STUDYING VOLATILITY REGIMES SHIFTS IN ENERGY PRICES

Roy Endré Dahl, University of Stavanger, roy.e.dahl@uis.no
Knut Anders Kjelaas Johansen, University of Stavanger, knut.a.johansen@uis.no

Overview

Recent events in the supply and demand of energy has altered the market's expectation, both short and long-term, which has resulted in another shift in energy prices. As the world's leading fuel, with 32.6% of global energy consumption, changes in the supply or demand side of oil can provoke large movements in the price of energy sources in general. Due to its importance, the price of oil can influence expectations and change industry incentives, as seen in the increasing investment in renewables and non-conventionals during the high oil price regime.

The paper studies a set of energy price data and considers price volatility, which is typically characterized by sudden shifts during highly volatile periods, interspersed by periods of relative calm. We try to identify and explain volatility regime shifts and consider if the set of energy commodities experience common price volatility shifts. In particular, we study recent events, originating from the increasing oil supply and the ongoing change in market expectations and market equilibrium. Consequently, oil price volatility has increased and due to its importance in the energy market, we expect to see the same for other energy commodities. We also investigate if the detected shifts could be related to specific events in the global economy.

Our data set consists of energy prices from different continents. Price series range from crude oils, natural gases and different liquefied petroleum gas (LPG) products. From the world total output of LPG, 60% is produced from natural gas (NGL) and 40% from the refining of crude oil. It is therefore reason to believe that a shift in the volatility of crude oil, will have a lagging effect on LPG prices. The methodology used in this paper will examine if this is the case or not.

Methods

In order to detect volatility shifts we use the Iterated Cumulative Sum of Squares (ICSS) statistic introduced by Inclan and Tiao (1994) and further developed and revised by Andreou and Ghysels (2002) and Sanso et al. (2004). This statistic test the null hypothesis of constant unconditional variance against the alternative hypothesis of breaks in the unconditional variance. This will help us identify a set of regimes for the commodities considered and allow us to test (1) if there is a relationship between oil price volatility and the volatility of other energy commodities, and (2) if there has been a change in volatility during the last year.

The volatility lagging effect between crude oil and LPG prices is analysed with a lagrange-multiplier test by Hafner and Herwartz (2006) testing for noncausality in variance. The test compare two bivariate time series and have a null hypothesis of no volatility spillover, with the alternative that there is. This test is selected ahead of ordinary Granger causality test (Granger, 1969), because the Granger test is sensitive to the applied lag length and distributional assumptions like normality and homoscedasticity.

We use daily price data between 2008 and 2016. This provide us with 2011 observations per product, all transformed into the same energy equivalent ($/MMbtu). Most of our data show excess kurtosis due to big outliers and ARCH effects. This suggest the use of the adjusted Inclan and Tiao statistic (AIT) by Sanso et al. (2004).

Results

For the entire data sample, we find volatility shifts in almost all energy prices. The only energy type with no breaks are the natural gases. From the 19 price series analysed we detect a total of 71 breaks, and the energy group with the highest amount of breaks are the crude oils. The shifts are mainly clustered around two periods, 2008 – 2009, and 2014. We relate this to the events during the 2008 financial crisis and the latest turmoil in the energy market in 2014 due to a supply-demand imbalance. For the majority of the energy series, volatility increase in 2008 followed by a

drop in the subsequent years, before it increase again in 2014. The recovery back from a high volatility state after 2008 is implemented either in one step or gradually over time.

The volatility spillover analysis focus on the realationship between the two main crude prices, Brent and WTI, and the other energy series. The test indicates no causal relationship between the volatility in Crude WTI and Crude Brent prices, meaning that the volatility found in one of the crudes does not affect the volatility in the other. However, the remaining causality tests, identify that there is a causal relationship between WTI and Brent for most of the refined oil products. Finally, the results indicate no relationship between volatility in WTI/Brent prices and volatility in coal or natural gas prices.

Conclusions

In general, during our data sample period, volatility levels have varied for the energy commodities considered. Using the ICSS method to evaluate volatility regimes, we find that the majority of these breaks occur during the 2008/2009 financial crisis, where volatility increases because of the added demand uncertainty due to doubts on future global economic activity. The volatility then shifts downward, towards a normal volatility level, until events since 2014 creates a second period of multiple regime breaks for the commodities tested as volatility increased because of the supply shock combined with demand uncertainty. By using a lagrange-multiplier test we identify that there is a causal relationship between WTI and Brent for most of the refined oil products. This relationship can not be identified for the natural gas and coal series.

References

Andreou, E., & Ghysels, E. (2002). Detecting multiple breaks in financial market volatility dynamics. Journal of Applied Econometrics, 17(5), 579-600.

Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. Econometrica: Journal of the Econometric Society, 424-438.

Hafner, C. M., & Herwartz, H. (2006). A Lagrange multiplier test for causality in variance. Economics Letters, 93(1), 137-141.

Inclan, C., & Tiao, G. C. (1994, Sep). Use of Cumulative Sums of Squares for Retrospective Detection of Changes of Variance. Journal of the American Statistical Association, 89(427), 913-923.

Sanso, A., Arago, V., & Carrion, J. L. (2004). Testing for changes in the unconditional variance of financial time series. Revista de Economia financiera, 4, 32-53.