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London vs. Leipzig: Price Discovery of Carbon Futures during Phase III of the ETS

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Abstract

Futures for European carbon emission allowances resemble a relatively new class of financial assets that are currently traded on two exchanges: the ICE in London and the EEX in Leipzig. While the former features greater trading volumes, the latter hosts the majority of the primary auctions of ETS emission allowances. This letter, therefore, investigates which of these trading places dominates the carbon price discovery process. The results of various price discovery measures based on a vector error correction model indicate that the ICE leads the price discovery process of carbon futures.

Keywords: Carbon, Price Discovery, Information Leadership Share, EUA, Futures Markets, ETS

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1 Introduction

To curb carbon dioxide emissions in Europe, European policy makers launched the European Trading System (ETS). Under this system, firms operating carbon emission intensive installations are required to purchase so-called emission allowances (EUAs) for each ton of carbon dioxide they emit. The respective companies can purchase these allowances in official auctions and trade them on secondary spot or futures markets. In the pilot phase of the ETS from 2005 to 2007 almost no EUAs were sold in auctions, such that nearly all allowances were given away for free. In Phase II from 2008 to 2013 free allotment remained by far the default method for obtaining allowances. However, starting with the introduction of Phase III in 2013, free allotment has been reduced significantly. This change of policy and the fact that the total number of issued allowances decreases every year turns carbon emission allowances into an increasingly scarce commodity. Consequently, the companies that are required to obtain these carbon emission certificates face rising price uncertainty. This obviously raises the importance of futures markets as an effective tool to hedge against unanticipated changes in the carbon price and to discover new prices.

Since the introduction of carbon futures trading, the majority of empirical studies concerning carbon prices analyze their determinants, see e.g. Alberola et al. (2008), Paolella & Taschini (2008), Chevallier (2009), Daskalakis et al. (2009), Hintermann (2010), Creti et al. (2012). Focusing on speculative activity as a driver of carbon prices and their volatility, Lucia et al. (2015) and Balietti (2016) study the impact that speculators have in these markets. However, only a few papers investigate the price discovery function of different carbon markets. Most notably, Rittler (2012) uses different price discovery metrics to determine whether the carbon futures contract traded on the ICE [1] or the BlueNext spot market dom-

[1] Note that until 2010 this futures contract was traded on the formerly independent European Climate Exchange (ECX) which is now part of the ICE.

inates the price discovery process at the start of Phase II of the ETS. His results suggest that price discovery mainly occurs in the futures market.

In the current Phase III of the ETS, two European futures exchanges, namely the ICE in London and the EEX in Leipzig, offer futures contracts for carbon dioxide emission allowances with practically the same contract specifications. The majority of primary auctions of emission allowances under the ETS take place at the EEX. In terms of price discovery, this exchange, therefore, is likely to have an informational edge over the ICE. However, compared to the relatively young EEX, the ICE is a historically well-established futures exchange which attracts many different investors and features far greater trading volumes.

Against this background, this letter uses a vector error correction model and computes several measures of price discovery to analyze which of these exchanges dominates the price discovery process for carbon dioxide emission allowance futures. A market is said to dominate the price discovery process, if it is the first to reflect new information about market fundamentals in the price. Our findings indicate that carbon futures prices are mainly made in London and not in Leipzig.

2 Methodology

A common definition of price discovery is the "efficient and timely incorporation of the information implicit in investor trading into market prices" (Lehmann 2002). This letter uses three different price discovery metrics based on the following standard vector error correction model (VECM):

$$\Delta p_{1,t} = \beta_1 + \alpha_1 ec_{t-1} + \sum_{k=1}^{K} \beta_{12,k} \Delta p_{2,t-k} + \sum_{q=1}^{Q} \beta_{11,q} \Delta p_{1,t-q} + \varepsilon_{1,t} \ , \tag{1a}$$

$$\Delta p_{2,t} = \beta_2 + \alpha_2 ec_{t-1} + \sum_{k=1}^{K} \beta_{22,k} \Delta p_{2,t-k} + \sum_{q=1}^{Q} \beta_{21,q} \Delta p_{1,t-q} + \varepsilon_{2,t} \ , \tag{1b}$$

where $p_{1,t}$ and $p_{2,t}$ denote the logarithmic futures prices of the ICE and the EEX in period t, respectively, while $ec_{t-1} = p_{1,t-1} - \theta - \xi p_{2,t-1}$ is the error correction term which resembles the long-run relationship between the two futures prices. This VECM has the following standard vector moving average (VMA) representation:

$$\boldsymbol{p}_t = \boldsymbol{p}_0 + \boldsymbol{\Psi}(1) \sum_{i=1}^{t} \boldsymbol{\varepsilon}_i + \boldsymbol{\Psi}^*(L)\boldsymbol{\varepsilon}_t \ , \tag{2}$$

with $\boldsymbol{p}_t = (p_{1,t} \ \ p_{2,t})'$.

The first price discovery measure used in this study has been proposed by Schwarz & Szakmary (1994) and relates to the work of Gonzalo & Granger (1995). This measure consists of two so-called component shares CS_1 and CS_2, which are computed from the long run adjustment coefficients α_1 and α_2 of the VECM:

$$CS_1 = \frac{|\alpha_2|}{|\alpha_1| + |\alpha_2|} \quad \text{and} \quad CS_2 = \frac{|\alpha_1|}{|\alpha_1| + |\alpha_2|} \ . \tag{3}$$

The two shares sum by construction to one and reflect how much each of the markets contributes to the price discovery process. The greater a market's component share, the greater its importance for price discovery. An alternative measure are the information shares IS_1 and IS_2 developed by Hasbrouck (1995) and Lien & Shrestha (2009):

$$IS_1 = \frac{\left(\left[\boldsymbol{\Psi F}\right]_1\right)^2}{\boldsymbol{\Psi \Omega \Psi'}} \quad \text{and} \quad IS_2 = \frac{\left(\left[\boldsymbol{\Psi F}\right]_2\right)^2}{\boldsymbol{\Psi \Omega \Psi'}} \ , \tag{4}$$

where $\boldsymbol{\Psi}$ is either of the two identical rows of $\boldsymbol{\Psi}(1)$, while $\boldsymbol{F}$ results from an eigen-value decomposition of the error covariance matrix $\boldsymbol{\Omega}$.

However, as demonstrated by Yan & Zivot (2010), the component shares primarily reflect noise avoidance of price time series, whereas the information shares capture both noise avoidance and the ability to incorporate new information. Thus, the information shares are only able to accurately describe the price discovery process if both series feature the same level of noise. To remedy this caveat, we follow Yan & Zivot (2010) and Putniņš (2013) and combine these previous measures to form the information leadership shares ILS_1 and ILS_2:

$$ILS_1 = \frac{IL_1}{IL_1 + IL_2} \quad \text{and} \quad ILS_2 = \frac{IL_2}{IL_1 + IL_2}\,, \tag{5}$$

where

$$IL_1 = \frac{IS_1}{IS_2} \cdot \frac{CS_2}{CS_1} \quad \text{and} \quad IL_2 = \frac{IS_2}{IS_1} \cdot \frac{CS_1}{CS_2}\,. \tag{6}$$

These metrics are, regardless of the underlying level of noise, able to accurately gauge price discovery in the sense of which market incorporates new price signals more quickly and efficiently. The interpretation of the information leadership shares is straightforward and follows that of the component shares and information shares. The greater the information leadership share of a market, the greater its contribution to the price discovery process. If one of the markets' information leadership shares is above 50 percent, this indicates that this market is is the price leader of the two.

3 Data and Results

To investigate where the carbon futures price is made, we obtain continuous futures price time series for the ICE and the EEX carbon emissions allowance contracts from Thomson Reuters Datastream. These daily futures price series are constructed by rolling to the nearest contract of the first day of the trading month. The two price time series are displayed in Figure 1.

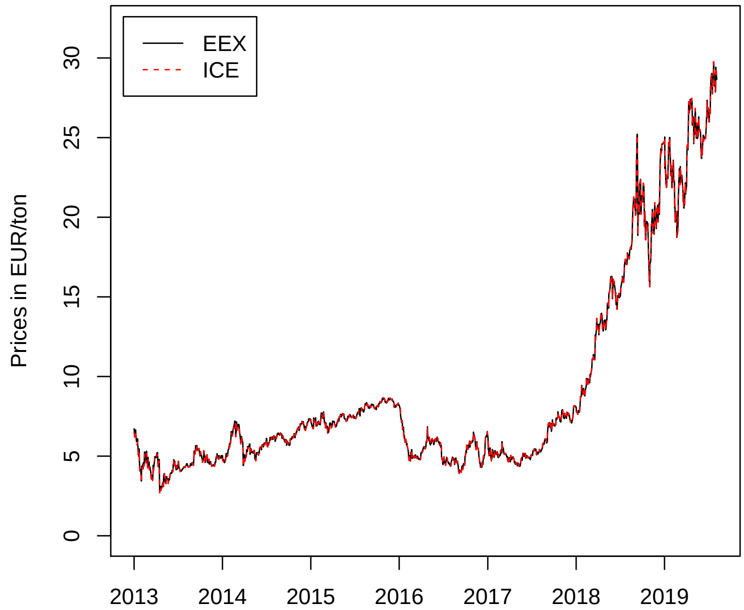

Figure 1: Carbon futures prices in Phase III of the ETS

Both contracts are priced in EUR per metric ton and comprise 1000 allowances, whereby each allowance permits the emission of one ton of carbon dioxide. Our sample ranges from the start of Phase III of the ETS, i.e. from 01 January 2013, until 05 August 2019. During the first five years, i.e. from 2013 until the end of 2017, the carbon price stayed around 5 EUR per metric ton of CO_2 and has since 2018 increased rapidly. At the moment, the prices are around 30 EUR per metric ton.

ADF tests of the prices and the logarithmic returns show that the former are integrated of order one but the latter are stationary. Moreover, the results of the Johansen cointegration test support the visual impression that the two futures price time series are cointegrated. Summary statistics are reported in table 1. The prices vary from a minimum of 2.70 EUR to a maximum of 29.77 EUR per metric ton and feature standard deviations of about 6.45.

Table 1: Summary statistics

Statistic	EEX	ICE
Min	2.80	2.70
Mean	9.09	9.07
Max	29.76	29.77
St. dev	6.44	6.45
Skewness	1.63	1.63
Kurtosis	4.36	4.35

The VECM is estimated as described in section 2, whereby the Schwarz-Bayesian information criterion suggests the use of six lags. The three price discovery metrics for the full sample period are reported in panel A of table 2. All of the three metrics, and in particular the information leadership shares, show that the ICE futures contract dominates the price discovery process, as all of its price discovery shares are above 50 percent. Thus, the ICE contract incorporates new information more efficiently into prices than the EEX contract.

Table 2: Price discovery results

A: Full sample		
	EEX	ICE
CS	32.86	67.14
MIS	25.27	74.73
ILS	32.32	67.68
B: 2018-2019 subsample		
	EEX	ICE
CS	40.23	59.77
MIS	30.60	69.40
ILS	30.03	69.97

As shown in figure 1, carbon prices deviated from moderate levels at the beginning of Phase III and soared throughout 2018 and continued to rise at a high pace in 2019. Therefore, we repeat our earlier analysis and re-calculate the price discovery metrics for the 2018-2019 sub-sample. These are listed in panel B of table 2. Again, the ICE futures contract is found to be dominant in the price discovery process.

4 Conclusion

Following the launch of the ETS, two major futures exchanges now offer futures contracts for carbon emission allowances in Europe. This letter investigates the price discovery process between these two contracts, which are traded at the ICE in London and the EEX in Leipzig. Using a VECM estimation and three well-known measures of price discovery, including the recently developed price discovery measure by Yan & Zivot (2010) and Putniņš (2013), we find that carbon prices are primarily discovered at the ICE.

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