INSIGHTS GLOBAL

Oil prices: interrelations & spread trading

The Netherlands | Stationsweg 1b | 4811 AX | Breda |
info@insights-global.com | www.insights-global.com |
T: +31 (0)850 66 25 00

Oil is the most widely traded commodity worldwide. Its importance is reflected in the large share in media attention where the development of oil prices are reported alongside stock indexes and foreign exchange rates. The media report on 'the oil price' as if there is one price for this heterogeneous commodity. Clearly this is not the case but how does pricing of various crude grades and oil products at various locations relate to each other? This question is analysed in this paper by utilizing econometric methods. Also the industry practice of spread trading, which is based upon these interrelations, is highlighted.

Benchmark oil prices

First of all let's look at how oil pricing in current markets is structured. Most prices of crude and oil products are priced against benchmarks. Brent crude is such a benchmark. Crude delivered to Europe for instance is almost always priced against Brent with differentials depending on specific crude characteristics. Brent crude is produced in the North Sea and on the ICE Futures exchange futures can be traded based on this crude grade. ICE Brent crude front month futures prices are mostly used as benchmark in Europe. Another crude benchmark, mainly used in the US, is the NYMEX WTI front month futures price.

The main oil product groups, gasoline and middle distillates, also use futures prices as benchmarks. In Europe middle distillates are priced against ICE gas oil front month futures and in the US against NYMEX heating oil front month futures. Gasoline, both in Europe and the US, are priced against NYMEX RBOB front month futures. Here differentials between spot and futures prices depend on local supply and demand characteristics.

The reason why futures prices are mostly used as benchmark is because financial markets are far more liquid then physical markets and futures prices and spot prices tend to converge just before expiration of the futures contract. Also because these contracts are widely used to hedge price risk in crude and oil products markets it makes sense to use these futures prices as benchmarks.

Futures markets

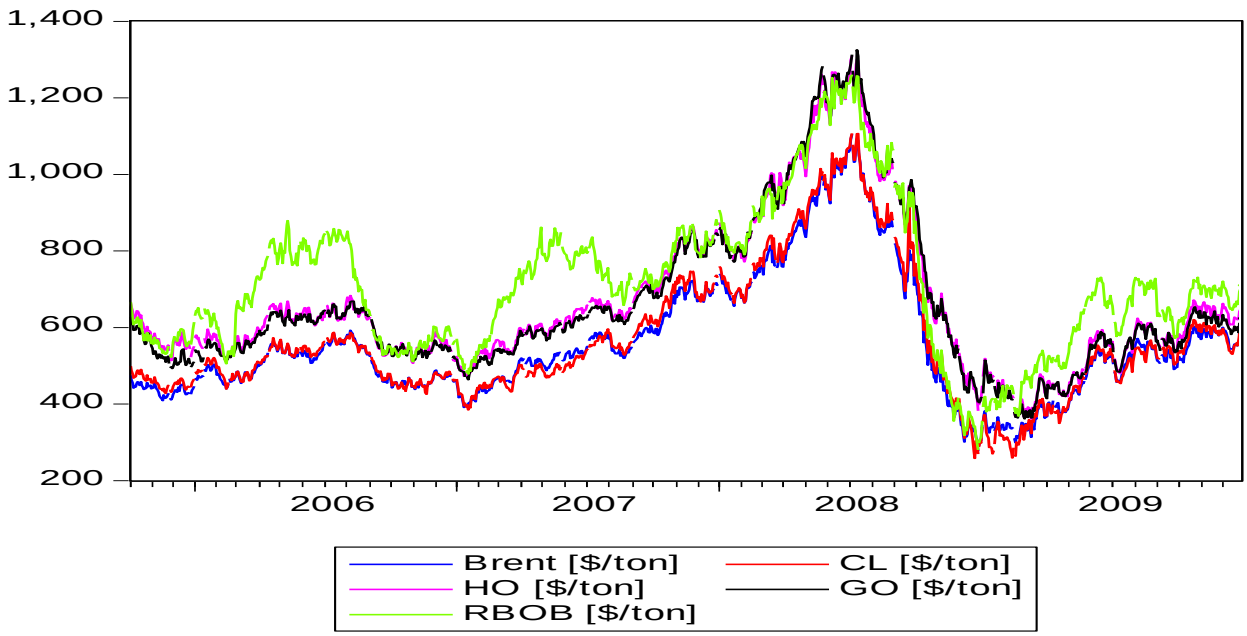
As we have explained futures markets play a very important role in oil pricing and in oil trading in general. Paying some more attention to these markets we will try to unravel the mechanisms that drive prices on these markets.

Futures markets are financial markets where futures contracts are traded. On a futures market oil can be traded against fixed and standardized delivery terms and conditions. The terms and conditions of delivery are documented in a contract. The price of such delivery contract is however not fixed and is determined by supply and demand. For a specific product multiple contracts are traded, each having a different delivery date in the future. For example gas oil futures, which are traded on the Intercontinental Exchange (=ICE) in London,

can be traded for delivery up to five years ahead. If a market participant holds onto a futures contract until it expires, it will result in a physical delivery of oil.
Trading volumes on the international futures markets are nowadays much larger then in physical markets. Futures markets have an important economic function. On futures markets producers, refiners and traders can hedge their price risk. Risk is transferred from risk adverse "hedgers" to speculators. These speculators try to profit from trading and use their superior market intelligence as competitive advantage. The leverage and high volatility that is accompanied with futures trading makes it even more attractive for speculators to trade. Speculators and also most hedgers are not interested in physical delivery of oil and will always close their trading positions before expiration. However, the possibility of physical delivery ensures that futures prices will converge with spot prices just before a futures contract expires. This link between spot and front month futures prices is key to the acceptance of futures prices as a suitable benchmark.

Analysing interrelations
"A picture tells a thousand words." According to this wisdom we look at how various benchmark oil prices are interrelated, comparing:

- ICE Brent crude futures
- ICE Gas oil futures
- NYMEX WTI/Crude Light
- NYMEX Heating Oil
- NYMEX RBOB



In the charts below all benchmark futures price time series are depicted.
Figure1: co-movement of benchmark oil futures prices

It is clear that there is a common trend in all oil futures price time series. Generally speaking all price time series behave similarly and move in parallel. These time series are said to be "co-integrated". To test for this feature the Johansen co-integration rank test was applied and it turned out that four co-integration relations were present. The estimated coefficients in the four co-integration relations show a remarking pattern. It seems that the four relations are actually four well known spreads:

- RBOB crack spread (RBOB – Crude Light)
- HO crack spread (HO – Crude Light)
- Atlantic gas oil spread (Gas oil – Heating oil)
- Atlantic crude spread (ICE Brent crude – NYMEX Crude Light)

Several spreads have been calculated, which are displayed in figure 2. Looking at these spreads some irregularities can be spotted. The most obvious one is RBOB crack spread. Here it looks like there is a sort of seasonal pattern visible. Spreads have an economic interpretation.
Crack spreads for instance give the gross refining profit margin for a product and thus are influenced by relative changes in supply and demand for the specific product with respect to crude oil. For the RBOB (gasoline) crack spread the seasonal pattern is explained by the occurrence of the "US driving season" in which more gasoline is consumed compared to the rest of the year. This causes the crack spread to increase in this period. Also other factors apart from seasonal circumstances influence crack spreads. Such factors are related to refinery capacity utilization and the relative supply of crude and demand for oil products.

The Atlantic crude spread is driven by the value of quality differences between the two crude grades, by differences in supply and demand between the USA and Europe and by the cross Atlantic arbitrage conditions. The Atlantic gas oil spread is driven by differences in supply and demand between the USA and Europe and by the cross Atlantic arbitrage conditions.

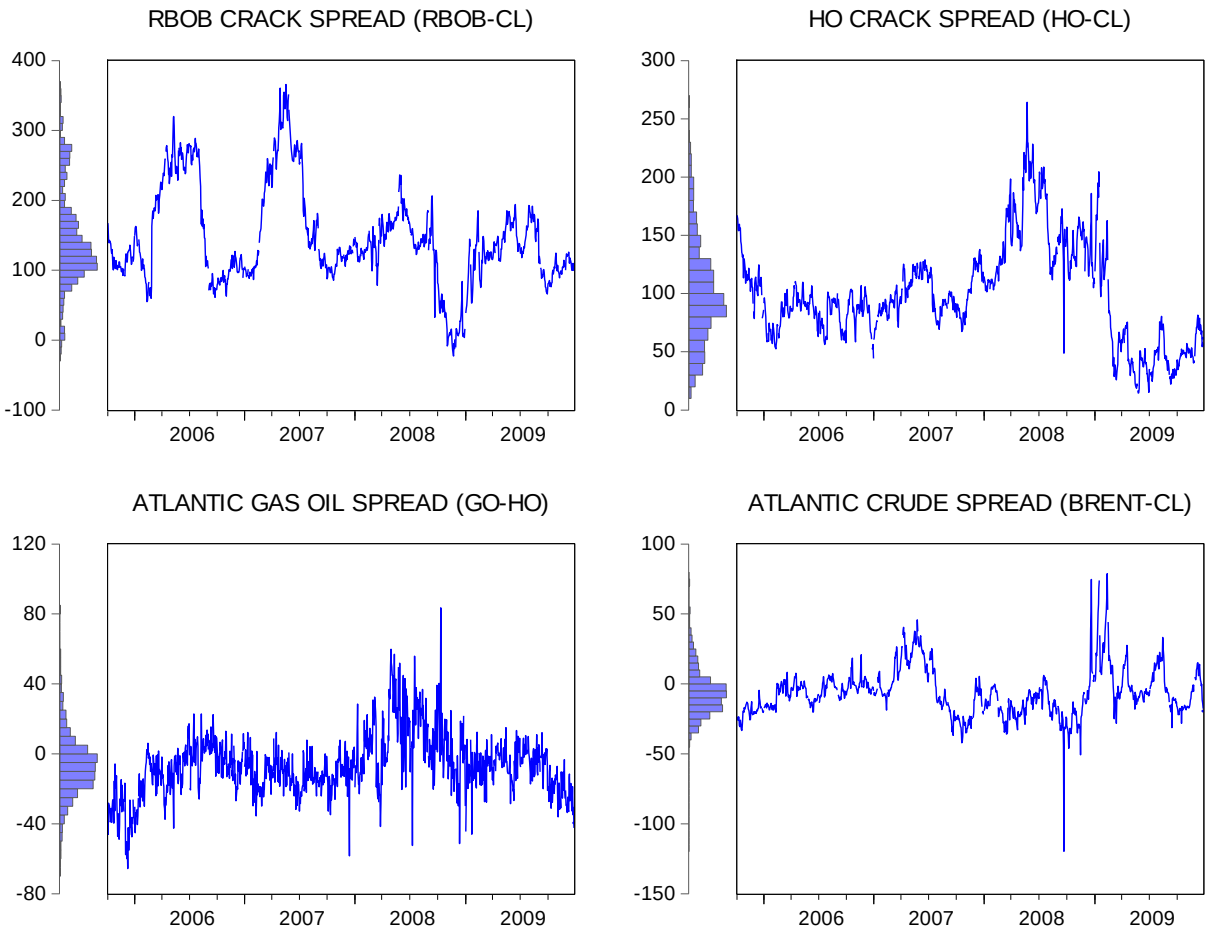


Figure2: spreads

Econometric modelling

The impact of the various factors on spreads has been studied by applying regression analysis. In the case of RBOB and HO crack spreads sine and cosine functions to account for seasonality were added. Additionally, fundamental factors such as US gasoline and heating oil inventories and US refinery capacity utilization also added to the explanation of variance in these spreads. In the model for heating oil crack spread a level shift was added (between 2004 and 2009) to account for abnormal high crack spread. Also an AR(1) variable was added to account for the remaining serial correlations in residuals. The results turned out to be very good with R^2 values ranging from 0.88 to 0.91. For all crack spread models the residuals were without unit roots thus satisfying the condition for co-integration.

In the case of both Atlantic spreads oil tanker freight rate data was used as an explanatory variable. This solution proved to work well for Atlantic heating oil / gas oil spread (Gas oil - Heating oil). The freight rate data added 0.10 in R^2. If also three subsequent autocorrelation terms are added the R^2 increases to 0.51 and all autocorrelations in residuals have been

eliminated. However, for the Atlantic crude spread (Brent crude – Crude Light) on this small sample still very large autocorrelations exist which point to a unit root. Here a different approach was taken. The Atlantic crude spread was regressed on US EIA crude stocks and on a lagged Atlantic spread variable. This resulted in a better model for this spread.

This simple analysis shows that crack and Atlantic spreads are mainly driven by fundamental factors that can be modelled using econometric methods. Applying more advanced econometric methods and adding more relevant fundamental variables will improve such models even more.

Spread trading

In spread trading two opposite positions are managed in the respective oil futures. To go long in for instance RBOB crack spread means that one has to be long RBOB futures and short WTI crude futures. The position size has to be similar in terms of mass (tonnes) or volume (barrels).

In order to develop a profitable spread trading strategy, one has to be able to forecast the change in spreads in a reliable manner. The simple and straightforward regression analysis which was highlighted in the previous section shows that crack and Atlantic spreads are mainly driven by fundamental factors that can be modelled using econometric methods. Such models can be applied to forecast spreads. However important parts of the explanatory factors are not lagged. This means that those explanatory variables, like EIA oil stocks and EIA refinery capacity utilization, need to be forecasted as well. This explains why large international oil traders invest heavily in such forecasting models and business intelligence systems and pay enormous amounts for information which can be used effectively to forecast fundamentals. With this they can outsmart the competition which is unaware of the anticipated change in spreads.

Curious?

If you want to learn more about these subjects or wish to be supported with econometric research or your daily oil market analysis, then you can always contact PJK International. PJK has more than thirty years of experience in this field and has helped many companies with its knowledge. Contact details can be found in the header of this document.

Authors:
Pieter J. Kulsen
Patrick D. Kulsen