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When Will Occur the Crude Oil Bubbles?☆

Chi-Wei Su[a,*], Zheng-Zheng Li[a], Hsu-Ling Chang[b], Oana-Ramona Lobonţ[c]

[a] Department of Finance, Ocean University of China, China
[b] Department of Accounting and Information, Ling Tung University, Taiwan
[c] Department of Finance, West University of Timisoara, Timisoara, Romania

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ABSTRACT

In this paper, we apply a recursive unit root test to investigate whether there exist multiple bubbles in crude oil price. The method is best suited for a practical implementation of a time series and delivers a consistent date-stamping strategy for the origination and termination of multiple bubbles. The empirical result indicates that there exist six bubbles during 1986–2016 when the oil price deviate from its intrinsic value based on market fundamentals. Specifically, oil price contains the fundamentals and bubble components. The dates of the bubbles correspond to specific events in the politics and financial markets. The authorities should actively fight speculative bubbles or just observe their evolutions and speculation activities may decrease, which is favour of the stabilisation of the staple commodities including crude oil price. These findings have important economic and policy implications to recognise the cause of bubbles and take corresponding measures to reduce the impact on the real economy cause of the fluctuation of crude oil price.

1. Introduction

This paper examines whether multiple bubbles exist in West Texas Intermediate (WTI) crude oil price using generalised sup Augmented Dickey-Fuller (GSADF) method proposed by Phillips et al. (2013). As a vital commodity, crude oil is proved to be of great importance both in energy and financial markets. In the past decades, international crude oil prices have experienced drastic fluctuations, especially when it occurs wars in Organization of Petroleum Exporting Countries (OPEC) or appreciation/depreciation in United States dollar (USD). Due to the strategic role of crude oil in economic development, the oil price has a negative non-linear effect on economic growth and usually acts as a predictor variable (Kilian,2008; Narayan and Narayan, 2014). The wild fluctuation in crude oil price has brought huge shocks on economic development. Specifically, the oil-importing countries suffer from a significant reduction of purchasing power and endure a significant downward pressure on economic growth (Narayan, 2007; Leung,2010). On the contrary, the oil-exporting countries increase the income (Brook et al., 2004). As a result, crude oil pricing mechanism becomes one major concern, for example, Deesand et al. (2007), Sari et al. (2011) and Coleman (2012). Furthermore, Zhang et al. (2008, 2010, 2011, 2014) study the impact of various drivers on crude oil price volatility.

Since the crude oil price volatility may exert a profound influence on the whole economic condition, it is vital to explore about what drives the value of crude oil price. According to the microeconomics, the supply and demand condition contributes to the crude oil market, which determines the fundamental value of crude oil price. Given the non-renewable fossil fuel reserves, the total production is fixed. On the condition of abundant reserves, oil supply is driven by political events in OPEC. The demand for crude oil is mostly derived from industrial commodities around the world (Kilian,2006). Hamilton (2008) considers that regarding the determinants of demand, the price elasticity of demand appears to be quite low and have decreased. The factors arise from storage arbitrary, financial futures contract, and the role of commodity futures speculation. However, as the financial arbitrary of crude oil has prevailed in the past decade, the role of speculation in the crude oil market has been highlighted, leaving oil price formation more complicated (Kilian,2006). Also, Zhang and Wang (2015) find that the supply-and-demand fundamentals in the crude oil market are difficult to explain the dramatic movement of crude oil price. The US Energy Information Administration (2015) points out that crude oil prices react to a variety of geopolitical, economic events and changes in expectations of economic growth. Hence, the non-fundamental factors (e.g. speculation, geopolitics, USD exchange rate) also contribute to oil price movement (Wang and Wu, 2012; Zhang and Zhang, 2015), which often lead oil prices to deviate from the fundamentals. According to the

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* Correspondence to: Department of Finance, Ocean University of China, 238, Songling Rd., Qingdao, Shandong, China.
E-mail address: cwsu7137@gmail.com (C.-W. Su).

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most widely recognised definition of bubbles, if the asset prices are deviated from the fundamentals, we can say that there exist bubbles (Stiglitz, 1990).

The definitions of asset price bubbles abound in the contemporary economic and financial literature (Blanchard and Watson, 1982; Tirole,1985; Stiglitz, 1990). Although there are no satisfactory definitions for bubbles accepted by the finance and economics communities, a few influential ideas are as follows. For instance, the bubble is an observable economic phenomenon, defined that bubbles are typically associated with dramatic asset price increases followed by a collapse (Brunnermeier, 2016). In the view of the theory of rational expectations, if the investors believe they will be able to sell an asset for a higher price in the future than they had been expecting, the current price of the asset will rise (Stiglitz, 1990). Thus, the reason that the price is high today is investors believe that the selling price will be higher tomorrow. When "fundamental" factors do not seem to justify such a price, a bubble exists. Following Blanchard and Watson (1982), a stochastic financial bubble occurs when speculators purchase a financial asset at a price above its fundamental value in the expectation of a subsequent capital gain. Given the assumption of rational behaviour and expectations, the price of an asset must simply reflect market fundamentals. Also, the price depends on information about current and future returns from this asset. Deviations from this fundamental market value are taken as preliminary evidence of irrationality. When current market price depends partly on the expected rate of market price change, it is possible that the market will launch itself onto a price bubble with the price being driven by arbitrary, self-fulfilling elements in expectations (Flood and Garber, 1980).

Crude oil, not only consumed in daily life but also is an official strategic reserve, has enormous investment value and speculative space. Liu (2007) holds that those factors not regarding the supply or demand of oil market dominate the oil pricing system, which indicates that international crude oil market has stepped into the "speculative bubble era". Eckaus (2008) shows that it cannot make reasonable explanations about the oil price from any current or expected fundamentals, which suggests that there exists speculative bubble in oil price. Sornette et al. (2009) find that the oil price run-ups are amplified by speculative behaviour which shows a bubble-like expansion and the uncertainty in the fundamental data has promoted speculation. Tokic (2010) argues that the oil bubble in 2008 was directly and indirectly created by the Federal Reserve's actions in response to deflationary risks looming after the financial crisis. Besides, Cifarelli and Paladino (2010) claim that the growing presence of financial operators in the oil market has led to the diffusion of trading techniques based on extrapolative expectations and has the potential of leading to considerable movement from the fundamental value of prices. It seems that the role of speculation in the oil market has been confirmed to drive the movement of oil price and its bubbles. Subsequently, Tokic (2011) suggests that institutional investors aiming to diversify their portfolios or hedge inflation can destabilise the interaction among commercial participants and liquidity-providing speculators, which may lead hedgers to positive feedback trading and contribute to the oil bubble. Furthermore, Lammerding et al. (2012) distinguish two distinct phases of bubbles; one is the stable process, and the other is the bubble explodes. They find robust evidence for the existence of speculative bubbles in oil price dynamics based on Markov-regimes technique. All this features point towards the existence of speculative bubbles.

As economic historians have argued, financial crises are often preceded by financial asset bubbles (Ahamed,2009). Since oil is an important input factor of many products, increasing oil prices may cause recessions, bearish stock markets, and inflationary pressure (Kilian,2008). As a result, overshooting oil prices may lead central banks to adjust monetary policy erroneously. Finally, misaligned oil prices may expose market participants to significant financial losses once the bubble bursts (Lammerding et al., 2012). Similar events occur in Norway, Finland and Sweden. While investment and consumption increase significantly, asset price sour accordingly. The collapse in oil prices helps burst the bubble and cause the most severe banking crisis and recession (Allen and Gale, 1999).

To apply the corresponding policy to reduce the disastrous consequence when bubbles burst, it is critical to locate the asset price bubbles. Previous researchers explore kinds of methodologies to test potential bubbles. The literature on the identification of rational bubbles from market fundamentals stems from the Lucas (1978) asset pricing model. Most econometric analyses of bubbles are conducted with the two-step test (West, 1987), the variance bounds test (Shiller, 1981; Leroy and Porter, 1981), the cointegration-based test (Diba and Grossman, 1988), and the intrinsic bubbles test (Froot and Obstfeld, 1991). Diba and Grossman (1988) note that the explosiveness in the gap between the asset price and the fundamental price is sufficient for bubble detection, and the unit root and cointegration tests can be employed as appropriate tools in identifying explosiveness.

However, the evidence on bubbles reported by these studies remains inconclusive, which asks the empirical validity of these techniques into question (Brenner and Kroner, 1995). Evans (1991) argues that unit root tests, applied to the full sample, have little power to detect periodically collapsing bubbles. The low power is attributable to the fact that periodical processes behave as $I(1)$ processes or even stationary linear autoregressive processes when the probability of collapse is non-negligible. Charemza and Deadman, 1995 analyse the possibility of using unit root tests for testing for the presence of multiplicative processes which have a stochastic explosive root. It is shown that such processes encompass a large class of non-negative processes used in the analysis of financial markets, such as the geometric unit root process and the non-negative version of the Diba-Grossman (1988) speculative bubble process. Although the procedure from Hall et al. (1999) offers certain appealing features such as regime probability estimation, recent simulation work by Shi (2011) reveals that the Markov-switching model is susceptible to false detection or spurious explosiveness. In addition, when regime-dependent error variance is allowed, as in Funke et al. (1994) and Van Norden and Vigfusson (1998), distinguishing between periods that may appear spuriously explosive because of high variance and periods with genuinely explosive behaviour by using filtering algorithms is difficult. Zhang and Wang (2015) measure the fundamental price of WTI crude oil and its price bubble with a multivariate regression model and then employs Markov regime-switching model to quantitatively investigate the evolution process of crude oil price bubble. This method needs to measure the fundamental price, however, it is a difficult work to evaluate adequately, and they do not point out the specific location when the bubbles start or end.

The contribution made by this paper to the present literature in the field employs two methods of sup ADF and generalised sup ADF (GSADF) (Phillips et al., 2011, 2012, 2013) to locate possible presence multiple bubbles in WTI crude oil market. Homm and Breitung (2012) indicate that the Phillips et al. (2011) procedure performs satisfactorily compared with the other recursive (as distinct from full sample) procedures for structural breaks, and it is particularly effective as a real-time bubble detection algorithm. On the other hand, the Phillips et al. (2013) method can be applied to data at any frequency. It is a formal statistical test of bubble existence whereas the other approaches rely on the subjective judgment of the deviations from the fundamentals or from the moderate states. This method is more objective for real-time bubble detection for the policy makers. Specifically, Phillips et al. (2011, 2012, 2013) rely on recursive and rolling regressions that are coupled with sequential right-sided unit root tests. Standard unit root test that tests for the alternative stationary hypothesis, which is located on the left-side of the probability distribution of the test statistic. However, the SADF and GSADF to assess hypotheses on the right-side of the probability distributions where the test statistic for an explosive root is located. The advantage of the SADF and GSADF tests