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Effects of NYMEX trading on IPE Brent Crude futures markets: a duration analysis

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Abstract

Recent developments in the energy markets, and the surge and dip in crude oil prices over the last few years, have renewed the interest in the workings of the two main price setting markets: London's International Petroleum Exchange (IPE) and New York's Mercantile Exchange (NYMEX). The interaction of these two markets, when both of them are open (synchronous trading) and when only London is open (asynchronous trading), is important, in view of the fact that most participants take positions in both markets.

This paper looks at how London is affected by New York by analysing the transaction duration of the IPE Brent futures contract, both when the NYMEX WTI futures contract is being traded and when NYMEX is closed. Using tick-by-tick data obtained from IPE, transaction durations are found to form two distinctive and inverted U-shaped patterns.

Autoregressive conditional duration (ACD) model, first introduced by Engle and Russell, is applied to the data. Parameters of IPE morning and afternoon are significantly different from each other, underlining the dominant effects of NYMEX on IPE trading. The results from the current analysis reinforce previous results by the authors, which indicate that NYMEX is a leading price setter in crude oil futures prices and has a dominant effect on the IPE-traded contracts.

Keywords: Lead-lag; Duration analysis; Energy futures

1 Introduction

In the crude oil market, there are two 'marker' crudes that set the pace in prices: West Texas Intermediate and Brent Blend. The former is the base grade traded, as 'light sweet crude', on the New York Mercantile Exchange (NYMEX), while the latter is traded on London's International Petroleum Exchange (IPE) and is also one of the grades acceptable for delivery of the NYMEX contract. Participants in these markets move with relative ease from one market to the other and usually take positions in both of them. Arbitrage opportunities thus could be seized with and without the involvement of underlying physical crude. These arbitrage activities ensure deviations from the long-run path of two prices are adjusted and equilibrium prices are restored. Interesting questions thus arise: Which direction do arbitrages take place? Does one market move faster than the other? In other words, is there a market leader?

To answer these questions, Engle and Granger (1987) cointegration analysis and vector error correction (ECM) model estimation are conducted.[1] Both Brent and WTI daily futures settlement prices are integrated of order 1 and are co-integrated, which confirms the existence of a long-run equilibrium between the two markets. Further estimation with ECM reveals that short-term adjustments to the long-run cointegrating vector are insignificant in either market. Given that both markets stop trading at the same time, one possible explanation is that information released within the trading hours is fully incorporated in the settlement prices so that no lead-lag relationships can be detected using daily data. The search for the possible market

[1] Cointegration analysis and ECM estimation are conducted using daily data from 14 April 2002 to 31 July 2002. Total observations: 574. The insignificance of parameter (α)—short-term adjustments to deviations from long-run equilibrium, remains across different contracts for both markets. Results are available from the authors.

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leader leads us to experiment with higher frequency data: tick-by-tick duration data.

This paper focuses on transaction durations of the IPE Brent futures contracts, both when IPE and NYMEX contracts are simultaneously traded and when NYMEX is closed, in order to uncover the effects of NYMEX trading on IPE. According to Easley and O'Hara (1992) timing between trades is related to new information. Analysing arrival times between events is a means of uncovering market information dissemination behaviour. Results of this paper uncover the high frequency facet of the markets. It is the first attempt, in our knowledge, to analyse transaction data in the area of energy futures markets. The rest of the paper is organized as follows. Section 1 introduces Engle and Russell's (1998) autoregressive conditional duration model (ACD). Section 2 discusses data construction and descriptive analysis. Section 3 presents empirical results and their implications and is followed by conclusions in Section 4.

2 The ACD model

This model was first introduced by Engle and Russell (1998) who applied it to tick-by-tick transaction data of IBM stocks traded on NYSE. The raw data in their model comprise durations between time-stamped transactions. The times at which transactions take place, termed the "arrival times" are treated as random, in other words, time duration between events is a random variable itself.

Conventional methodology relies on fixed interval observations for inference. The duration concept is in direct contrast to this methodology. The nature of fixed interval frequency methodology is such that aggregates all events happening within a predetermined amount of time irrespective of how many events actually happen during this time. For example, for a 5-min interval only one average price is quoted, regardless of whether this is a result of several transactions, a single transaction or even no transaction at all. In the latter case, when there are no events observed within an interval, information is carried forward from the previous interval which may lead to spurious autocorrelation.

In contrast to this, the duration methodology takes into account the occurrence of every single event, which makes each transaction, rather than the fixed time interval, the unit of measurement. The time interval ceases to be fixed and becomes itself a variable which takes different values according to the frequency at which transactions occur, which in its turn depends on how busy a market is.

By using tick-by-tick data, Engle and Russell's ACD model specifically catches the duration clustering effect; a short duration tends to follow another short duration while a long duration tends to follow another long duration. They define the expectation of the duration ψ with parameter θ as follows:

$$E_{i-1}(x_i|x_{i-1},\ldots,x_1) = \psi_i(x_{i-1},\ldots,x_1;\theta) \equiv \psi_i. \quad (1)$$

The expected duration follows an autoregressive process as below:

$$\psi_i = w + \sum_{j=0}^{m} \alpha_j x_{i-j} + \sum_{j=0}^{n} \beta_j \psi_{i-j}, \quad (2)$$

where actual duration $x_i = t_i - t_{i-1}$.

The ACD class of models have the following assumption:

$$x_i \equiv \psi_i * \varepsilon_i, \quad (3)$$

where $\{\varepsilon_i\} \sim$ iid $p(\varepsilon;\Phi)$, and θ, Φ are variation free. Φ are parameters in the distribution of ε.

Various distributions can be used to fit ε_i. Engle and Russell used the exponential and Weibull distributions for the analysis of trade duration, price duration and market microstructure hypothesis. Other distributions, such as log normal and log logistic, have been used to fit $\{\varepsilon_i\}$ which resulted in alternative duration models (see Lancaster, 1990). Variations of ACD can also be found in the specification of durations. For example, Jasiak and Ghysels (1999) used the fractionally integrated ACD model, which allows for long-range dependence in the duration. Bauwens and Giot (2000) proposed the logarithmic ACD model where the autoregressive equation is specified on the logarithm of the conditional expectation of the durations. This model relaxed the non-negativity restriction imposed on the coefficient of the autoregressive term as in α and β in Eq. (2).

In this paper, the first-order ACD with exponential distribution (EACD(1,1)) is used to explore the duration analysis and microstructure characteristics of IPE Brent futures contracts. It is defined as follows:

$$E_{i-1}(x_i) \equiv \psi_i = w + \alpha\psi_{i-1} + \beta x_{i-1}, \quad (4)$$

$$x_i \equiv \psi_i * \varepsilon_i, \quad (5)$$

$\{\varepsilon_i\} \sim$ i.i.d. exponential $f(\lambda)$, with its parameters λ and w, α, β, variation free, where x_i is the interval between two transactions, called duration; t_i is the time when event i takes place; ψ_i is the expected ith duration; and ε is the residual. The expected duration is affected by its one period past events. The actual duration is the result of the expected duration combined with an error term. The simplicity of the EACD(1,1) model lies in the use of a multiplicative error in the ACD and its connection to the established quasi-maximum likelihood estimation (QMLE) properties of the GARCH(1,1), which ensures the consistency of estimated parameters when the assumed distribution is incorrect or when the sum of α, β is close to 1. The likelihood can be estimated as follows, subject to certain conditions: (Engle and