UNDERSTANDING NATURAL GAS PRICES: BUBBLES, OIL INDEXATION AND STRUCTURAL CHANGES

Dayong Zhang, Southwestern University of Finance and Economics, +862887092878, dzhang@swufe.edu.cn

Overview

Natural gas price is usually considered to be indexed to the international crude oil prices. Being two potentially substitutable energy sources, the relative value of gas and oil should reflect the differences of their intrinsic heat contents plus any necessary cost of production/transportation. Their prices should not deviate, or at least do not deviate persistently, from their fundamentals, which results in the foundation of oil-indexation hypothesis. The hypothesis, however, has been challenged more regularly in the recent literature.

Bachmeier and Griffin (2006), for example, suggest that oil has an international market, whereas natural gas markets are geographically segmented. Price deviation can persistently exist across markets, for example, the US gas price is persistently lower than it is in the Asian/European markets. Hartley et al. (2008) find that fundamental factors, such as inventories, weather and supply shocks can cause short-term decoupling of the oil-gas equilibrium relationship. Brown and Yucel (2008) also find evidence against the oil-indexation hypothesis. Indeed, the market fundamentals in the international energy market have changed quite significantly in the new century.

The international energy market has witnessed dramatic changes in crude oil and natural gas prices since the 2008 global financial crisis. The shale revolution, in addition, also brought new factors into the market. A regime shift of natural gas pricing mechanism is expected. Bubbles may exist in the market. Oil-indexation, if exists at all, may disappear in the new market conditions. It is therefore necessary to investigate the natural gas pricing mechanism and accommodating possible structural changes. This paper aims to solve the problem with a newly developed time series approach proposed by Phillips et al. (2015), specifically, it is used to test price bubbles and also the oil-indexation hypothesis in the natural gas prices. The results enable us to better understand natural gas pricing mechanism.

Methods

The econometric method is originally proposed by Phillips and Yu (2011) and used to test asset bubbles via a right-tailed unit root test (i.e. the Augmented Dicky Fuller test). Asset price may deviate from its fundamental values and can follow an explosive behaviour (asset bubble). The original idea is to perform rolling windows ADF tests and taking the largest value as the test statistic. Let y_t as the time series variable, r_1 and r_2 are the starting position and ending position of the rolling windows, then the regression model can be written as:

$$\Delta y_t = \hat{c}_{r_1,r_2} + \hat{\beta}_{r_1,r_2} y_{t-1} + \sum_{i=1}^{k} \hat{\phi}^i_{r_1,r_2} \Delta y_{t-i} + \hat{\varepsilon}_t$$

The Phillips and Yu (2011) test statistic is the *sup* of the sequence of ADF test statistics given by this model.

Phillips et al. (2014, 2015) further set up the procedure to test for the existence of multi-bubbles. It is to further extend the basic model by introducing a forward expanding sample sequence, which repeats ADF test regressions on subsamples of the data in a recursive fashion. Asymptotic critical values are given by Phillips et al. (2015) for the aforementioned test.

Results

Monthly Henry hub gas price in the US and the WTI crude oil spot price are used in this paper. The time series data are collected from the EIA. Standard unit root tests show that both series are nonstationary processes. Zivot and Andrews (1992) structural break tests are statistically significant, indicating that both series experience structural changes, though the breaking date differs for oil (2005) and gas (2008). The basic rolling windows right tail ADF test statistic is 2.27 for natural gas price, suggesting the existence of bubble. The largest test statistic for WTI price is 2.34, which also proved that oil price experience bubble entering the new century. GSADF test on multi-bubbles

show that more bubbles exist in the Japanese and European gas markets than that in the US market. The structural break test and bubble detecting procedure are then applied to the oil-gas price ratio (in natural logarithm). The results show that a structural changes in the intercept exist after the end of 2008 but no significant evidence of explosive bubbles were found.

Conclusions

Using Phillips et al. (2015) generalized sup ADF (GSADF) test, this paper investigates whether there are bubbles in the natural gas prices, and then it is applied to the oil-gas price ratio to test for the oil-indexation hypothesis. The results show that bubble exists and the oil indexation hypothesis is rejected. Empirical findings from this paper demonstrate that natural gas pricing mechanism has become more complicated after the 2008 global financial crisis. More frequent happened bubbles in Japan and Europe relative to the US indicates that hub pricing mechanism can help reduce market distortions.

References

Bachmeier, L.J., Griffin, J.M., 2006. Testing for market integration crude oil, coal and natural gas. Energy Journal 27, 55-71.

Brown, S.P., Yücel, M.K., 2008. What drives natural gas prices? The Energy Journal, 45-60.

Hartley, P.R., Medlock III, K.B., Rosthal, J.E., 2008. The relationship of natural gas to oil prices. The Energy Journal, 47-65.

Phillips, P.C.B., and J. Yu, 2011. Dating the Timeline of Financial Bubbles During the Subprime Crisis. Quantitative Economics 2, 455-491.

Phillips, P. C. B., Shi, S., and Yu, J., 2014. Specification sensitivity in right-tailed unit root testing for explosive behaviour. Oxford Bulletin of Economics and Statistics 76, 315-333.

Phillips, P.C.B., Shi, S., and Yu, J., 2015. Testing for Multiple Bubbles: Limit Theory of Dating Algorithms. International Economic Review 56, 1079-1134.

Zivot, Eric and Andrews, Donald, 1992. Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis, Journal of Business & Economic Statistics 10, 251-270.