How does oil market uncertainty interact with other markets? An empirical analysis of implied volatility index

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ABSTRACT

OVX (Crude oil volatility index), as a measure of oil market uncertainty and new volatility derivatives published by CBOE (Chicago Board Options Exchange) during the 2008 global financial crisis, provides a direct prediction of the market's expectation for future 30-day crude oil price volatility. This paper investigates the short- and long-term cross-market uncertainty transmission implied by OVX and other important volatility indices which are VIX (stock market volatility index), EVZ (euro/dollar exchange rate volatility index) and GVZ (gold price volatility index). The results indicate that there are no strong long-run equilibrium relationships among these volatility indices, which indirectly verify the effectiveness of cross-market volatility portfolio strategy for risk hedge. Furthermore, OVX is significantly influenced by other ones, which indicates that investors' volatility expectation in the oil market become more sensitive to uncertainty shocks from other markets when the global economic situation is extremely unstable. Finally, impacts of interior and exterior uncertainty shocks on OVX are found to be positive and transient. And the significant short-term uncertainty transmission between oil and other major markets has been confirmed.

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1. Introduction

With the acceleration of global market integration and rapid development of information carriers, more traders tend to employ global portfolio strategies and include commodity assets, such as oil and gold, to reduce market risk. Therefore, the financialization of crude oil market has been enhanced since 2000s when the crude oil prices had kept increasing for a long period with active trading activities and large investment fund influx [1]. Moreover, climate mitigations and renewable energy policies also increase uncertainty on oil market development [2–6]. Especially during the 2008 global financial crisis, the crude oil price crashed down violently soaring the investors' uncertainty. To provide a new information source on the crude oil market during those extremely uncertain periods, Chicago Board Options Exchange (CBOE), the largest options marketplace in the U.S. and the creator of listed options, published the first crude oil volatility index (OVX), which measures the market's expectation of 30-day volatility of crude oil prices by applying the well-known CBOE Volatility Index methodology to options on the United States Oil Fund,[1] spanning a wide range of strike prices. In March 2012, CBOE and CFE (CBOE Futures Exchange) launched new investment products based on the OVX: security futures and options on the OVX Index. Therefore, investors could choose to invest these new volatility products in the face with increasing uncertainty in the crude oil market.

After the 2008 global financial crisis, the whole market system becomes more fragile and the cross-market contagion effects have been enhanced due to the global macroeconomic shocks. Obviously, when fundamental factors of the oil market cannot afford sufficient explanations, investors' expectation on future changes will be heavily disturbed by global economic situation as well as exterior information spillovers from other commodity and financial markets. Hence, the oil market participants have become more sensitive to external information and tend to change their trading strategies when they perceive risk changes in other markets. There is an unquestionable fact that the price and volatility transmission between oil and other financial markets have become significant (e.g Refs. [7–12]). There have been many studies investigating the interdependence between oil and other major markets using price series. Malik and Ewing [9] employed bivariate GARCH models and found significant volatility transmission between oil prices and some stock market sectors for US. Arouri et al. [10] took a VAR-GARCH model to examine the extent of volatility transmission

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  [1] The United States Oil Fund is an exchange-traded security designed to track changes in crude oil prices. By holding near-term futures contracts and cash, the performance of the Fund is intended to reflect, as closely as possible, the spot price of West Texas Intermediate light, sweet crude oil, less USO expenses.

between oil and stock markets in Europe and the United States at the sector-level and found significant bidirectional volatility spill-over between oil and sector returns in the United States. Hammoudeh et al. [11] found that the volatility sensitivity of precious metals (gold, silver, platinum and palladium) to exchange rate volatility was strong when oil price shocks were included in the model. Ji and Fan [12] revealed that the crude oil market had significant volatility spillover effects on non-energy commodity markets and that the financial crisis had enhanced the consistency of market price trends. In short, the significant price information spillover effects between oil and other major markets have been verified through the price series.

Unlike the above studies, this paper will investigate the relationship between the newly published OVX and the stock volatility index (VIX),[2] foreign exchange rate volatility index (EVZ) and gold price volatility index (GVZ)[3] instead of using traditional price series. Implied volatility indices derived from option prices which reflect market's expectation on the future volatility over the remaining life of the options are generally considered to be a better measure of market's uncertainty. It is because that implied volatilities not only contain the historical volatility information but also include investors' expectation on future market conditions [16]. As the volatility index measures investors' expectation on future market changes, the linkage among them could to a large extent reflect uncertainty transmission between oil and other underlying markets after the 2008 global financial crisis which has seriously lead to a structural change in the crude oil market (e.g Refs. [12,17]).

Though OVX is a totally new measure in the crude oil market, there have been many studies using volatility indices or implied volatilities to investigate uncertainty transmission among financial markets (e.g Refs. [18–20]). Among others, Peng and Ng [21] showed that the dependence between volatility indices in five popular equity markets was more easily influenced by financial shocks and reflected the instantaneous information faster than the stock market indices. In addition, Sari et al. [22] selected VIX as an indicator of global risk perceptions and uncovered that VIX had a significantly suppressing effect on oil prices in the long run. Qadan and Yagil [23] investigated the causal relationships between the VIX index and the price of gold futures, and found that VIX would move gold prices. These studies suggested that the implied volatilities, as measures of investor sentiment or risk aversion, could be used to examine the cross-market uncertainty linkages and to uncover more information than the historical price series.

However, the newly published crude oil volatility index OVX has some specific features compared to the volatility indices in financial markets. For example, in most cases the stock volatility index VIX tends to increase when stock prices fall [13,24]. Thus it is a skewed measure of volatility which mainly takes into consideration downside risk. However, investors in commodity markets (e.g. oil and gold) can go both long (buy) or short (sell) positions in futures markets and thus a price downside may benefit them financially. It indicates that the impacts of crude oil price changes on OVX tend to be more uncertain. Therefore, analyzing the uncertainty transmission between commodity and financial volatility indices can provide a special perspective to understand the expected volatility mechanism in commodity markets.

This paper explores uncertainty transmission among oil, stock, exchange rate and gold markets using the implied volatility indices OVX, VIX, EVZ and GVZ, and provides a new perspective to understand the volatility linkage between oil and other major markets. Unlike most existing literature which mainly employ ex-post volatility measures based on GARCH models (e.g Refs. [9–12]), our selected implied volatility indices can reflect market's expectation for future near-term volatility and have been popularly considered as a direct measure of market uncertainty (e.g Refs. [18–21]). Specifically, our sample period focused on the recent global financial crisis when the crude oil prices showed large wings and extreme volatility. As the cross-market allocation portfolios including both oil and financial assets have been increasingly popular, understanding expected volatility linkage between them could help investors to hold changes in time-varying market conditions and to timely adjust asset allocations. Therefore, in the context of a weakening internal mechanism and increasing uncertainty in the crude oil market, understanding the cross-market uncertainty transmission between oil and other major markets (e.g. stock, exchange rate and gold) is very helpful for investors and provides a realistic guidance for global portfolio management.

In addition, futures and options on OVX provide new investment benchmarks and can become a new type of financial tool to hedge volatility risk just as those products on VIX[4] in the stock market [25]. Investors in the oil markets can express their attitude on further volatility of crude oil prices through trading futures and options on OVX and gain additional profit opportunity when the crude oil market is shocked by some extreme events which cause large uncertainty, e.g. the recent global financial crisis. Therefore, this study may attract those investors who want to use new financial tools to hedge oil price volatility risk and are potentially interested in futures and option trading on OVX. It's very necessary for them to understand the dynamics between OVX and other major volatility indices since many investors realize that it's better to construct volatility-related portfolio including OVX and other major volatility indices from a perspective of diversifying risk [26].

The remainder of the paper is organized as follows. The following section simply gives an analysis on the volatility indices used in this study. Some econometric methods for investigating cross-market uncertainty transmission are presented in Section 3. The main empirical results are provided in Section 4. At last, Section 5 concludes.

2. Data

To denote market's assessment of expected volatility, the implied volatility indices on oil, stock, exchange rate and gold markets are used in this study. As OVX has just been calculated and published since the middle of 2008 year, the whole sample consists of daily closing prices from 2008/06/03 to 2012/07/20 due to the date availability, and all index series are obtained from the CBOE official website.[5] It's worth noting that the data can only be acquired after the 2008 global financial crisis which leads us to focus on revealing the uncertainty transmission between oil and other major markets during the recent global economic turmoil.

Fig. 1 illustrates the four volatility indices during the sample period. It presents that there are four significant hikes in the OVX during the whole sample period. The first one begins in September 2008 when the bankruptcy of Lehman Brothers triggers the global

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[2] Early since 1993, Chicago Board Options Exchange (CBOE) constructed VIX, which is calculated using implied volatilities of S&P 100 options [13]. In 2003, CBOE calculated a new and more robust VIX using market prices on S&P 500 out-of-the-money options with a model-free method [14].

[3] The CBOE applied the same model-free method to the Exchange Traded Fund (ETF) options and construct the Gold Volatility Index (GVZ) and the EuroCurrecncy Volatility Index (EVZ) in 2008. The corresponding ETFs for GVZ and EVZ are SPDR Gold Shares (GLD) and Currency Shares Euro Trust (FXE), respectively [15].

[4] The average daily volume of VIX futures and options increased largely, from 4169 and 102,560 in 2008 to 47,744 and 388, 845 in 2011, respectively [15].

[5] The underlying options used to construct VIX, OVX, GVZ and EVZ, respectively, are all traded in the CBOE exchange with synchronously closing prices.