Dynamic price relationship in crude oil markets

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Overview

Although often considered one commodity, the crude oil market offers a wide variety in quality and location. The three major benchmarks, Brent, WTI and Dubai oil, provide standards for different sets of crude oils due to their quality variation. For regional crude oil markets, these differences together with regional differences, helps putting the price on a diverse commodity.

In this paper, we test integration between a set of crude oil prices. We perform the test in two parts. First, we consider integration between the three majors: Brent, WTI and Dubai oil. Second, we do tests for the minor crude oils against the majors, and show both individual and aggregated results to assess the relationship between minor and major crude oils. The paper contributes with time-varying analysis on crude oil markets and the results indicate a time-varying relationship between the three major benchmarks, in addition to variations for the minor crude oils. This is important to the industry and speculators utilizing the crude oil futures markets, which depends on reliable and stable relationship between prices and standards.

Methods

The data considered is daily prices for a set of 18 crude oil prices from May 1996 until March 2017, providing 4 820 observations per price series. The series include the three major benchmarks (Dubai, Brent and WTI) and 15 other prices covering Asian (Tapis, Minas, Duri and Australia), Arab (Murban and Oman), African (Forcados, Bonny), North Sea (Oseberg, Ekofisk and Statfjord) and American (Louisiana, West Texas and Alaskan) oil producing regions.

First, we use ADF-test to verify that all time series are I(1), i.e. stationary in first differences. This allows us to test the long-run and short-run relationship between the series. In particular, we assess to what degree the three major benchmarks are linked, and further, how the minor crude oil prices are reflected by the majors. We use a vector error correction model (VECM) of order p to identify long-run and short-run relations:

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-1} + \varepsilon_t$$

With cointegration, we can define Π as $\Pi = \alpha\beta'$ where β is an n x r cointegration coefficients matrix and α is an n x r matrix of speed adjustments matrix. We estimate α over time, creating $\alpha(t)$ by rolling the cointegration analysis with a time incremented observation window of 250 observations. This allow us to identify time-variations in the cointegration between markets.

Results

Figure 1 presents the rolling alpha for Dubai, Brent and WTI for the period considered. A positive number indicates influence on the other markets. For most parts until 2010, the results indicate that Brent and WTI affects Dubai oil prices to a varying degree. However, the results are insignificant and we cannot find a dominant market, thus indicating that all three benchmarks influenced the oil price to the same degree. However, since late 2010 there is a notable and significant shift, as WTI becomes the dominant market, influencing both Brent and Dubai oil prices. This coincides with the shale oil supply boom in US from 2010. Figure 2 confirms this, as the Brent-WTI spread turned from marginally negative to highly positive at the end of 2010, due to the supply surplus in US. The spread prevailed, although slowly declining towards the price level set by WTI over the following years. The same is found for the Dubai – WTI spread, indicating that the shale oil revolution in US had a substantial effect on the global oil price.

For the other regional prices, the results indicate strong regional relations. In particular, we find that Gulf oil prices are dominated by the Dubai oil price, although with varying significance over time. Asian oil prices has varying relations over time to all major benchmarks, although dominated by WTI since 2010. African oil prices are connected to Brent until 2010, when prices tend to be more WTI-dominated. Finally, other American prices are linked to WTI and North Sea prices to Brent throughout the period.

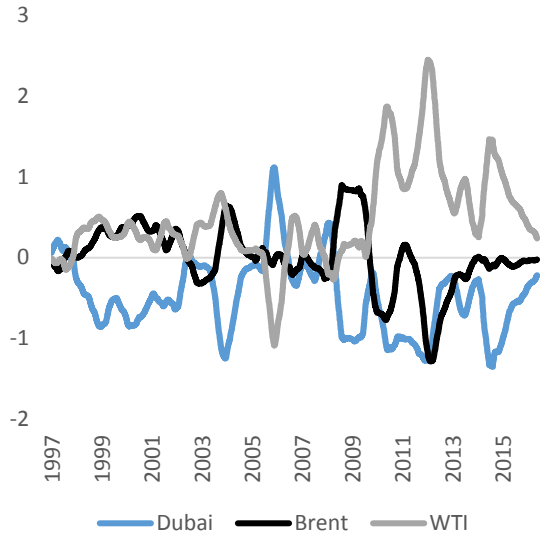

Figure 1 – Rolling speed of adjustment (α(t)) for Dubai, Brent and WTI crude oil 1997 – 2017.

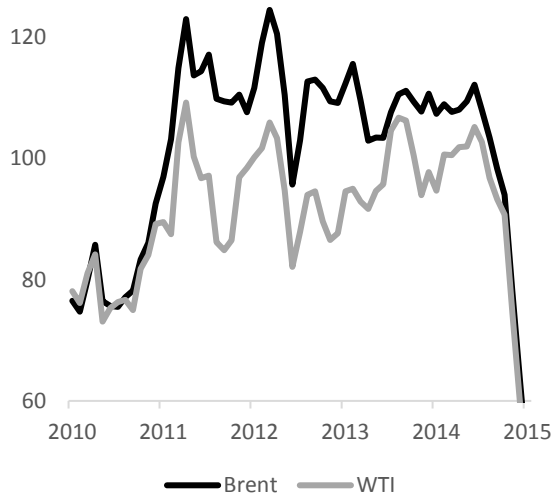

Figure 2 – Crude oil prices in $/bbl for Brent and WTI for 2010 – 2015.

Conclusion

The major benchmarks are important for traders and industry in investments decisions, and for regulators considering energy policy. This paper confirms time-varying dynamics between the major benchmarks. First, oil supply from Arab and Gulf countries has little influence on global oil prices, which may be a consequence of low marginal cost. On the contrary, it seems that marginal supply from the North Sea and US has more effect on global oil prices, although at insignificant levels until the US shale oil revolution after 2010. With the increasing US production, WTI became the dominant benchmark, putting a downward pressure on prices towards its marginal cost. Finally, the paper indicates geographical relationships between other regional oil prices and the three major benchmarks.

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