mean specifications are presented next.

2.1. The Smooth Transition Box-Cox ACD (ST-BCACD) model

In order to account for likely non-linearity and asymmetric effects of past durations on expected durations an enhanced version of the non-linear Box-Cox ACD (BCACD) model of Dufour and

[2] In this trading mechanism, a participating state allocates a certain amount of "European Union Allowances" (EUAs) across its emitting installations. Each EUA entitles the holder to emit one tonne of CO_2 equivalent of Green House Gases (GHGs).

[3] Exchange for Physical (EFP) and Exchange for Swap (EFS) facilities are offered to OTC allowance holders in order to register their positions. Further information can be found at http://www.ecx.eu/index.php/Exchange-for-Physical-EFP.

[4] In lower frequency data, time intervals are fixed and all relevant information is either aggregated or attempts are made at synchronising it. However, in Ultra-high-frequency datasets duration varies and would have informational content. In developing the ACD framework for the proper modelling of economic time, Engle and Russell (1998) highlight the differences between economic and calendar time and the deficiencies of considering calendar time intervals in modelling economic events, especially at high frequencies.

[5] Today Viswanathan (2010) raises the importance of regulatory and monitoring issues, arguing that the driving forces of Carbon trading need to be understood and regulated to ensure viability. He argues that carbon markets need a regulatory approach that restricts manipulation while simultaneously allowing innovation to enhance liquidity. A non-regulated and non-transparent market would be liquid but inaccurate in terms of price. In contrast, strict regulation would increase price accuracy but not liquidity. Both would result in a divergence from EU ETS's initial purpose.

[6] Today Engle and Russell (1998) use the linear ARMA specification and the Exponential and Weibull distributions. This simple specification has been subsequently expanded and generalised (*e.g.*, Meitz and Teräsvirta, 2006), and more flexible density functions proposed (*e.g.*, Hujer & Vuletic, 2007).

[7] The exponential is $f(x_i|x_{i-1}, \ldots, x_1; \theta) \equiv 1/\Psi_i \cdot \exp(-x_i/\Psi_i)$, the Weibull is $f(x_i|x_{i-1}, \ldots, x_1; \theta) \equiv \gamma/\chi_i \cdot [x_i \Gamma(1+1/\gamma)/\psi_i]^{\gamma} \exp(-[x_i \Gamma(1+1/\gamma)/\psi_i]^{\gamma})$ and the generalised-gamma is $f(x_i|x_{i-1}, \ldots, x_1; \theta) \equiv \gamma/\chi_i \Gamma(\lambda) \cdot [x_i \Gamma(\lambda+1/\gamma)/\psi_i]^{\gamma\lambda} \exp(-\left[x_i \Gamma(\lambda+1/\gamma)/\psi_i \Gamma(\lambda)\right]^{\gamma})$, where $\Gamma(:)$ is the gamma function with parameters γ ($\gamma > 0$) and λ ($\lambda > 0$). These three distributions are nested. If $\lambda = 1$ the Generalised Gamma distribution reduces to the Weibull, and if $\gamma = 1$ the Weibull reduces to the Exponential.

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