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Understanding volatility dynamics in the EU-ETS market

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HIGHLIGHTS

- Phase 2 EUA price fundamentals differ before and after January 2008.
- Sharp rises in volume increased volatility during before January 2008 but not after.
- EC announcements regarding supply of EUAs increase volatility before and after January 2008.
- The previous effect is weaker from January 2008 on.
- Trade off between providing information effectively and promoting market stability.

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ABSTRACT

We study the short-term price behavior of Phase 2 EU emission allowances. We model returns and volatility dynamics, and we demonstrate that a standard ARMAX-GARCH framework is inadequate for this modeling and that the gaussianity assumption is rejected due to a number of outliers. To improve the fitness of the model, we combine the underlying price process with an additive stochastic jump process. We improve the model's performance by introducing a time-varying jump probability that is explained by two variables: the daily relative change in the volume of transactions and the European Commission's announcements regarding the supply of permits. We show that (i) sharp increases in volume have led to increased volatility during the April 2005–December 2007 period but not for the period beginning in January 2008, and (ii) announcements induce jumps in the process that tend to increase volatility across both periods. Thus, authorities face a trade off between disseminating information effectively and promoting market stability.

1. Introduction

In 2005, the European Union established a region-wide cap on emissions and created a market for pollution allowances, called the EU Emissions Trading Scheme (EU ETS). The objective of this scheme is to efficiently reduce European emissions at the EU level. In this market, installations can exchange their surpluses or deficit of allowances (called EUAs). The EU ETS has been implemented in phases: the preliminary phase (Phase 1) ran from 2005 to 2007, Phase 2 began in 2008 and finished in December 2012 and Phase 3 begun in January 2013 and will end in December 2020. Because Phase 2 was the period of the actual implementation of the Kyoto Protocol objectives, banking of allowances was not allowed between Phase 1 and Phase 2 but was allowed between Phase 2 and Phase 3. This point is particularly important; although Phase 1 and Phase 2 prices have followed completely different patterns since April 2006, Phase 2 and Phase 3 prices depend on identical fundamentals: the supply and demand factors that have an impact on the right to emit one ton of CO_2 in the EU after December 2007

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(Mansanet-Bataller and Sanin, 2014).[1] For this reason, we focus on Phase 2 and Phase 3 prices in this paper. It is notable that it has been possible since 2005 to trade futures contracts that underlie Phase 2 allowances (the right to emit one ton of CO_2 in the EU beginning in 2008). Thus, the period from April 2005 to December 2007 featured interphase trading, whereas intraphase trading was featured from January 2008 until May 31, 2013 (the end of the sample period). In this paper, we analyze the short-term price behavior of Phase 2 prices by dividing the timeline into two subsamples to distinguish between interphase and intraphase trading. To this end, we study Phase 2 prices during the EU ETS trial phase, on one hand, and we study Phase 3 prices beginning, in fact, during the actual beginning of Phase 2 in January 2008, on the other hand.

Installation-level trading began in January 2005; by the beginning of 2006, the volume of transactions had already increased by a factor of 10 (Ellerman and Joskow, 2008). The development of the EU ETS market has also been affected by the increasing market participation of intermediaries, *i.e.*, risk managers, brokers and traders, who may be trading on behalf of their clients or holding their own stock of EUAs. The market has gained both in complexity and in flexibility as intermediaries have introduced an increasing range of new instruments, such as futures, forward contracts and other derivatives. In this regard, many observers believe that the creation of the EU ETS has been a success, whereas others remain skeptical. In particular, the rules behind the price formation mechanism and the price dynamics are still unclear. While some authors support the argument that the EUA price responds to market fundamentals – such as energy prices, extreme weather conditions and economic growth (see Bunn and Fezzi, 2009; Mansanet-Bataller et al., 2007; Alberola et al., 2008; Hintermann, 2010; Creti et al., 2012) – that affect the production of CO_2 and thus demand and supply of the EUAs, others find no such evidence and favor a pure time-series approach (see Milunovich and Joyeux, 2010; Paolella and Taschini, 2008, Benz and Trück, 2009; Chesney and Taschini, 2012; Seifert et al., 2008; Chevallier et al., 2011). An adequate assessment of short-term price and volatility dynamics in the EU ETS is crucial because accurately measuring and forecasting market risk is a key factor for portfolio management and hedging to realize efficient trading strategies and to make informed investment decisions.

In order to shed light on this issue, we analyze the short term price and volatility dynamics of Phase 2 and Phase 3 allowances from April 22, 2005 to May 31, 2013 as a sole price series. We model the conditional mean and variance of returns within an ARMAX-GARCH framework. The standard approach based on the Gaussianity assumption is rejected due to the presence of a number of level and volatility outliers. Furthermore, the presence of additive outliers in the process, if not directly accounted for, typically induces bias in the parameters governing the level and variance dynamics and may result in the detection of spurious non-stationarity. Consequently, we rely on a Bernoulli mixture of Gaussian distributions (BMN) to allow for endogenously determined additive jumps in the price process. Individual distributions in the mixture can be interpreted as different regimes while the mixing law gives the probability of each regime (Alexander, 2004; Alexander and Lazar, 2006). We find that a two-regime model based on a BMN proves adequate to fit the data.

Paolella and Taschini (2008) have adopted a similar modeling strategy for Phase 1 prices. They propose a three-component mixture which identifies two different GARCH-type volatility dynamics plus a constant variance component. Although their model does not account for an additive jump component, they provide solid arguments to support the use of a mixture of distributions, including the extreme flexibility of the model, the fact that it induces time-varying skewness and kurtosis (see also Hansen, 1994; Harvey and Siddique, 1999; Rockinger and Jondeau, 2002; Brännäs and Nordman, 2003) and the accuracy of the out-of-sample VaR forecasts.[2]

An alternative approach, based on a two-regime Markov Switching model, has been proposed by Benz and Trück (2009). They argue that the occurrence of spikes in EUA prices and volatility during Phase 1 might be caused by changes in policy and the regulatory framework, such as announcements regarding the National Allocation Plans (NAPs, the document elaborated by the Member States and approved by the European Commission in which the country cap was fixed for Phase 1 and Phase 2) or fluctuations in production levels resulting from unexpected changes in market fundamentals (such as fuel prices and weather conditions). However, their hypothesis cannot be directly tested because they assume that the probability that governs the switch between the regimes is constant, which yields few economic insights.

The procedure based on the use of a GARCH-type model with mixed innovations to fit an underlying price process combined with an additive jump component has been proposed in other contexts by Vlaar and Palm (1993), Vlaar (1994) and Beine and Laurent (2003). Their approach is appealing because it provides useful insights regarding the occurrence of jumps and their economic interpretation. In this paper, the determinants and the occurrence of jumps are further investigated by allowing the probability associated with the jump component to vary over time and to depend on exogenous variables. In particular, we explicitly account for two drivers of the shifts between regimes: the daily relative change in the volume of transactions and the change in the regulatory environment that is induced by the European Commission's disclosure of information.

Our results suggest that large incoming volumes have a destabilizing effect, which translates into large negative returns and sudden volatility movements only in the preliminary phase, *i.e.*, prior to January 2008. This result is consistent with Gabaix et al. (2006) and Milunovich and Joyeux, 2010. The latter states that during the trial phase, trading in the EU ETS was concentrated among a few leading players and characterized by a low number of transactions. Our results show that from January 2008 on this characterization is no longer accurate: the market has developed and, as a consequence, large incoming volumes no longer have a destabilizing effect. Most notably, the GARCH estimates of EUA prices from January 2008 on show a degree of market maturity that is worthy of a financial series belonging to the SP500.

The impact of EC announcements on EUA prices is comparable to the effect of Central Bank interventions on the exchange rate market assessed by Beine and Laurent (2003) in the sense that they induce jumps and tend to increase volatility. The instability following the EC announcements regarding the cap for Phase 2 that were released before the beginning of Phase 2, *i.e.*, until December 2007, can be explained by the unexpected relative scarcity of EUAs for the second phase: the adopted NAPs were revealed to be substantially more restrictive than the target proposed by each member state. In fact, the emission cap approved by the European Commission for Phase 2 (*i.e.*, the sum of the national allocations) was less then 90% of the total emission target

[1] In April 2006, the EC published the real emissions of the permitted installations under the EU ETS for 2005, which were much lower than the allowances distributed. The banking restriction provoked the decline on Phase 1 prices that finished at levels near zero while Phase 2 prices remained near pre-announcement levels.

[2] For an extensive overview of the properties of the mixture of distributions, see Alexander and Lazar (2006) and Haas et al. (2004), among others.