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Modelling the joint dynamics of oil prices and investor fear gauge

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ABSTRACT

This paper investigates the interdependent relationship between WTI returns and the newly published crude oil volatility index (OVX), combining a cross-correlation function approach, a time-varying parameter (TVP) GARCH model, and a multivariate regression analysis, by which the direction, dynamics, magnitude and asymmetry of their relationship are modelled. At the same time, the implied volatility indexes in the stock market and the gold market are considered for comparison. It is found that there is a significant unidirectional causality-in-mean from WTI returns to the OVX changes, while causality-in-variance from the OVX changes to WTI returns is also significant. The contemporaneous relationship between the OVX changes and WTI returns is significantly negative, and their asymmetric relationship implies that OVX has played a greater role as a gauge of investor fear than as risk preference. The time-varying results indicate that the relationship between the changes in OVX and WTI returns is not always negative.

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1. Introduction

The international oil market has become increasingly volatile since the 2000s, owing to the rapid evolution of financialization, unexpected exogenous emergencies and the increased complexity of the market's driving forces. During the 2008 global financial crisis in particular, international oil prices experienced rollercoaster-ride of fluctuation, ranging from $147 per barrel to nearly $30 per barrel. Furthermore, as a result of the Libyan war in 2011, international oil prices soaring by 40% in three months, while in 2014 the global overproduction of oil and slowdown of oil demand led to a fall in international oil prices from $100 per barrel to below $50 per barrel. Price volatility has been paid more attention to model market uncertainty and risk premium. The potential linkage between price returns and its volatility is of importance for asset pricing, portfolio risk management and hedging effectiveness. However, there is still no consensus on whether such a relationship is positive or negative (Fleming et al., 1995; Bollerslev and Zhou, 2006). Especially, little empirical finding is explored in oil

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finance. Therefore, this paper seeks to investigate the dynamic interdependent relationship between oil price returns and its volatility, which can provide new evidences on this controversy.

Volatility is traditionally measured based on historical prices series widely using ARCH/GARCH models, which is ex-post volatilities (Zhou, 2014). These volatilities cannot reflect expectations of future market information. As a necessary complement, implied volatility is developed derived from the option prices to reflect market's expectations on the future volatility over the remaining life of the options (Liu et al., 2013). In 2008, the Chicago Board Options Exchange (CBOE) constructed a new crude oil volatility index (OVX) using implied volatility of United States Oil Fund options. The main advantage of OVX is that it is a market-determined forecast which is similar to the implied volatility index (VIX) in the stock market, whereas other volatility estimators are model-based forecasts (Becker et al., 2009; Wagner and Szimayer, 2004). However, the role of OVX in risk aversion or risk preference has not yet been verified in the literature. This paper tries to answer this issue and present its specific findings in oil futures market.

In general, the literature on the relationship between VIX and stock returns has been widely researched and the conclusion is almost consistent that expected market volatility will rise (fall) when stock prices and returns fall (rise) (Christie, 1982; Fleming et al., 1995). Hatemi-J and Irandoust (2011) apply a bootstrap test with leveraged adjustment to find that volatility causes returns negatively. Sarwar (2012) finds that there is a strong negative and asymmetric contemporaneous relationship between changes in VIX and stock returns in BRIC and the US, suggesting that the VIX is more of a gauge of investor fear than of positive investor sentiment. Tanha and Dempsey (2015) also find the impact on stock market volatility is higher following negative market shocks than following positive shocks of the same magnitude. Kanas (2012) concludes that the VIX carries important forward-looking information, which improves the precision of conditional variance estimation. Fernandes et al. (2014) examine the relationship between the VIX index and the S&P500 index return, finding a strong negative relationship between the two indices. One possible explanation for such a negative correlation between volatility and return is that price decrease could increase portfolio adjustment cost of risk-averse agents than price increase (Glosten et al., 1993).

Although the VIX index has been widely referred to as the benchmark of risk aversion, the judgment cannot be simply applied to OVX. It's because that crude oil options contain more complicated structure due to its diversified traders in futures market, including producers, swap dealers, managed money and so on. However, research on the OVX index has received little attention so far. Liu et al. (2013) investigate the relationship between OVX and other implied indices and find no long-run equilibrium relationship among them. Aboura and Chevallier (2013) find that the inverse leverage effect is the dominant effect driving the WTI crude oil prices from 2007 to 2011. Haugom et al. (2014) examine the information content of the OVX and conclude OVX can help to improve efficiency of volatility forecast. Above literatures provide little information on the risk role of the OVX. This paper fills in this gap and makes several contributions to the literature.

In this paper, the dynamics between the OVX index and oil price returns is investigated to disclose the specific characteristics in oil market. The findings will provide important instructions for practitioners (e.g. investors and financial analysts) as well as theoreticians (academic researchers). The indication of relationship between the OVX and WTI may allow us to improve forecasts of oil prices volatility as well as to improve the portfolio risk management. The aims of this paper are to identify (1) whether the OVX index reacts in the same way to oil price return rises and falls; (2) whether the relationship between the OVX index and oil price returns keep unchanged over time; and (3) whether the OVX index plays a similar role to that of other implied volatility indices.

The contributions of this paper are as follows: (1) the direction, dynamics, magnitude and asymmetry of the relationship between the OVX changes and oil price returns are investigated using a cross-correlation function approach, a time-varying parameter (TVP) GARCH model and a multivariate regression analysis, respectively, which provide further evidence of the role of the OVX index as an indicator of investor fear; and (2) the performance of the OVX index in oil market is compared with the VIX in stock market and the GVZ in gold market, revealing the similarities and differences between commodity market and financial market.

The paper is organized as follows. The introduction is followed by the second section, which introduces our methodology. Section 3 presents summary statistics of data for the oil, stock and gold markets. Section 4 provides the main empirical results of the interdependence relationship between OVX changes and oil price returns. Concluding remarks are offered in the last section.

2. Methodology

In this section, the direction, dynamics, magnitude and asymmetry of the relationship between the OVX changes and oil price returns are modelled by different models. First, compared to traditional Granger-causality tests, the cross-correlation function (CCF) approach proposed by Cheung and Ng (1996) is applied to test the direction of causality both in-mean and in-variance for OVX changes and oil price returns. Second, a TVP GARCH model is constructed to trace how the pattern of co-movement between OVX changes and oil price returns has changed over time. Finally, a multivariate regression is constructed to examine the asymmetric return-implied volatility relationship, in which the role of the OVX as a fear gauge is verified. In addition, as a comparison, a similar framework has been applied to investigate the relationship between the VIX and S&P500 stock returns and between the GVZ and gold returns.

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