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Impact of allowance submissions in European carbon emission markets

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ABSTRACT

This paper studies the impact of the April allowance submissions mandate under the European Union emission trading scheme (EU ETS) in carbon emission markets. Using intraday order flow data, we test for the cross-market efficiency of spot-futures dynamics and find that the equilibrium level, adjustment speed and no-arbitrage boundaries of the spot and futures relationship shift subsequent to the submission date. In addition, our results show that the allowance submissions affect the price discovery process, with the carbon spot market providing stronger price leadership in the periods before the submission date and the futures market playing the predominant informational role thereafter. Using the heterogeneous autoregressive realized volatility (HAR-RV) model, we also find a change in volatility spillovers before the submission date, particularly from the spot to the futures market. Overall, the results suggest that the April allowance submissions have significant impact on the time series dynamics of spot and futures carbon emission markets.

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1. Introduction

Carbon emission markets, which are designed to reduce emissions of global greenhouse gases (GHG), have experienced rapid ongoing development even during the recent recession and have attracted considerable attention from policy makers and investors. The European Union Emission Trading Scheme (EU ETS), accounting for around 84% of the total value of the global carbon market, is the most influential and successful emission trading market in the world (World Bank, 2012). By March 31 of each year, operating firms report information about their realized emissions from the preceding year, and subsequently the aggregate figures on the emissions realized are announced by the European Commission. Under the EU ETS, by April 30, operating firms are required to surrender sufficient carbon allowances to cover their annual emissions.

Firms with spare allowances have the incentive to sell their allowances on the exchange for cash before the submission date. On the other hand, firms that emit more than their allotted allowance will want to buy allowances from firms with spares before the submission date to avoid the heavy penalty. This would mean that the trading activities in the spot and futures emission market should be pronounced during the period before the submission date, as compared with periods thereafter. Moreover, since the surrendered carbon allowances are no long available to trade, the inventory level of allowances in the market decreases significantly as we near the April submission date each year. The changes in the inventory levels influence the costs and constraints of arbitrage. Lower inventory levels after allowance submissions will increase the inventory risk and widen the bid–ask spread, affecting trading behavior. Market makers require additional compensation for inventory risk (Ho & Stoll, 1981; Biais, 1993). In addition, it is harder for market makers to conduct short-selling activities when inventory levels are lower. Hence, the allowance submissions mandate in April can alter the price dynamics in the European carbon spot and futures markets.

Previous evidence for abnormal price changes, increase in volume and volatilities in the futures contracts around the European Commission announcement date of aggregate realized emissions has been documented by recent studies such as Grüll and Kiesel (2012) and Hitzemann, Uhrig-Homburg, and Ehrhart (2013). However, unlike previous studies, this paper is the first to analyze the changes in the trading behavior and the joint price dynamics underlying the carbon spot and futures markets, before and after the allowance submissions mandate of April 30. First, we test whether there is a change in the mispricing relationship of the spot and futures markets; that is, we test for changes in the equilibrium level, mean-reverting speed, and no-arbitrage bands of the carbon spot and futures relationship before and after the submission date. The results obtained are important in understanding the arbitrage

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activities in the European carbon emission markets at market microstructure level. Second, we investigate whether allowance submissions influence the information transmission between spot and futures carbon markets. It is possible that the spot market responds to new information more quickly than the futures market before the submission date due to the active trading in the spot market. Therefore, we test for changes in the short-run price discovery process using Granger causality tests (Granger, 1969), and also examine for changes in the dynamics of the volatility transmission process before and after the submission date. In particular, we use the heterogeneous autoregressive realized volatility (HAR-RV) model of Corsi (2009) for testing changes in the volatility spillover process between the spot and futures markets. For the empirical analysis, we use the intraday Phase II transactions data on the EU ETS from 2009 to 2011.

The empirical results show that the mispricing relationship underlying the spot and futures markets differs significantly before and after the allowance submission date. In particular, we observe a change in the long-run equilibrium level, the speed of adjustment, and the upper and lower bands of the no-arbitrage area after the allowance submission date. The above effects are prominent in 2009 and 2011, but not in 2010. This disparity is primarily driven by the broader market movements observed in the emissions market over these years (explained below). In terms of the information transmission process, the results of Granger causality tests reveal that, although in line with Rittler (2012) there is bidirectional information transmission between carbon spot and futures returns, the spot market leads (or Granger-causes) the futures market much more in the periods before the allowance submission date, while the futures market leads (or Granger-causes) the spot market much more after the submission date. Further, for the volatility transmission process, the results of the bivariate HAR-RV model show that the volatility spillovers between spot and futures markets significantly differ before and after the submission date. More specifically, we find that volatility spillovers from the futures market to the spot market are only significant in the periods after the submission date. Before the allowance submission date, the price discovery happens in the spot market, with informational spillovers in the volatility from the spot to the futures market. This is driven by the fact that the buying and selling of carbon allowances is much more pronounced in the spot market before the submission date as part of unwinding hedge positions and rebalancing books. Hence any new information revealed in the market will be first incorporated into the price dynamics and volatility in the spot market. Our results are in contrast to Rittler (2012), who does not consider the impact of allowance submission and finds unidirectional information spillovers from the futures to the spot market, but not vice versa. Our results also differ from Milunovich and Joyeux (2010), who find minor relevance of information transmission in the volatility process at a lower frequency. As in our previous analyses, we find that the effects of allowance submission on volatility spillovers are more pronounced in the years 2009 and 2011 than in 2010.

Our findings indicate that the dynamics of the EU emissions market during the compliance year 2009 are drastically different from those we observe during the compliance years 2008 and 2010. This is because of the differential market dynamics witnessed during these years. The 2008 compliance year can be overall characterized by a steady growth in the carbon emissions market, reaching double its 2007 value. But late 2008 and early 2009 showed a deteriorating market, with lower oil and energy prices, and a sluggish economic outlook. During 2009, the global financial crisis intensified and industrial production in the EU dropped significantly, causing an unexpected deep decrease in demand for carbon emissions. By February 2009, EUA prices had plummeted to €8, versus €30 nine months earlier. According to the World Bank report, the carbon emission in the EU decreased by 11% from 2008 to 2009, following a 15% reduction in the EU industrial production in the same period (World Bank, 2012). While the amount of carbon allowances allocated to firms is based on the forecast of industrial production, since firms emitted less than expected in 2009, the total amount of carbon allowances surrendered in April 2010 also declined considerably. On the supply side, the financial crisis stimulated financial institutions and private investors to deleverage and redirect their positions away from risky investments and toward safer assets and markets. This meant that the EU ETS project-based mechanisms, where operators implement projects that reduce emissions in emerging regions and use the resulting emission reduction units to help meet their own targets, were hard to implement and effectively came to a standstill. According to the World Bank, the carbon market endured its most challenging year to date in 2009. In contrast and relative to the previous year, 2010 brought tranquility with EUA prices stabilizing to a new equilibrium level of around €16. The year 2010 can be characterized by a move towards improvement of market mechanisms, implementing robust and transparent regulation, and building market confidence. Hence, we observe that the carbon market dynamics during the 2009 compliance year are distinct from those in 2008 and 2010. This explains the differential and insignificant impact of the allowance submission mandate in April 2010, while the impact is pronounced before and after the April 2009 and 2011 submission mandates. All the above findings are also robust when considering order flow transactions sampled at various intraday time frequencies (such as 10 and 30 min).

Therefore, we contribute to the existing studies of the EU ETS carbon emission market and show that the April allowance submissions mandate significantly influences the carbon price dynamics. Furthermore, the results in this paper are of interest to investors and operators who manage carbon allowances and its derivatives for compliance, risk management, arbitrage, raising capital and profit-taking purposes. The distinct pricing efficiencies between the EU ETS carbon spot and futures contracts before and after the April submissions date have to be taken in consideration for effective hedging and risk management. The changing lag effects and liquidity changes due to the April submissions will aid arbitragers in understanding the price discovery process and the arbitrage opportunities in the EU ETS market. Additionally, the findings will also aid market makers in their liquidity management. Further, the results will be of special interest to regulators and carbon market designers aiming to improve the trading mechanisms of the EU ETS. To minimize the impact of the submission date on the carbon trading markets, several alternative submission mechanisms (and their implementation costs) should be considered, such as instituting multiple submission dates within the year or allowing operating firms to submit allowances in multiple installments.

The remainder of this paper is organized as follows. Section 2 gives a brief overview of the EU ETS framework. Section 3 describes the construction of intraday spot and futures prices. Sections 4 and 5 investigate the impact of allowance submissions on carbon market mispricing dynamics and on information transmission between the spot and futures markets, respectively. Section 6 concludes.

2. The EU ETS compliance process and data construction

EU ETS operates an annual compliance process of monitoring, reporting and verification of emissions by operating firms. The central authorities set a “cap” on the total amount of greenhouse gases that a country or region is allowed to emit within a calendar year. By the end of February, they allocate free GHG emission allowances to operating firms covered by the scheme. Firms' emissions during the year should not exceed the allocated allowance represented by their in-hand allowances; otherwise they must surrender additional allowances in the next calendar year to cover the excess emissions from the previous year and further pay a heavy civil penalty. The scheme involves regular monitoring of operators during the year starting from January to the end of December. Firms that emit more than their allocated allowances are required to undertake measures to reduce their emissions (for example, by investing in more efficient technologies and/or energy sources) or they can buy carbon allowances from another firm that has

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